SEASONALITY AND NUTRITIONAL STATUS

A Review of Findings from Developed and Developing Countries[1]

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SUMMARY

Studies of seasonality and growth from developed nations demonstrate distinct effects on weight and height gains according to the season. When maximal group gains in height are recorded, minimal weight gains are detected. Only a quarter and a third of all children had their minimal and maximal height gains respectively, in the same period as minimal and maximal group gains occurred.

Manuscrito modificado recibido: 10–2–82.

1 This work was supported by the Agency for International Development (AID), Contract No. 931-17-560-625-73 and by the Ford Foundation of México.

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INCAP Publication I-1249.

Rain and pre-harvest months are usually associated separately with the disease incidence peaks and with lower energy and nutrient intake. In most areas of the developing world, however, rainy months with a higher incidence of diseases coincide with the lean or hungry pre-harvest months. Some communities have devised certain mechanisms which are likely to buffer negative seasonal effects (rainy or pre-harvest months) on health and nutritional status. Thus, either as a result of lower intakes of energy and nutrients and/or less efficient utilization of energy and nutrients, one is likely to find important seasonal effects in poor agricultural communities of developing countries.

The importance of adequate knowledge about seasonal effects to support the better use of existing resources allocated to health and nutrition programs is discussed.

INTRODUCTION

This paper reviews the available information from developed and developing nations on seasonal variations and nutritional status. "Season" is defined as a period of the year determining a given event in the life style of a particular community: winter, summer, harvest, non-harvest. The definition of "nutritional status", particularly malnutrition, is more difficult. A variety of techniques has been used in the last 50 years to assess malnutrition at community and individual levels. These include anthropological non-quantitative studies, food availability studies at the national or community level, evaluation of food consumption and energy and nutrient intakes of families and individuals, energy expenditures, mortality and morbidity rates, cross sectional or longitudinal anthropometry, biochemical tests, and clinical examinations. For the purpose of this paper, nutritional status can be assessed by any of the different types of information mentioned above.

This review describes the type of environment where most studies on seasonality and nutritional status have been conducted, the methods used to assess nutritional status and the definition of seasonality by different authors. It also explores a series of mechanisms that certain individuals and communities have exercised through the years to buffer the detrimental, acute impact of temporary food shortage and/or higher incidence of disease occurring in some periods of the year.

No attempt is made herein to formulate and test hypotheses related to the effect of seasonal factors on health and nutritional status of the study population. Rather, the purpose is to document the diversity of field methods, environments and analytical approaches which have been used and, of course, the most important findings as reported by the authors.

SEASONAL GROWTH IN DEVELOPED COUNTRIES

In 1930 Orr and Clark (1) reviewed 12 studies on seasonal growth conducted in Europe and the United States. Most findings suggested a greater increase in height from March to June, and a minimum height gain during the winter months. Periods of maximum height gain did not correspond to periods of maximum weight gain. The same authors (1) also reported, from their own experiences, that 7- to 11-year-old Scottish children, measured and weighed at quarterly intervals, showed greater height gains during the spring season, March to June, than in any other quarterly period. Height gain was minimal from October to December. During the period of greatest group height gain, around 25o/o of the children lost weight. Nylin *et al.*, quoted by Orr and Clark (1), communicated that in Swedish children the maximal increase in height was observed from March to May, a period also corresponding to minimal weight gain.

Marshall (2) reviewed in 1973 the evidence from studies on seasonal growth in the United States and communicated that American children followed a similar pattern of seasonal growth to that described by Nylin *et al.* as quoted by Orr and Clark (1) for European children.

More recently, Shull *et al.* (3) pointed out that in 23 studies on seasonal variation and growth carried out in developed countries, 15 demonstrated that the periods of greatest growth are the spring and summer months; three reported that it occurred during the winter months, and five claimed that no seasonal variation in growth took place. These authors (3) informed their results on seasonal growth of 51 vegetarian children, 15 to 18 months of age, and concluded that weight gain was minimal during the spring and summer months, and height gain was greater in the summer than in the winter, but not significant ($P > 0.05$). In contrast to most available data, height gain was minimal during the spring, and they attributed the growth pattern to dietary practices of the vegetarian population.

Marshall (4) reported height gains of 260 well-nourished

English children, aged 7 to 10 years, measured every month for a period of 13 months. Slow growth during winter and autumn was observed and greater gains in height during spring and summer were also detected.

