FOOD HABITS AND THE APPARENT NATURE AND EXTENT OF DIETARY NUTRITIONAL DEFICIENCIES IN THE PERUVIAN ANDES[1]

Marco A. Ferroni[2]

The Rockefeller Foundation and Instituto Nacional de Investigaciones Agrícolas, México, D.F., México

SUMMARY

Food patterns, and energy and nutrient intake of a sample of rural and urban families in the Peruvian Andes are analyzed and compared with requirements and recommended figures of nutrient allowances. It is concluded that, with the exception of vitamin A, there is very little nutrient deficiency where calorie requirements are met. About half the population in the region suffers from some degree of calorie deficiency in the sense that the total quantity of food available to the family is insufficient to satisfy energy needs of all family members. The incidence of calorie deficiency is about equally distributed between rural and urban areas and there is strong evidence that calorie intake is positively correlated with the proportion of home-produced to total (home-produced and purchased) food.

Modified manuscript received: 30—9—81.

1 An earlier version of this paper was presented under the title "La Alimentación del Campesinado Andino: Mitos y Realidades", at the Catholic University Seminar on Agriculture and Food, Chaclacayo, Peru, October 10-13, 1979.

2 Agricultural Economist, The Rockefeller Foundation and Instituto Nacional de Investigaciones Agrícolas (INIA), de México, Apartado 6-641, México 6, D.F., México.

INTRODUCTION

Two of the most frequently encountered nutrition concepts in Peru (1) and other Latin American countries are that nutritional deficiency is synonymous with protein deficiency and that the nutritional situation is worse in rural than urban areas. The first of these ideas, however, is being challenged increasingly in international literature (2-5). The second is questionable, because (as shown below) rural diets are relatively well balanced nutritionally and because food security in self-provisioning rural areas may be greater than in towns and cities where people's access to food depends on cash income which is typically low and unstable. In accordance with the cited international literature, the first hypothesis examined in this paper is that protein (and other nutrients) deficiency can be traced to insufficient energy intake in Peru. The second hypothesis is that nutritional deficiencies are at least as frequent in urban as in rural areas.

To test these hypotheses, food consumption patterns and their determinants, and dietary nutrient sources in the Peruvian Andes are reviewed. This is followed by an assessment of apparent rural and urban incidence of deficiencies in food energy, protein, and selected vitamins and minerals.

DATA AND METHODS

The analysis draws on 1958 family units from the Central and Southern Sierra (Highlands)[3] of the 1971-72 Peruvian national food consumption and household budget survey (ENCA), where food intake of a year-round sample of 8,000 families was studied by the seven-day weighing method. Families were sub-divided into rural (communities of less than 2,000 inhabitants) and urban residents.

Energy and nutrient content of foods consumed was determined by means of a food composition table.[4] Daily *per capita* in-

---

3 I.e., the Sierra portions of the departments of Huánuco, Pasco, Lima, Junín, Huancavelica (Central Sierra); Ayacucho, Apurímac, Cuzco, Arequipa, Puno, Tacna (Southern Sierra). Sierra portions are delimited by the 2,000 meter altitudinal contour.

4 Contributions by FAO advisors to development of the food composition table are acknowledged.

take was calculated by dividing weekly family-level consumption by a composite family size-meal attendance index. Energy requirements, recommended safe levels of protein intake (RSLPI) and vitamin and mineral allowances, weighted by individual meal attendance, were calculated on the basis of FAO/WHO recommendations with the proposed adjustments for protein quality (7). Minimum and ideal calorie requirements were estimated based on observed and ideal weights, respectively. The conventions adopted —see (8) for justification— 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% of RSLPI. Intake levels between the minimum and the ideal calorie requirement and/or between 60 and 100% of RSLPI are interpreted as pertaining to consumer units "at risk" of nutritional deficiency. For vitamins and minerals "deficiency" is said to occur where observed intake is less than 60% of the allowance.

