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DIARRHEAL DISEASES, NUTRITIONAL STATUS AND HEALTH CARE: ANALYSES OF THEIR INTERRELATIONSHIPS

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The relationship between diarrheal diseases, nutritional status and health care has been studied prospectively in a group of Guatemalan Indian children below two years of age. From the data it was concluded that acute and chronic malnutrition is positively associated with the incidence and duration of gastrointestinal disorders, and that the negative nutritional consequences of diarrhea are more significant in malnourished children than in well-nourished ones. A positive effect of a simplified health care program on the nutritional status of children suffering gastrointestinal disorders was also found.

KEY WORDS: diarrhea, nutritional status, simplified health care, oral rehydration, impact evaluation.

INTRODUCTION

The existence of interactions between children's nutritional status and morbidity, particularly gastrointestinal disorders, has long been reported in the medical literature (Scrimshaw, Taylor and Gordon, 1968; Mata, 1978). Recent publications by Tomkins (1981) and Trowbridge, Newton and Campbell (1981), and those of Rowland, Cole and Whitehead (1977) and Martorell *et al.* (1975, 1980) have also contributed to the understanding of the interrelationships between diarrheal diseases and nutritional status. In addition, papers presented at the Symposium on Effective Interventions to Reduce Infection in Malnourished Populations, held in Port-au-Prince, Haiti, in 1977 focused on the adverse effect of diarrheal disease on nutritional status and on the impact of practical interventions to improve the nutritional status of the population and/or control infectious diseases (Keusch and Katz, 1978).

This paper analyzes data on malnourished Guatemalan Indian children to further explore the interrelationships of diarrheal diseases and malnutrition, and to measure the nutritional impact of a simplified health care program implemented in the study population.

METHODS

The data come from the Patulul Project, a nutritional intervention study carried out by the Division of Human Development of the Institute of Nutrition of Central America and Panama (INCAP). The study population consisted of malnourished Indian families working and living in 12 coffee plantations of the Pacific lowlands of Guatemala, near the town of Patulul, where INCAP field headquarters were located. The total population was estimated at 7000 inhabitants for the year 1977. Home environments and socioeconomic conditions are very homogeneous in these plantations. All heads of household are agricultural workers who receive the legal minimum wage and all houses belong to the plantations and are very similar to one another. Analyses of drinking water in all plantations at the beginning of the project revealed serious contamination, particularly with coliforms from fecal origin. Latrines were not available; people defecated in open fields near their houses.

According to the information obtained from pregnancy history for the period 1970–1975, infant mortality was approximately 160 per thousand live births. Based on census data, preschool mortality

(1–4 years) was calculated as 36 per thousand for the period 1970–1975, and the crude birth rate as 49.6 per thousand. Cross-sectional anthropometric data collected in 1976–1977 regarding children 0–60 months of age demonstrate that this area has one of the highest prevalences of growth retardation in Guatemala: the proportion of children with second and third degrees of malnutrition according to Gómez *et al.* (1956) (below 75 percent of weight-for-age) was 49.6 percent. Cross-sectional morbidity information (15-day recall) indicated that running nose, cough, diarrhea, anorexia and fever had a prevalence greater than 20 percent in children 0–24 months of age.

The subjects of this report are a sample of children between 0 and 24 months of age who participated in a longitudinal study of health and nutrition during the 12-month period from October, 1977 to September, 1978. During this period, morbidity data was collected prospectively (Division of Human Development, INCAP, 1977). Child morbidity information was obtained through fortnightly surveys. The surveys was symptom-oriented and utilized retrospective home interviews of mothers or children's caretakers. Regarding diarrheal diseases, the morbidity surveyors, following standardized methods, asked the mother about the frequency, consistency and other characteristics of the stools; an increment in the frequency and/or a modification in the consistency of the stools was considered diarrhea. These surveyors were periodically rotated between plantations in order to reduce the possibility of observer bias. Infant anthropometry was obtained at birth and every three months thereafter up to 24 months of age. These variables were measured with high reliability and following standardized procedures.