Tanner recognized a well-marked seasonal effect on growth velocity in most human growth studies: height gain is fastest in the spring and weight gain is greater in the autumn (5). Weight in the autumn months may be as much as five times greater than that observed in spring.

Gransby (6) and Marshall (4) reported that only a few individual cases followed the seasonal pattern of growth observed in the entire group. The data collected by Bransby in 1941 and 1942 showed that 27 to 29o/o of the children had their lowest increment, and 33 to 36o/o their greatest increment, in the season where the entire group achieved the minimum and maximum growth (6).

Marshall's data were arranged in centiles of growth for periods of three and six months. The author concludes that a gain of three to four cm . per year is normal for periods ending in December or January, but the same value is below the 10th percentile for periods ending in March and June (4).

SEASONAL VARIATIONS AND NUTRITIONAL STATUS IN AFRICAN COUNTRIES

Most of the evidence on seasonal variation and nutritional status available for developing countries is derived from studies conducted in Africa. Some authors have given importance to the differences observed during the rainy and dry periods, while others have stressed the effect of the agricultural cycles: harvest, post-harvest and pre-harvest months.

Fortes and Fortes described the effect of the agricultural cycle on food consumption in a community located in a Sudanic zone of Ghana (7). In April and May food stores were low and rationing began, with June being the peak of the hungry season. In July, people stove off their hunger by cutting ripe millet and groundnuts and pulses were eaten in large amounts. During the post-harvest period, from October to December, large quantities of foods were consumed. In January, rationing of millet began again, becoming gradually more severe in February, March and the following months, until the next harvest. Moody (8) has communicated similar observations from Dagomba villages in Northern Ghana.

African villages which depend mostly on cash crops also have a food consumption pattern influenced by the harvest of their main crop. Satge *et al.*, quoted by Annegers (9), have described an abundance of food resources in a population dedicated to the cultivation of groundnuts for sale during the harvest period, October to December, when there is a cash inflow in the community. Food reserves bought during the harvest of groundnuts last until July and August.

Annegers (9) pointed out that in the Sudanic zones of West Africa, food intake restrictions can occur before the next harvest if the previous one has been poor. McGregor, Billewicz and Thomson (10) also reported that, in an African village of the Gambia, shortages of cereals were noted from May until late July for a period of seven years in the 1950's. Sai (11) communicated that the annual 90-95% of total energy requirements met by people in the savannah in West Africa, can drop to 80% in the pre-harvest period, and to as low as 50% if the previous year provided a poor harvest.

Davey (12) has described patterns of food shortages in different ecological regions of Ghana, based on descriptions and results of surveys of food consumption and energy and nutrient intake conducted in 1962. The northern savannah has an overall lack of food, and the five or six months prior to the harvest of maize are called the hungry months. In this period, children received 60% of their energy requirements and many of them died of marasmus. Shortages of plantain occur in the southwest forest from April to August. Maize is the basic staple in the coastal zone and the product is rationed from April to August, when a national shortage occurs. Very little agriculture takes place in the fishing villages of the coastal zone, and if the two fishing seasons (from June to October and from December to January) are good, the nutritional status of food availability are also good.

Based on dietary observations made in an agricultural village in the Gambia, Fox (13) reported that food availability was related to the agricultural cycle, with plenty of food during the post-harvest season and a lack of it in the pre-harvest or hungry months.

Studies by Rowland *et al.* (14), Rutishauser (15) and a review of family dietary information by Schofield (16) have drawn attention to the effect of the rainy season on food consumption of African populations. Rutishauser (15) reported a higher energy and protein intake in 1- and 3-year-old-Ugandan children from July to September, when food is plentiful, than during the dry period from January to March, when supplies are limited, and during the rainy periods of October to December and April to June. However, in 2-year olds, the reverse is observed. Schofield (16) reported a higher caloric consumption during the dry season than during the wet one in an analysis of dietary information from different African countries. Rowland *et al.* (14) also reported a higher energy consumption in children from the Gambia during the dry season.