The statistical properties of the ENCA sample are such that population frequencies of dietary nutritional deficiencies in the early 1970s are closely approximated by the sample frequencies shown below (9). Nevertheless, to gain a dynamic understanding of the apparent incidence and spatial distribution of deficiencies, and to develop practical conclusions for nutrition planning beyond classification of observations according to levels of nutrient intake at a particular point in time, it is necessary to consider the determinants of the latter and their secular variation. These are, family income and —in the highly mobile populations of Latin America— the proportion of home-grown to total food (the subsistence ratio) figure among the main determinants of levels and composition of food intake. Thus, a multidisciplinary approach (i.e., socioeconomic and nutritional analysis) is needed for policy-oriented nutritional status evaluation, here approximated on the basis of dietary data. Examination of the food and nutrient intake effect of income and the subsistence ratio is limited to considerations needed to study the hypothesis regarding the relative incidence of undernutrition in rural and urban areas. The reader is referred to (8) for details of methodology and quantitative results derived from the socioeconomic analysis.

RESULTS AND DISCUSSION

Food Patterns and Nutrient Intake in the Peruvian Andes

The ENCA survey points to far-reaching dietary change (from an array of "traditional" diets to a uniform "modern" diet) in the Andes. Key elements of traditional and largely subsistence-produced diets are potatoes (fresh, or processed into such forms as *chuño* and *papa seca*), barley, maize, quinua, canihua, and beans. Their relative and absolute importance in peasant family calorie budgets varies with ecological conditions and farming practices. Traditional Sierra diets are characterized by a large proportion of starchy staples to total food. Carbohydrates not infrequently account for 75°/o (or more) of energy intake. Diets are high in protein as compared to RSLPI, very low in sugar and fat, and largely vegetarian. Consumption of fruit, eggs and dairy products is infrequent. Apart from the use of dairy products as cash crops, widespread adult lactose intolerance (9) may explain a low level of milk consumption.

The main calorie sources in the modern diet are wheat bread and biscuits, rice, noodles, sugar, and vegetable oil. Soft drinks and sweets are consumed frequently. The modern diet has prevailed in urban areas for many years, but now it is increasingly encountered in the countryside. Causes of this dietary change include the growing monetization of rural life, the decline in subsistence production and consumption, migration, and agricultural policy designed to satisfy market demand for food with imports, industrially processed food, and commodities such as rice and oil seeds produced in agricultural regions other than the Sierra.

Food habits of Peru's rural Southern Sierra population, where 77°/o ingested calories are derived from subsistence production, conform closely to the traditional Andean dietary. Diets consumed in the rural Central Sierra, where the market economy has replaced subsistence farming to a greater degree, feature many "urban" or purchased foods, although not to the same extent as in the case of Sierra urban areas (Table 1). Since mean nutrient requirements for the geographical sample strata are similar (small differences being due to variations in population age/sex distributions), coefficients of nutrient satisfaction (intake divided by allowance) can be used to rank diets according to their nutrient content per calorie unit. Thus, it follows from Table 2 that the "typical" and largely traditional diet of the rural Southern Sierra has

TABLE 1

ENCA: FOOD ITEMS CONTRIBUTING AT LEAST 75% OF CALORIES IN AVERAGE SIERRA DIETS,[a] FOUR GEOGRAPHIC STRATA

Rural Southern Sierra CSR 0.77			Rural Central Sierra CSR 0.59			Urban Southern Sierra CSR 0.22			Urban Central Sierra CSR 0.22		
	A	B		A	B		A	B		A	B
Fresh potatoes	20	93	Fresh potatoes	20	84	Bread	20	16	Bread	17	10
Maize	13	91	Maize	19	91	Fresh potatoes	11	25	Fresh potatoes	15	42
Chuño	10	90	Bread	8	14	Sugar & sweets	11	7	Sugar & sweets	10	8
Barley	11	94	Sugar & sweets	7	11	Rice	9	0	Rice	9	0
Quinua	8	95	Rice	5	0	Veg. oil & fat	8	6	Maize	9	62
Bread	5	20[b]	Noodles	5	6	Noodles	5	1	Veg. oil & fat	7	7
Sugar & sweets	4	9	Wheat grain	5	67	Milk	5	22	Noodles	5	1
Canihua	4	96	Veg. oil & fat	4	8	Chuño	4	64	Barley	2	45
			Dry beans	2	87	Maize	3	58	Milk	3	11

[a] Foods are listed in order of caloric importance.
CSR = Average calorie subsistence ratio, i.e., home-produced calories/total calories.
A = Per cent of total calories.
B = Home-produced fraction of calories from foods under consideration (%).