As part of this program, a simplified health care program became available to the population in each plantation (Delgado *et al.*, 1980). This was a complete innovation since there were no health services nor health personnel in residence in the plantations prior to 1977. The simplified health care program implemented maximized the utilization of paramedical personnel and the appropriate technology. The auxiliary personnel, that is, auxiliary nurses and health promoters, were trained to take clinical histories, to conduct simple physical examinations and to diagnose and treat the most common diseases in the plantations. In addition, auxiliary personnel were responsible for the delivery of preventive care and the promotion of maternal, infant, and child health care activities. Regarding gastrointestinal tract disorders, the auxiliary personnal were trained to record the patient's history, symptoms, signs and the treatment recommended for simple diarrheas and diarrheal episodes with blood and mucus in the stools, characteristic of amebic dysentery, shigellosis and some other viral gastroenteritis. In all cases, treatment was aimed at replacement of fluid and electroytes through oral rehydration, and at the relief of symptoms. Based on clinical impressions, amebic dysentery or shigellosis were treated with hydroxyquinoline or antibiotics. In addition to the provision of health services, information related to the provision of health services, information related to health activities and data on children's visits to the clinic and causes of the visit were recorded. The personnel delivering the health services were also responsible for obtaining the anthropometric information. However, they had not access to past anthropometric and morbidity data of the children at the time of their visits to the clinics. This reduced the possibility that observer bias would put into a more positive light the benefits of the health interventions.

The climate in the zone influences the prevalence of disease and visits to the clinics. Therefore, the year during which data were collected was divided into four quarters as follows: October-December, representing the dry season; April-June, representing the rainy season; and January-March and July-September as trimesters of transition. Therefore, the subjects of analyses were those children 0–24 months of age (cohort of those born between January, 1976, and July, 1978) whose weight and height were measured at the beginning of each quarter (October, January, April and July) and who were subsequently measured after a three-month period.

RESULTS

Descriptive statistics for some characteristics of the study population are presented in Table 1. The high percentage of cases with global (weight-for-age), chronic (length-for-age) and acute (weight-for-length) malnutrition (Waterlow *et al.*, 1977), as well as the number of episodes and percent of time ill with simple diarrhea and diarrhea with blood and mucus, per trimester, are indicative of the magnitude of the nutritional and health problems in the area. The number of visits to the clinic for

TABLE I

Selected anthropometric measurements and diarrhea experience of a sample of Guatemalan infants at intervals of three months.

Infant characteristics	Trimesters Oct–Dec	Jan–Mar	Apr–Jun	Jul–Sept
Number of cases	143	246	289	261
Weight-for-age (≤75%) (percent)	33.8	37.1	32.9	33.3
Length-for-age (≤90%) (percent)	54.6	51.6	48.1	52.1
Weight-for-length (≤90%) (percent)	17.7	21.0	15.0	15.9
Simple diarrhea				
Cumulative incidence (mean number of episodes)	1.20	0.93	1.12	0.73
Mean percent time ill	10.85	9.01	17.00	12.96
Diarrhea with blood and mucus				
Cumulative incidence (mean number of episodes)	0.14	0.09	0.28	0.09
Mean percent time ill	0.99	0.96	3.02	2.12
Mean number of visits to the clinic for gastrointestinal disorders	0.73	0.55	0.42	0.40

gastrointestinal disorders, per trimester, are also presented in Table I. It can be seen that the highest proportion of illness episodes and percent time ill occurs during the April and June trimester, the rainy season. In addition, the number of episodes and time ill with diarrhea with blood and mucus are much lower than that of simple diarrhea. Also, the number of visits to the clinic for gastrointestinal disorders does not follow the curve obtained for the gastrointestinal symptom episodes. For example, the number of clinic visits declines steadily across the four trimesters, whereas diarrhea with blood and mucus is most frequent during April-June.