McGregor *et al* (10), reviewing the mortality records of children in a village in the Gambia, noted that nearly two-thirds of the deaths occurred during the rainy season, July to October, and a quarter in August alone. Poskitt (17) communicated that the peak of diseases in Ugandan villages occurred during the rainy months and was followed, a month later when harvesting was taking place, by the peak of malnutrition cases at the clinic. At the beginning of the year, when food supplies are short, fewer cases were seen in the clinic. As the peak of measles and malaria occurred in the winter months, he concluded that the precipitation of more cases of malnutrition was the result of disease patterns. Waldmann (18) reported from South Africa a peak of admissions for gastroenteritis during the rainy months, followed by a peak incidence of admissions of children with malnutrition, arriving at the same conclusion as Poskitt(17): that the pattern of disease precipitated the cases of malnutrition. Spalding *et al.* (19) have also notified a peak of admissions of malnourished children during the rainy period in Gambia and Rowland *et al.* (14) a higher number of days of illness and 82o/o of all infant deaths occurring in the same period in the same country.

A series of anthropometric studies, addressing the effect of seasonal variations and nutritional status, are available for African countries. Fox (13) studied weight changes in adults during different periods of the agricultural cycle. From March to May no weight changes were observed, as little agricultural work was done. Weight losses occurred from June to October, as there was an increase of agricultural activities and food supplies were short. Body weight stopped falling and began to rise during the harvest months, and from December to February it continued to rise as a result of increased food supplies and little agricultural work. When the same data were analyzed by wet and dry periods, the following pattern emerged: weight was gained from November to mid-March in the dry season; no change was observed from mid-March to early July, when the rainy season began; and weight was lost during the middle and end of the rainy season, from mid-July until the beginning of November.

The Ghana Nutrition Survey of 1962 also contains information on seasonal variation and changes in adult weights and children's growth (12). In the North, weight declined from January until August and was gained during the harvest until the end of the year. During the hungry months losses were as high as 10 pounds. The same pattern was observed in some villages in the South. In the fishing villages weight loss occurred from November to January, after the fishing season was over.

Hunter, quoted by Annegers (9), states that at the end of the hungry season, 287 adults engaged in agricultural activities in the upper region of Ghana had lost 6.4o/o of the weight gained after the previous harvest. Weight losses of 10o/o or more were detected in 23 women and 21 men.

Children under two years of age, in the northern and forest zones of Ghana (12), had greater weight and height gains from September to February than from March to August. In the coastal zone the greatest weight gain occurred in the middle of the year. These findings were in close agreement with those for adults.

Serre, quoted by Annegers (9), studied children's weight in Upper Volta in 1955 and found no strong seasonal effect in growth, nor important changes in energy intake throughout the year. Slooff (20) found no differences between the wet and dry seasons in the proportion of children under five years of age with a weight-for-age relationship below 80o/o. He suggested that the lack of seasonal effects on nutritional status may be explained by the fact that the community has two harvests per year, and many people generate income from other non-agricultural activities, making them less dependent on seasonal fluctuations.

Marsden and Marsden (21), McGregor *et al.* (22) and Rowland *et al.* (14) have studied growth during the rainy and dry periods. In the first study, 95 Gambian children were followed longitudinally from birth to the age of 18 months. The authors conclude that weight gain was poorer from June to September, as a result of a combination of seasonal effects, especially the rains. As the anthropometric measurements for the seasonal effect on growth were done in two cohorts of children born in different periods of the year, however, it is necessary to control for age of the children when one analyzes weight gained. Furthermore, during this same period, food was scarcer than in any other month of the year.

McGregor *et al.* (22) examined birth weights of 95 Gambian children collected in different months of the year. Although no statistical differences were found, mean birth weights were lower in the rainy than in the dry season. Children's weight gains were estimated for the following periods: a) 15 November to 14 February (dry); b) 15 February to 14 May (dry); c) 15 May to 13 August (rainy); and d) 15 August to 14 November (rainy). Seasonal effects were more obvious at older ages than during the first months of life. Children born in period (b) gained weight well until the end of the first rains (period c). Those born in the early part of the dry season (period a) had a sharp check in growth soon after they entered the rainy season (period c). Weight gains after the first year were good in the dry months, and poor in the rainy ones. The minimal period of weight gain was observed in the last period of the rainy seasons (period d). When the weight gains of the different cohorts were controlled by age, the same pattern of depressed growth in the winter months emerged.

Rowland *et al.* (14) reported that Gambian children have lower weights during the rainy months than during the dry ones. The data are not analyzed for absolute increments, but rather weight values are compared with those of normally growing children from developed countries. Birth weights of children born during the rainy season are also lower than those of children born during the dry months.