[b] Subsistence-produced bread is largely maize bread.

TABLE 2

ENCA: AVERAGE DAILY *per capita* INTAKE OF CALORIES AND NUTRIENTS, FOUR GEOGRAPHIC STRATA (SIERRA)[a]

Strata		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		2,255	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	0.77											
TEX	21,595											
Rural Central Sierra		1,938	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	0.59											
TEX	23,294											
Urban Southern Sierra		2,029	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	0.22											
TEX	37,127											
Urban Central Sierra		2,453	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	0.22											
TEX	42,637											

[a] CSR = Average calorie subsistence ratio, i.e., home-produced calories/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% of 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).

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 recorded in ENCA), but provides the lowest level of satisfaction of vitamin A and the lowest fat intake. Ingestion of these two nutrients increases with urbanization.

Apparent nutrient satisfaction, of course, is not only a function of diet composition, but also of food intake level as measured by total calories. These, as well as food choice, depend on socioeconomic variables among which income is usually considered the most important. A significant result for the food and nutrition policy planning in the Peruvian Andes, which emerges from ENCA, is that both total income and the subsistence ratio are positively correlated with total calorie intake. Up to a certain income threshold, the subsistence proportion is the premier determinant of calorie intake. This is documented by Table 2. Caloric intake 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 for other sample strata with higher incomes but lower calorie subsistence ratios. It is surpassed only by caloric intake calculated 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 preferred foods, calorie intake decreases as the proportion of monetary to total (i.e. monetary plus subsistence) income grows. Among other reasons, this is due to the growing need for non-food outlays as people migrate off the farm, as well as to the erosion of purchasing power from food price inflation. The nutritional status of people with income below the identified monetary minimum, therefore, will worsen as they change diets from traditional to modern by rural-urban migration. The reason is that 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, particularly in light of the lower nutrient density of the modern diet.

Apparent Incidence of Nutritional Deficiencies in the Peruvian Andes

Energy and protein

The physiological interaction between food energy and protein 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.

Sierra-wide, 37o/o of families consume less than the minimum allowance of food energy and another 16o/o are classified in the "at risk" category (weighted rural and urban average from Table 3). Although the average coefficients of calorie satisfaction noted in Table 2 are close to 100o/o, about one out of two families appears thus to be 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 members. The urban incidence of energy deficiency (certain and "at risk") is similar to the rural (51 and 54o/o of households, respectively).

Cells 1 and 2 in Table 3 group families with one or more members apparently affected by protein-energy malnutrition. Again, the prevalence of this affliction is similar in urban and rural areas (24 and 28o/o of households). The remaining contingency cells in Table 3 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 allowances. Diets of these households are likely to be poor in such non-protein 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 the Sierra diets that calorie intakes as low as those implied by appearance in cell 3 are compatible with protein intakes exceeding RSLPI (see also cell 6). The data under consideration demonstrate the tendency of protein intake to be nutritionally adequate as energy levels approach the recommended values. Cells 6, 8 and 9, which assemble households without protein deficit and only a change of energy insufficiency (cell 6), contain more than half the rural and urban observations. These frequencies as well as the appropriate marginal totals of Table 3 lend support to the generalization that in the Sierra and for family aggregates (as opposed to individuals), consumption of current diets in amounts that satisfy energy requirements will automatically assure sufficient and in many cases abundant protein levels. The dietary changes occurring in the Sierra do not appear to affect the incidence of