It was found that the number of visits to the clinic was higher than the mean number of episodes of diarrhea with blood and mucus. From these data, it would be tempting to conclude that the clinics look after patients having the more severe diseases, such as the cases of diarrhea with blood and mucus. Unfortunately, this is not the case. Based on individual morbidity data collected at the home level and on visits to the clinic, the conditional probabilities of visiting the clinic, given a gastrointestinal disorder, were calculated. The values of these are higher for the more severe symptoms of disease (diarrhea with blood and mucus) than for the more common symptoms (simple diarrhea); however, all conditional probabilities are below 50 percent. Although there were no sex differences in diarrheal illness rate, the conditional probability of visiting the clinic, given the existence of diarrhea or diarrhea with blood and mucus, is higher for boys than for girls (40.9 percent and 46.3 percent for boys, and 34.2 percent and 37.5 percent for girls, respectively).

Table II presents the average trimestral cumulative incidence and the duration of diarrhea, and diarrhea with blood and mucus, according to three different indicators of nutritional status; it also compares the results of those who were malnourished with those who were well nourished. The data for the three months' rainy season are also shown in Table II. The cumulative incidence and the percent time ill with diarrhea with blood and mucus is consistently higher in the malnourished children than in the well-nourished counterparts. Although the differences in means between well-nourished and malnourished groups are small, t-tests indicate that several of the comparisons are statistically significant. Also, the magnitude of the differences between nutritional groups was higher in the data collected during the rainy season than in the data from annual averages.

Finally, the effects of morbidity and health services on the nutritional status of these children are examined in Table III. For these analyses, the dependent variable was the trimestral weight-for-age changes in children below 24 months of age,

TABLE II

Cumulative incidence and percentage of time ill with diarrhea and diarrhea with blood and mucus in relation to the nutritional status of a sample of Guatemalan infants

Nutritional status	Number of children	Simple diarrhea trimestral cumulative incidence per child	Time with simple diarrhea (%)	Diarrhea with blood and mucus cumulative incidence per child	Time with diarrhea with blood and mucus (%)
Weight-for-age					
≤75%	321 (95)	1.01 (1.30)	12.7 (18.9)	0.20 (0.39)	2.4 (3.8)
>75%	616 (194)	0.96 (1.04)*	12.9 (16.0)	0.14*(0.23)*	1.6 (2.6)
Length-for-age					
≤90%	469 (139)	1.04 (1.18)	12.9 (19.1)	0.17 (0.31)	2.3 (4.1)
>90%	470 (159)	0.91*(1.07)	12.7 (15.0)*	0.14 (0.25)	1.6 (2.1)*
Weight-for-length					
≤90%	152 (40)	1.02 (1.53)	13.2 (23.1)	0.18 (0.48)	2.0 (4.1)
>90%	727 (226)	1.00 (1.11)*	13.1 (16.2)*	0.16 (0.26)*	1.9 (2.8)

In parenthesis, information for the three-month rainy season.
*t-test between malnourished and well-nourished children, $p < 0.05$.

and the independent variables were the presence or absence of gastrointestinal illness episodes in each trimester of the year (simple diarrhea and diarrhea with blood and mucus), and the demand for services for gastrointestinal disorders in the same trimester. In addition, the analyses were performed for two categories of weight-for-age: less than or equal to 75 percent and more than 75 percent adequacy.

The reason for the above is that a greater subsequent increment in weight-for-age is expected in those children with a lower initial attained value of weight-for-age than for those with higher initial attained weight-for-age values. This phenomenon

TABLE III

Trimestral weight-for-age percent changes in Guatemalan children 0–24 months of age in different categories of initial percentages of weight-for-age, gastrointestinal disorders and utilization of health services during the trimester

IIIa Weight-for-age ≤75%* at the beginning of trimester

	Gastrointestinal disorders		
	Absent	Simple diarrhea	Diarrhea with blood and mucus
Total	4.74 ± 1.14 (51)[b]	1.03 ± 0.62 (104)	0.18 ± 1.18 (37)
No utilization of services		0.94 ± 0.76 (61)	—0.95 ± 1.64 (21)
Utilization of services		1.16 ± 0.50 (43)	1.65 ± 1.67 (16)