Robson (23) explored the effect of seasonal variations on growth, in two studies carried out in well-fed children from distinct genetic stock and living in different environments in Tanganyika. Children 8 to 18 years of age, living in a hot and humid coastal zone and attending a school where meals provided 3,000 calories and 110 g of protein a day, were measured every six months and weighed monthly. Maximal weight gains occurred from October to December and between March and April. Height gains and weight gains were also greater during the last six months than during the first six months of the year. Anthropometry data were also collected in European children attending a boarding school in a cool inland area located at an altitude of 4,500 feet, in Tanganyika (23). Maximal periods of weight gain were detected in the semester from May to October. Thus, it was concluded that seasonal patterns of growth, independent of climate, elevation and race, are observed in well-fed children living in Tanganyika.

SEASONAL VARIATIONS AND NUTRITIONAL STATUS IN OTHER DEVELOPING AREAS

Malina and Himes (24) have observed a greater number of births occurring during the winter season for a period of 27 years in rural Mexico. The authors suggest that the seasonal distribution of births reflects the cultural patterns related to the agricultural cycle.

Anthropological non-quantitative information was collected in communities living in a region of marginal agricultural exploitation (subsistence), a coffee-growing farm, and outside a large cotton plantation in the coastal area of El Salvador in 1976 (25, 26). The seasonal effects of the maize harvest on food availability in the subsistence region, the cotton harvest on availability of labor and food, and the increment produced by the cofeee harvest on family income is described as follows (26):

> *Subsistence agricultural region:* "Diet is subject to seasonal changes. For example, immediately after the first corn comes in, in the middle of August, women prepared corn gruel (atol) in considerable quantities and the families invited friends and neighbors to an 'atolada' where the gruel was consumed along with deep fried corn, patties and other treats for the occasion, in a festive environment. June and July are the more austere months. Many families have by this time consumed all their beans and corn; the families who were fortunate to have theirs last long enough are usually down to their last reserves".

> *Cotton growing region:* "Although there is a seasonal variation in the availability of certain food items, the matter is more quantity than quality. Corn and beans are less obtainable in the months of June, July and August (when the majority of people are out of work and therefore have no income, and before the harvest of corn, when national storages are low)".

> *Coffee growing region:* "These families should receive,

except during harvest time, 52 dollars every two weeks. However, as 'alimentación' is discounted, they received only 32 dollars. During the harvest season, October to January, they earn 60 dollars or more every two weeks and 'alimentación' for all family members who participate in the harvest".

Seasonal patterns of disease are recognized by the communities. In the coastal cotton region, an increase of malaria is observed between May and October, the winter months, with a decline in August when the plantations are fumigated with insecticides to minimize crop damage. In the coffee farms the incidence of diarrhea noticeably increases in May, with the early rains. Chest colds, sore throats, influenza and diarrhea also increase during the harvest, when there is a strong north wind and the farm is crowded with migratory workers, doubling the population of permanent families.

In order to alleviate the detrimental effects of seasonal shortages, the communities have developed a series of mechanisms. In the subsistence region, migration to the coffee and/or cotton plantations during the harvest of those products allows poor families to obtain some cash to buy staple foods during the lean months. Cultivation of seasonal vegetables may also provide cash for lean months. Furthermore, neighbors and relatives usually sell locally-produced staple foods to those with no reserves or cash –on a credit basis– to be paid at the time of the next maize harvest. In the coffee farms, families buy almost all their goods on credit in a local store and pay part of the debt every two weeks, immediately after they are paid by the plantation. Most families have running debts with their local store until the coffee harvest season, when they can afford to pay their previous nine- or ten-month debts.

Rawson and Valverde (27) described the same credit system at local stores in a Costa Rican community engaged in agricultural activities of their own, but heavily dependent on the labor demands, during the harvest period, of surrounding large coffee plantations. Credit was available in the local stores but prices were very high and the variety of goods very limited. Again, the major purchases or cancellation of debts were put off until the coffee season. The authors also concluded that the mother's labor during the coffee harvest may have a detrimental efffect on the nutritional status of preschool children, as they are left home with older siblings who lack the motivation or training to take care of their younger brothers and sisters.

