# Country study

## The evolution of diarrhoeal diseases and malnutrition in Costa Rica

### The role of interventions

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*Costa Rica has an infant mortality rate of 17.7‰, one of the lowest for developing countries. Two unusual factors have contributed to this achievement: on the one hand, Costa Rica has no army and a significant portion of the budget is invested in socio-economic development (particularly in education and health), and on the other hand, there has been a political will to reduce infant mortality.*

*Some of the interventions adopted in this aim have been:*

- *improvements in the maternal environment (education, status, and health);*
- *the extension of water supply and waste disposal systems;*
- *the provision of health education throughout the country;*
- *the launching of a rural community health programme, including immunization;*

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- *the use of oral rehydration therapy in the hospitals and the free distribution of oral rehydration salts in some municipalities;*
- *and the adoption of hospital practices conducive to breast-feeding.*

*In setting its priorities for the future, Leonardo Mata concludes that Costa Rica must emphasize those actions aimed at an even better coverage of pregnant women, an even more effective family planning, and a sustained effort to prevent infectious diseases.*

Like most developing nations, Costa Rica exhibited a very high morbidity and mortality attributable to diarrhoeal diseases during the first half of this century. Relatively good data on total population and on diarrhoea deaths are available from 1925 onwards.[1] San José, the capital city, had a population of about 25 000 at the turn of the century and an estimated mortality from all causes of 41 per 1000 population; the city was described as one of the filthiest in the world.[2] The diarrhoeal disease death rate for 1900 was 239 per 100 000, likely an underestimate, and clinical descriptions in the records of the San Juan de Dios Hospital indicate that most fatal cases were due to dysentery and cholera-like syndromes. The diarrhoeal disease mortality and infant mortality rates in Costa Rica progressively declined from very high rates during the first quarter of the century, to very low figures in the 1970s (Table 1). Rates in the 1930s are comparable to figures in contemporary parts of Asia and Africa, where poverty and malnutrition are still highly prevalent.

The graphical display of diarrhoeal disease mortality and infant mortality rates during the stated period (Fig. 1) reveals a remarkable yearly correspondence of their peaks, falls, and plateaus. This correlation was noted for both the neonatal and the postneonatal infant mortalities throughout the entire observation period up until 1968, but after this date the fall in diarrhoea deaths was not matched by a fall in neonatal deaths. From 1926 through 1942 the diarrhoeal disease death rate did not show an overt decline, but a decrease was clear during

1942-1948, coinciding with a period of social and economic reforms: labour laws, minimum wages, paid vacations, social security, founding of the University, improvement of water supplies, building of roads, etc. This period was interrupted by a civil war that generated social disruption, a certain exodus of people from the country, migration from rural to urban centers, a population explosion, and the adoption of bottle feeding by a significant portion of the population.

**TABLE 1**

**Infant mortality (per 1000 live births) and diarrhoeal disease mortality (per 100 000) in Costa Rica, 1926-1981**

| Selected years | Infant mortality | | Diarrhoea mortality (codes 008, 009) |
|---|---|---|---|
| | Neonatal | Total | |
| 1926 | 59.9 | 215.0 | 324.9 |
| 1930 | 43.6 | 160.2 | 327.1 |
| 1935 | 35.6 | 156.9 | 417.0 |
| 1940 | 31.5 | 132.4 | 282.5 |
| 1945 | 27.4 | 110.1 | 237.9 |
| 1950 | 26.1 | 90.1 | 143.4 |
| 1955 | 25.2 | 82.0 | 156.1 |
| 1960 | 23.3 | 68.6 | 124.5 |
| 1965 | 27.2 | 76.0 | 109.3 |
| 1970 | 25.2 | 61.5 | 69.6 |
| 1975 | 17.7 | 37.1 | 27.2 |
| 1980 | 11.2 | 19.1 | 7.4 |
| 1981 | 10.1 | 17.7 | 7.5 |

Source: General Directorate of Statistics and Census, quoted in Leonardo Mata, Epidemiologic perspective of diarrhoeal disease in Costa Rica, and current efforts in control, prevention, and research, *Revista Latinoamericana de Microbiología*, vol. 23, 1981.

For 15 years after the civil war, the diarrhoeal disease and infant mortality rates remained high. It is possible that part of the phenomenon was due to the improvement of vital statistics, but this has not been determined. Costa Rica exhibited one of the highest population growth rates in the world during the 1950s, with diarrhoea accounting for 10 to 15% of all the deaths in the community throughout the period of stagnation in mortalities. By the middle of the 1960s, the diarrhoeal disease and infant mortality rates began descending again, par-

ticularly during the 1970s. The changes described affected all age groups, excepting persons 15 to 44 years old, and was more striking in children under 5 years of age and in persons older than 44 years. Today, more than 90% of all diarrhoea deaths still occur in infants, but mortality has continued its decline to very low levels despite a serious socio-economic crisis affecting the country since 1979.