IIIb Weight-for-age > 75% at the beginning of trimester

	Gastrointestinal disorders		
	Absent	Simple diarrhea	Diarrhea with blood and mucus
Total	−3.25 ± 0.78 (148)[b]	—3.46 ± 0.59 (220)	—4.21 ± 1.21 (51)
No utilization of services		—4.12 ± 0.73 (135)	—4.09 ± 1.81 (30)
Utilization of services		—2.40 ± 1.00 (85)	—4.38 ± 1.44 (21)

*Degree II and III of Gómez classification.
[b]Mean ± standard error of the mean; in parenthesis, number of cases.

has been described by Standard, Desai and Miall (1969) in rural Jamaican children, and more recently by us (Delgado *et al.*, in press) in non-Indian Guatemalan children.

Table III presents the effects of gastrointestinal illness episodes (diarrhea and diarrhea with blood and mucus) and visits to the clinic for gastrointestinal disorders on trimestral weight-for-age changes. As shown in Table IIIa, children with initially low weight-for-age (≤75 percent) and with diarrhea during the trimester gained considerably less weight-for-age than children without diarrhea during the trimester. Furthermore, children with diarrhea who visit the health post gain more weight-for-age than those with diarrhea who do not demand health post services. The effects of diarrhea with blood and mucus on trimestral weight-for-age changes and those of the health services are also present. On the other hand, as shown in Table IIIb, children with initial high weight-for-age (>75 percent) and with diarrhea or diarrhea with blood and mucus lose more weight-for-age than those without diarrhea. In this category, those demanding health services because of simple diarrhea also lose less weight-for-age than those who do not visit the clinic. No effects were detected regarding health services on the weight-for-age changes in children suffering from diarrhea with blood and mucus. Similar results were obtained when length-for-age and weight-for-length were used as indicators of nutritional status.

Our data suggest that diarrhea and diarrhea with blood and mucus and the utilization of health services affect the nutritional status of well-nourished children to a lesser degree than that of malnourished children at the beginning of the trimester. Similar trends emerged when trimestral length-for-age and weight-for-length changes per categories of initial length-for-age and weight-for-length were studied.

While this paper is not addressing the capability of undernourished children to have more accelerated periods of growth (catch-up-growth), Tables IIIa and IIIb clearly indicate that this phenomenon occurred in the cohort of children described in this study.

DISCUSSION

Diarrheal diseases and malnutrition are the leading causes of death of malnourished infants and children and a frequent cause for demand of health services in most developing countries. In the Patulul Project, gastrointestinal disorders represented 41 percent of all children's visits (0 to 5 years of age) during the first 24 months of the project. This study shows that malnutrition, either acute, chronic or global, is positively associated with the incidence and duration of simple diarrhea and diarrhea with blood and mucus, particularly during the rainy season. The results also support the hypothesis that the negative nutritional consequences of diarrhea are more significant in the malnourished children than in the well-nourished counterparts. Finally, positive effects of the health services were noted especially in the malnourished group.

On the other hand, data on the demand for services indicate that less than 50 percent of the children suffering either simple diarrhea or diarrhea with blood and mucus actually attend the health post. Different factors could affect the utilization of health services, one of them being the sex of the children. A similar sex-based health related behavior has been reported in rural Bangladesh (Chen, Huq and D'Souza, 1981). These results and those reflecting the benefits derived from the health services, especially in the malnourished groups, support the need for the integration of educational activities with the provision of services in simplified health care programs.

Based on these and other results, the Patulul Project was further simplified to include household visits by health promoters and health educational activities. The abrupt termination of the project due to funding problems in 1979 made it impossible to measure the effects of health education activities and related nutritional interventions on the incidence of diarrheal diseases and the nutritional status of children in this population.

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