Trowbridge and Newton (28) gathered anthropometric and morbidity information from June 1975 to June 1976 in a series of samples of children from a coastal community severely affected by malaria in El Salvador. Weight for age, height for age, and weight and arm circumference for height indicators were elaborated for different quarters of the year corresponding to seasonal climatic patterns: May-July, the early rainy season; August-October, the late rainy season; and November-January and February-April, the early and late dry seasons, respectively. The highest prevalence of malnutrition, measured by the percentage of children under 90o/o of weight for height, was observed in June 1975 and June 1976, and the lowest in December 1975 and March 1976 ($P < 0.05$). No specific seasonal trends were noted when weight for age and height for age were used. The highest incidence of diarrhea was observed in the May-July quarter, and the lowest from February to April. The incidence of respiratory disease was high in the May-July quarter, but peaked in the August-October quarter. The authors conclude that there is a high prevalence of malnutrition in the early part of the rainy season, closely related to the occurrence of diarrheal diseases, and they pointed out that the period of early rains is also the one of lowest income. They suggest the use of weight for height and arm circumference as anthropometric indicators capable of reflecting short-term changes in the nutritional status of children.

Trowbridge *et al.* (29), using information from the national nutrition surveillance system of El Salvador, showed that the peak of cases with second and third degree malnutrition (Gómez scale), reported from government health clinics, occurred at the initiation of the rainy season and was followed by the peak of reported cases diagnosed clinically as malnourished. More diarrheal events, as judged by clinicial diagnosis data, followed a seasonal pattern related to malnutrition with the peak of the disease being observed prior to the peak of reported cases of second and third degree malnutrition, and just after the initiation of the rainy period. Again, the beginning of the rainy season coincides with the lean period described for populations living in subsistence, cotton and coffee-growing regions (26, 28).

As part of a national evaluation of the sugar enrichment program with vitamin A in Guatemala (30), a series of anthropometric measurements were collected in samples of children from the same rural communities in October-November 1975, April-

May 1976, October-November 1976, April-May 1977 and October-November 1977. October to November is the end of the rainy season, and April to May the end of the dry season. No specific seasonal pattern of malnutrition related to the end of the rainy and dry seasons is observed when data on weight for height, weight for age and height for age are analyzed.

Preliminary information derived from an on-going longitudinal study in 13 coffee farms located in western Guatemala has been analyzed by Valverde (31). Data on trimestral increments of weight and height for children under 24 months of age and semestral increments for children of 24 to 60 months were collected from June 1977 to August 1978, and analyzed separately —to determine the effects of rainy and dry periods and harvest and non-harvest months. The data show no specific pattern across ages of better growth in a given period, rainy, dry, harvest or non-harvest. The author concludes that the existing high levels of growth retardation, produced by a combination of factors interacting throughout the whole year, reduce the probability of finding seasonal variations, as the problem is more chronic than acute. The negative effect on food consumption during periods when cash availability is low, may be reduced due to the following reason. Maize provides around 50% of the adult energy intake, and by itself it is the food with the highest contribution to energy intake in other age groups. The maize needed by farm workers is made available by the farm owner who purchases it twice a year at harvest time, when its cost is lowest, and it is sold every two weeks to the permanent farm workers at this same price, regardless of external price increases due to local or national shortages. Furthermore, during periods of cash shortages, farm administrations usually give interest-free loans to permanent workers. The loan is repaid over a long period of time with installments being deducted from fortnightly salaries. Remaining debts are paid off during the coffee harvest seasons, when families with good coffee pickers may make four times more income than in the non-harvest periods. Furthermore, the same credit system in local stores, already described for El Salvador and Costa Rica also exists, although it is not used as much as in those countries.

Mata (32) found no relationship between the peak incidence of cases of marasmus, the most severe type of protein-energy malnutrition, and seasons of the year in a village located in the highlands of Guatemala. The author concludes that the lack of association is due to generalized poverty in the community, independent of food crops and income. A greater number of children with kwashiorkor, however, were observed during the rainy months, from June to September, when food is not scarce. The peak incidence of edematous protein-energy malnutrition is associated with measles, diarrhea and respiratory infections, as they occur more frequently at the end of the dry, and beginning of the rainy season, just before the peak of edematous cases of protein-energy malnutrition (32).

Standard, Desai and Miall (33) followed a cohort of 229 children from birth to four years of age in an agricultural area of Jamaica. No rainy and dry season differences in growth patterns existed, a finding to be expected in an area where malaria has been eradicated and no marked seasonal climatic differences exist.