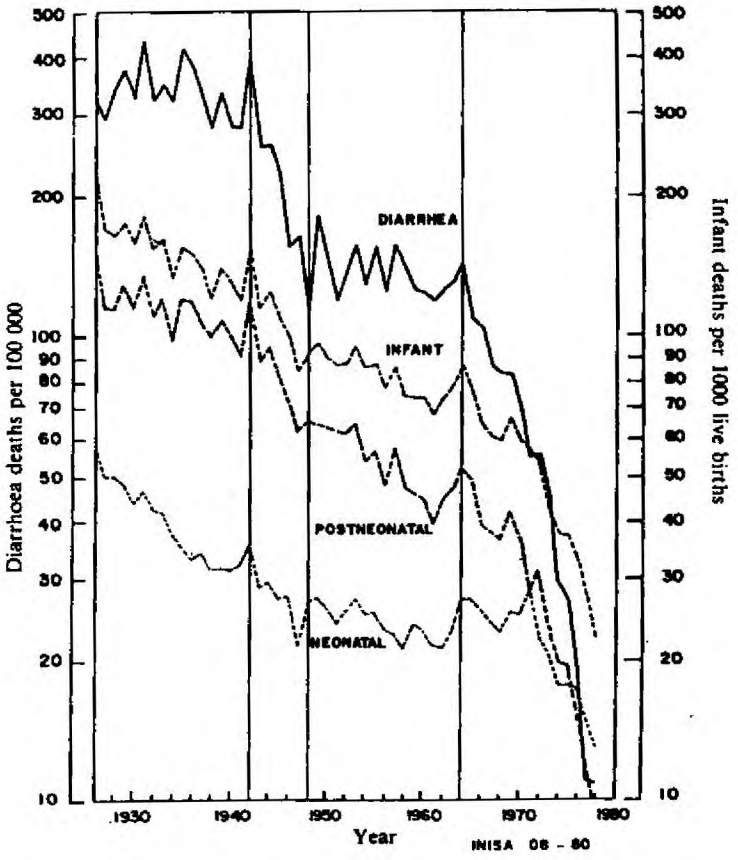


**Fig. 1: Infant mortality and diarrhoeal disease mortality in Costa Rica, 1926-1978**

Source: Leonardo Mata, Epidemiologic perspective of diarrheal disease in Costa Rica, and current efforts in control, prevention, and research, *Revista Latinoamericana de Microbiología*, vol. 23, 1981.

## Nutrition, infection, and infant mortality in Costa Rica

It is difficult to establish precisely which factors, conditions, and interventions accounted for the drastic decline in diarrhoeal disease and infant mortality rates in Costa Rica, especially in the last two decades. Based on current knowledge on determinants of host susceptibility to die from diarrhoea, it appears evident that the decline in diarrhoea deaths should have been due to an improved host resistance on the part of infants, and/or a decrease in exposure to infection. Host resistance is determined by better intrauterine growth and development; a lower risk of exposure to etiologic infectious agents of diarrhoea is obviously due to improved hygiene, sanitation, and education. The relationship of these determinants to child survival will be explained hereafter, using data obtained in two prospective field studies, one of a cohort of Mayan Indian children in their natural ecosystem, Santa María Cauqué, Guatemala,[3] and the other in Puriscal, Costa Rica, where children live under much better environmental conditions.[4] These studies used similar field methods, and comparable clinical and laboratory techniques.

### *Foetal growth and infant mortality*

The most striking observation of the field studies in the contrasting Cauqué and Puriscal highland populations was the strong association between foetal growth and infant survival:[5] no Cauqué child died in the first year of life if his birth weight was at least 2750 grams and he was breast-fed, despite an environment of crowding, poverty, poor sanitation, rampant infection, and lack of governmental effort to prevent diseases by vaccination. A better definition of the variable "birth weight" revealed that about 7% of all births in Santa María Cauqué were preterm (PT), and an additional 34% were term-small-for-gestational age (TSGA).[6] If most of the TSGAs had been prevented, the infant mortality would have been reduced by 30%. It also became clear that preterm delivery carried a high risk of death in infancy, while foetal growth retardation was associated with an increased risk of death in later years

(Table 2).[7] Fifty-two percent of the PT infants died in the first year of life, with no further deaths in the following three years. Contrastingly, fewer TSGA infants died in the first year of life, but an excess mortality prevailed throughout preschool age. While family factors likely affected TSGA children, a deficiency in T-cell function and probably an impaired amplification of immune responses in TSGA children probably explain their more fragile lives.[8]

**TABLE 2**

**Mortality from birth to 4 years of life, by foetal maturity, Santa María Cauqué, 1964-1972**

| Class | Cohort population | Cumulative deaths and %, by year of life | | | |
|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th |
| Preterm | 31 | 16(51.6) | 0 | 0 | 0 |
| Term-small-for-gestational age | 143 | 12(8.4) | 20(13.9) | 23(16.1) | 26(18.2) |
| Term | 242 | 12(5.0) | 21(8.7) | 26(10.7) | 27(11.1) |
| Total | 416 | 40(9.6) | 57(13.7) | 65(15.6) | 69(16.6) |

Source: Leonardo Mata, *The children of Santa María Cauqué, a prospective field study of health and growth*, The MIT Press, Cambridge, Mass., 1978.