TABLE 3

ENCA: INCIDENCE OF PROTEIN—CALORIE DEFICIT IN RURAL AND URBAN SIERRA, PER CENT OF SAMPLED FAMILIES[a]

A. Rural Sierra

Protein	Calories: Deficit	Calories: At risk	Calories: No deficit	Total
Deficit	9 [1]	- [4]	1 [7]	10
At risk	19 [2]	6 [5]	5 [8]	30
No deficit	10 [3]	10 [6]	40 [9]	60
Total	38	16	46	100

B. Urban Sierra

Protein	Calories: Deficit	Calories: At risk	Calories: No deficit	Total
Deficit	9 [1]	- [4]	- [7]	9
At risk	15 [2]	2 [5]	1 [8]	18
No deficit	12 [3]	13 [6]	48 [9]	73
Total	36	15	49	100

[a] See text for definition and interpretati

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 (references cited above), ENCA 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 mineral and vitamins

The evaluation of dietary adequacy of the so-called micronutrients is 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 protential 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 (11) and on first sight, Table 4 moderately confirms this contention. The apparent incidence of calcium deficiency is estimated at 44 and 38o/o of rural and urban households, respectively. However, the great majority of calcium-deficient families are simultaneously deficient (or at risk of being deficient) in calories. Furthermore, 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 "non-conventional" dietary vectors of calcium, Baker and Mazess (12) conclude that the inhabitants of the rural Southern Sierra (their study population) 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 (13). The data

TABLE 4

ENCA: INCIDENCE OF MINERAL AND VITAMIN DEFICIENCY BY CALORIE ADEQUACY, RURAL AND URBAN SIERRA
(% of sampled families)

Calories	Calcium Rural		Calcium Urban		Iron Rural		Iron Urban		Vit. C Rural		Vit. C Urban		Thiamine Rural		Thiamine Urban	
	D	ND	D	ND	D	ND	D	ND	D	ND	D	ND	D	ND	D	ND
C ≥ 100	8	38	5	45	1	59	1	72	1	44	1	50	—	45	—	50
C < 100	36	18	33	17	5	35	7	20	7	48	2	47	6	49	9	41
Total	44	56	38	62	6	94	8	92	8	92	3	97	6	94	9	91

Calories	Riboflavin				Niacin				Vit. A			
	D	ND	D	ND	D	ND	D	ND	D	ND	D	ND
C ≥ 100	—	45	—	50	—	46	—	50	33	12	14	36
C < 100	16	39	14	36	5	49	9	41	45	10	32	18
Total	16	84	14	86	5	95	9	91	78	22	46	54

a D = deficient; ND = not deficient. See text for definitions and interpretation. C = Per cent index of calorie satisfaction based on "ideal requirement."

in Table 4 were calculated on the assumption of a low 8o/o absorption rate, given that, in the Sierra, the bulk of dietary iron is derived from grains and potatoes.[5] 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.* (11) place the maximum figure at 15o/o. In a study of public health conditions in four Peruvian villages located in various ecological zones, Buck, Sasaki and Anderson (14) do not point to iron deficiency anemia in the high-altitude community they surveyed. Apart from the considerable iron content of Andean diets, this is explained by a low prevalence of parasite (including hookworm) infection in the dry, cold Sierra climate and high intake of ascorbic acid. Brise and Hallberg (15) have shown that this nutrient promotes iron absorption because of its reducing action in the gastrointestinal lumen which delays and in some cases prevents 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 100o/o of satisfaction (Table 4). Even adopting the across-the-board 50o/o loss coefficient suggested by Davidson *et al.* (16) for cases where losses are unknown, it appears safe to assume, in view of the high dietary vitamin C content noted in Table 2, that requirements for this nutrient are largely met. There are indications, furthermore, that losses from potatoes (the main dietary source of ascorbic acid) may not be large in the rural Sierra, at least as derived from cooking practices. The practice of roasting potatoes in makeshift ovens built with hot stones *(watis)*, fairly widespread in the South, the habit of boiling the

5 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 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 (13) 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.

unpeeled potato to a point where its center is still almost raw, and the frequent practice of consuming water in which potatoes were boiled in the form of soup *(chupe)*, appear to contribute significantly to the conservation of vitamin C content of the fresh tuber.