Seasonal effects on growth were also studied by Hauck, Thorangkul and Rajatasilpin (34) in 307 children 7 to 14 years of age in Thailand. Weight and height were measured at 3-month intervals from 1952 to 1954. Greater weight gains were detected in the rainy season from May to November. No clear pattern of better growth in height in any season emerged, and the authors concluded that seasonal variations in food supplies, work activity related to the agricultural cycle and occurrence of illness (as drinking water is obtained from canals and fish ponds during the dry season), may account for the observed differences in weight.

Dietary information from rice-growing areas collected during the national nutrition survey conducted in Bangladesh in 1975 and 1976 (35), indicated a higher energy intake, following the rice harvest. Lower intake values were obtained in the lean months preceding the harvest that begins in October.

Studies on food consumption and energy and nutrient intake, in different periods of the year, have been carried out by Rao *et al.* (36) in families, and by Sundaraj *et al.* (37) in children, from the North Arcot District of India. Frequency of consumption of different foods was related to seasonal availability as a result of the harvest periods. The mean calorie intake was 1,856 from January to March; 1,576, the lowest, from April to June; 1,727 from July to September; and 1,702 from October to December. The statistical significance of these differences is not given by the authors (37). Sundaraj *et al.* (37) pointed out that children's diets were subject to seasonal availability of foods, but differences in energy intake, corrected by kilogram of body weight, are not significant ($P > 0.05$). Nevertheless, the higher mean energy intake was observed, as opposed to Rao *et al.*'s (36) findings, from April to

June, the hot season, and secondly in the rainy period of October to December.

In Punjab, India, Kielmann and McCord (38) studied seasonal effects on mortality in 3,000 children, age 1 to 36 months, with different levels of nutritional status. The mortality risk was five times higher from January to June than from July to December in children with weights below 70o/o of the Harvard median. However, the death risk is independent of season in children with weights above 80o/o of the standard. Food is scarce in the preharvest months of January to March, and although the wheat harvest from late March to mid-May provides food, adults and older children spend the entire day in the field, leaving infants and toddlers with siblings who are only a few years older. A peak incidence of diarrhea, high temperatures and cases of dehydration are recorded during the harvest season. As no differences in environmental sanitation are found among families with well and undernourished children, the authors suggest that in the former group, good nutrition protects them from seasonal attacks of diarrhea and other diseases.

Seasonal data on weight of 205 mothers and 37 children between 13 and 23 months, collected monthly in Bangladesh in 1976 and 1977, have been reported by Alauddin Choudbury (39). Maternal weight remained stable during the first six months of the year, but the figure obtained in July dropped by 5o/o in the lean month of September. After the harvest, in November, weight began to rise again.

CONCLUSIONS

The evidence of anthropometric studies, conducted in developed countries, most of them with a sound methodology and analytic approach, demonstrated that the winter, spring, summer and autumn months have distincst effects on height and weight gains. When maximal gains in height are observed, minimal weight gains are also detected. When the growth curves of individual children are analyzed, only a quarter of them have their smallest, and a third the greatest, increment in height when the minimal and maximal increments are observed for that variable in the entire group of the children studied.

The validity of some methods devised to assess nutritional status in developing countries may be open to question. The lack of quantitative data to evaluate observers' bias, makes descriptive studies somewhat unattractive to those engaged in quantitative types of research. The method is useful, however, for identifying events and processes which determine malnutrition and deprivation, and for describing the mechanisms that communities have developed in order to minimize the effects of environmental hazards.

Reliability and validity of dietary surveys are low when one looks at individual intakes, but response biases seem to cancel each other out when analyses are conducted for population groups. Serious gaps still exist in our knowledge of energy and nutrient needs for populations and individuals in developing countries. Furthermore, measurements of intake need to be related to those of expenditure, in order to make minimal reasonable assumptions of dietary adequacy. Nevertheless, analyses of frequency of consumption, particularly of staple foods, can provide useful information regarding availability of foods at the community and family level in different periods of the year.

Between-observer and within-observer errors, as well as those in equipment, registration of results and procedures of data editing, may mask true seasonal differences in anthropometric indexes, particularly when one deals with small samples for increments in a given period and if the impact of the seasonal effect is not very large. Analytic approaches relating absolute values of weight and height of children, obtained in distinct seasons, to a set of weight and height data from children of developed nations, do not necessarily reflect the effect of the periods when measurements were obtained. Periodic exercises to standardize observers, calibration of equipment and other procedures of quality control minimize measurement error. The use of children's weight and height increments during different periods of the year, derived from longitudinal studies, weight for height in cross-sectional studies, and changes of adults' weights (40), can be very illustrative of seasonal variations in children's growth and nutritional status of adults.