Allowances for the B-complex vitamins, *thiamine, 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 the B-complex vitamins is low (Table 4). The largest deficit recorded is that of riboflavin, not unexpectedly, because of the importance of cereals in Sierra diets. On a unit-calorie basis, cereals are a richer source of thiamine and niacin than riboflavin. The latter nutrient is found in higher concentrations in milk, dairy products and eggs, while meat and leafy vegetables contain more riboflavin than thiamine. But these foods are not consumed in large quantities in rural areas, and their higher average urban consumption tends to be disproportionately accounted for by the rich. Unaware of clinical signs attributable to deficiencies of thiamine and niacin, Collazos *et al.* (11) did diagnose cheilosis and skin abnormalities in several Sierra locations. These lesions, as we know, are associated with riboflavin deficiency, but it is difficult to separate the nutritional effect from the role that high-altitude wind and frost play 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. Deficiency occurs as a consequence of undernutrition and is 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 2, the calculated frequency of *vitamin A* deficiency is large, particularly in rural areas (78 and 46% of rural and urban families, respectively; Table 4). In the rural areas, deficits appear with great frequency in situations of calorie sufficiency, whereas in towns and cities, vitamin A deficiency is more clearly associated with inadequate calorie intake.

Collazos *et al.* (11) 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. Nevertheless, clinical deficiency symptoms, Collazos and co-workers note, are considerably less frequent than might be expected from the low consumption of foods rich in vitamin A activity which they recorded. ENCA, too, reveals unrealistically low levels of retinol intake for many rural families. Seasonality in retinol intake also does not appear to be so marked that high intakes and formation of 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. Considering that (because of the possibility of liver stores) vitamin A deficiency symptoms, however, 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 (17).

CONCLUSION

More often that not, the nutritional deficiencies which affect many of the world's poor are of a quantitative rather than a qualitative nature. The intake of protein and most other nutrients is normaly 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 probably 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 (defined above) 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.

The incidence of calorie deficiency appears to be only marginally higher in rural than urban areas. 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. Undernutrition does occur where people migrate seasonally or permanently to off-farm employment, not sufficiently remunerative to permit nutritionally adequate food consumption. In Peru, and from national population figures, this is the situation of approximately two million families which do not have the identified minimum amount of land and/or which migrate with the expectation of improving their living conditions in an urban area. Given inadequate employment and income possibilities on many individual farms, as well as in urban areas, this figure will grow in absolute terms with population growth. Relative urban prevalence of undernutrition may become greater than rural in the near future as rural emigration, responding to poverty and dissatisfaction in the countryside, accelerates under these economic circumstances, unless appropriate policy and programs are put into action.

Caloric deficiency is corrected by increased staple food consumption, regardless of diet type. This requires income supplementation or re-distribution, although other factors may also have to be manipulated to achieve maximum nutritional effect. In rural areas, special attention should be placed on ways to increase 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 tenuously related to income variables considered. The only potentially successful income policy aimed at reducing the vitamin A deficit is therefore the promotion of horticulture for subsistence consumption. Nutrition education for homemakers on economic foods of high vitamin A content and promotion of demand for vegetables is important. The feasibility of vitamin A fortification of diets should also be assessed. Fortification may be 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 fortification of a centrally processed, widely consumed cheap food such as sugar.

RESUMEN

NATURALEZA Y GRADO DE DEFICIENCIAS NUTRICIONALES EN LOS ANDES PERUANOS

Se analizan los patrones de ingesta de alimentos y nutrientes en una muestra de familias urbanas y rurales de los Andes Peruanos, y se comparan

con los requerimientos establecidos. Se concluye que, con excepción de vitamina A, existe poca deficiencia nutricional en los casos en que se satisfacen los requerimientos calóricos. Cerca de la mitad de la población en la región padece de cierto grado de deficiencia calórica en el sentido de que la cantidad total de alimentos disponibles para la familia, es insuficiente para satisfacer las necesidades energéticas de todos sus miembros.

La incidencia de deficiencia calórica es más o menos la misma en las áreas rurales que en las urbanas, y existe evidencia fuertemente indicativa de que la ingesta calórica está correlacionada positivamente con la proporción de alimentos que se producen a nivel del hogar a alimentos totales (producidos en el hogar más los comprados en el mercado).

ACKNOWLEDGEMENTS

The author appreciates and acknowledges the significant contribution in terms of data preparation and analysis made by J.-P. Cotier of FAO. Additional helpful comments were provided by D. G. Sisler and J. D. Haas, both of Cornell University as well as ALAN reviewers. Of course, none of these individuals bear responsibility for inadequacies which may remain.

BIBLIOGRAPHY

1. Perú, Oficina Nacional de Apoyo Alimentario. **La Asistencia Alimentaria en el Perú.** Lima, Ministerio de Agricultura y Alimentación, 1978.
2. Sukhatme, P. V. Incidence of protein deficiency in relation to different diets in India. **Brit. J. Nutrition, 24**: 2, 1970.
3. Sukhatme, P. V. Protein strategy and agricultural development. **Indian J. Agr. Economics, 27**: 1, 1972.
4. Valverde, V., G. Arroyave & M. Flores. Revisión del aporte calórico y proteínico de las dietas de poblaciones de bajo nivel socio-económico en Centroamérica. **Arch. Latinoamer. Nutr., 4**: 327, 1975.
5. Valverde, V., W. Vargas, I. Rawson, G. Calderón, R. Rosabal & R. Gutiérrez. La deficiencia calórica en preescolares del área rural de Costa Rica. **Arch. Latinoamer. Nutr., 4**: 351, 1975.
6. Waterlow, J. C. & P. R. Payne. The protein gap. **Nature, 258**, 1975.
7. **Energy and Protein Requirements.** Report of a Joint FAO/WHO *ad hoc* Expert Committee, Rome, 22 March-2 April, 1971. Rome, Food and Agriculture Organization of the United Nations, 1973, 20 p. (FAO Nutrition Meetings Report Series No. 52; WHO Technical Report Series No. 522).

8. Ferroni, M. A. **The Urban Bias of Peruvian Food Policy: Consequences and Alternatives.** Ph. D. Thesis. Cornell University, Department of Agricultural Economics, 1980.
9. Ministerio de Agricultura del Perú. **Encuesta Nacional de Consumo de Alimentos. Diseño Muestral.** Lima, Ministerio de Salud, 1960.
10. Paige, D. M., *et al.* Response of lactose-intolerant children tó different lactose levels. **Am. J. Clin. Nutr., 25**: 5, 1972.
11. Collazos, C. C., *et. al.* **La Alimentación y el Estado de Nutrición en el Perú.** Lima, Ministerio de Salud, 1960.
12. Baker, P. T. & R. B. Mazess. Calcium: unusual sources in the highland Peruvian diet. **Science, 142**: 1466, 1965.
13. Moore, C. V. The absorption of iron from foods. In: **Symposia of the Swedish Nutrition Foundation VI.** Uppsala, Sweden, 1968.
14. Buck, A., S. Sasaki & K. Anderson. **Health and Disease in Four Peruvian Villages: Contrasts in Epidemiology.** Baltimore, Johns Hopkins Press, 1968.
15. Brise, H. & L. Hallberg. Effect of ascorbic acid on iron absorption. **Acta Med. Scand.**, 1971. Supplement 376, 1962.
16. Davidson, L. S. R., *et. al.* **Human Nutrition and Dietetics.** 6th ed. New York, Churchill & Livingstone, 1975.
17. Roel, O. A., *et. al.* Carotene balances on boys in Rwanda where vitamin A deficiency is prevalent. **J. Nutrition, 65**: 1, 1958.