Some estudies have addressed the impact of the rainy and dry seasons on health and nutritional status, while others have stressed the effect of periods related to the agricultural cycle. Periods of rain, and lean months –previous to the harvest of the main staple or cash crops– are usually associated separately with peaks of higher incidence of different diseases and low energy and nutrient intakes, respectively. In areas of the world where studies on seasonal variations and nutritional status have been conducted, however, the rainy months –where the peak incidence of diseases is found– coincide with the lean or hungry pre-harvest months. To elucidate the relative importance of rainy and lean months on nutritional status in developing countries is only of academic interest, and requires a well-controlled longitudinal study the major findings of which may not be extrapolated, even to other regions and population groups within a given country.

In assessing seasonal variations on nutritional status, one must be careful to discern the impact of negative effects at the community, family and individual levels, as well as in adults and children. In the absence of noticeable effects for population groups, one must try to identify sub-sets of high-risk families. On the other hand, it is important to understand how some communities and families have succeeded in "buffering" acute negative effects, spreading the detrimental impact chronically over longer periods of time. Thus, critical periods identified for communities and certain families within a population group may not be reflected, as a result of community and family interactions, in indicators of nutritional status of individuals, i.e, minimal height increments in children and weight losses in adults.

Most communities studied in Africa, Asia, Latin America, and the Caribbean share common problems of deprivation, and rely, for survival, on specific events such as a good fishing season, adequate harvest of staple or cash crops, and labor demand from large cotton and coffee plantations. Data identifying lean periods in distinct regions and population categories within a country, the peak incidence of diseases, factors conditioning seasonal effects and mechanisms developed by communities to minimize detrimental effects on health and nutrition, are necessary in order to design interventions aimed at reducing negative seasonal effects.

Nutritionists in developing nations are confronted with the problem that most of their suggestions to reduce effectively nutritional deficiencies are likely to be taken by politicians as "the single" program to combat malnutrition. This is particularly true when the suggested actions do not entail critical political decisions nor an increase of existing budgets allocated to social problems. While a better understanding of seasonal impacts on health and nutrition can contribute to design more effectively and less costly programs, the approach should not be understood as the solution to overcome malnutrition. One must bear in mind that malnutrition is generally the result of chronically deprived living conditions and that practical measures to reduce effectively the magnitude of the nutrition problem are those designed to reduce the number of families and individuals living in poverty. Thus, seasonal effects should be considered when programs aimed at combating the nature of poverty and malnutrition are designed.

RESUMEN

RELACION ENTRE EL ESTADO NUTRICIONAL Y LAS ESTACIONES DEL AÑO

Una revisión de los hallazgos de estudios realizados en países desarrollados y en vías de desarrollo

Estudios llevados a cabo en países en vías de desarrollo sobre la relación existente entre factores estacionales y crecimiento físico, señalan un impacto distinto en el peso y en la talla según los períodos del año. Cuando se registran las ganancias mayores en talla, ocurren las ganancias menores en peso. Sólo de una tercera a cuarta parte de todos los niños tienen una ganancia mínima y máxima en talla, respectivamente, en el mismo período en que ocurren *las ganancias mínimas y máximas de todo el grupo.* La lluvia y los meses que anteceden a las cosechas se asocian con el pico máximo de incidencia de enfermedades y de menor ingesta energética y de nutrientes. No obstante, en la mayor parte de los países en vías de desarrollo, los meses de lluvia, con mayor incidencia de enfermedades, coinciden con los meses anteriores a la cosecha, en los cuales hay escasez de alimentos. Algunas comunidades han identificado ciertos mecanismos que reducen los efectos estacionales negativos (períodos lluviosos o que anteceden a las cosechas) en el estado de salud y nutrición. Se discute la importancia de un conocimiento adecuado de los efectos estacionales para apoyar el uso más eficiente de los recursos que en la actualidad se asignan a programas de salud y nutrición. Por lo tanto, ya sea como resultado de ingestas menores de energía y nutrientes y/o de menos utilización eficiente, es probable que se encuentren efectos estacionales importantes en comunidades agrícolas pobres de países en vías de desarrollo.

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