The comparison of neonatal mortality rates adjusted by birth weight between Cauqué, 1964-1969,[9] and Baltimore, 1960,[10] did not reveal significant differences (Table 3). The divergence in overall infant mortalities is thus accounted for by differences in the environment which affected all birth weight categories with more intensity in Cauqué than in Baltimore. The contrast is also evident in rural Puriscal, where only 8% of the infants are of low birth weight, mainly PT, but living under better environmental conditions than in Cauqué.[11] Again, neonatal mortality was similar in this transitional society if adjusted by birth weight, and differences in overall infant mortality were then accounted for by differences in postneonatal risks of infant death (Table 4). It can be concluded that the marked differences in neonatal mortality between modern and traditional societies today are due almost entirely to variations

in the incidence of prematurity and foetal growth retardation. Furthermore, the evidence indicates the need for prevention of intrauterine malnutrition and premature delivery, more than for fostering sophisticated neonatology. Still more, differentials in postneonatal mortality are related, in significant part, to the immunological incompetence of intrauterine retarded infants.

**TABLE 3**

**Infant mortality per 1000 live births in two contrasting societies, by birth weight**

| Birth weight, kg | Neonatal | | | Postneonatal | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | SMC | B | SMC/B | SMC | B | SMC/B | SMC | B | SMC/B |
| 1.5-2.0 | 273 | 210 | 1.3 | 303 | 26 | 11.7 | 576 | 199 | 2.9 |
| 2.0-2.5 | 34 | 45 | 0.8 | 34 | 13 | 2.6 | 68 | 54 | 1.3 |
| 2.5-3.0 | 10 | 10 | 1.0 | 43 | 7 | 6.1 | 53 | 17 | 3.1 |
| 3.0-3.5 | 0 | 5 | 0.0 | 23 | 5 | 4.6 | 23 | 10 | 2.3 |

SMC = Santa María Cauqué; B = Baltimore

Source: Leonardo Mata, *The children of Santa María Cauqué, a prospective field study of health and growth*, The MIT Press, Cambridge, Mass., 1978; H. C. Chase, *Relationship of certain biologic and socioeconomic factors to fetal, infant, and early childhood mortality, II. Father's occupation, infant's birth weight and mother's age*, New York State Department of Health, Albany 1967.

**TABLE 4**

**Infant mortality per 1000 live births in two contrasting rural populations, by birth weight**

| Birth weight, kg | Number of live births | | Neonatal | | Postneonatal | | Total | |
|---|---|---|---|---|---|---|---|---|
| | SMC | P | SMC | P | SMC | P | SMC | P |
| $<2.5$ | 179 | 100 | 78.2 | 80.0 | 83.8 | 0.0 | 162.0 | 80.0 |
| $>2.5$ | 251 | 1146 | 8.0 | 0.0 | 39.8 | 2.6 | 47.8 | 2.6 |
| Total | 430 | 1246 | 37.2 | 6.4 | 58.1 | 2.4 | 95.3 | 8.8 |
| % deaths related to LBW | | | 87.5 | 72.7 | 60.0 | 0.0 | 70.7 | 72.7 |

SMC = Santa María Cauqué; P = Puriscal

Source: Leonardo Mata, *The children of Santa María Cauqué, a prospective field study of health and growth*, The MIT Press, Cambridge, Mass., 1978; L. Mata, M. A. Allen, J. R. Araya, J. J. Carvajal, M. E. Rodríguez, y M. Vives, Estudio de Puriscal, VIII. Efecto de intervenciones hospitalarias sobre la lactancia y la salud en el período neonatal, *Revista Médica del Hospital Nacional de Niños*, Costa Rica, vol. 17, 1982, pp. 99-116.

### *The effect of infections on nutritional status*

The second relevant determinant of infant death is the intensity of infection and infectious diseases in postnatal life in less-developed countries. The Cauqué study showed that mothers commonly harbour enteric pathogenic organisms and are a source of infection since the beginning of life, favoured by traditional deliveries in the squatting or kneeling position which expose neonates to maternal feces. Infections occur as early as the first few days or weeks of life, although they are usually asymptomatic owing to protection by human colostrum and milk.[12] By contrast, the incidence of neonatal infection is practically nil in Puriscal: neonates are delivered in modern hospitals and clinics by mothers who are generally negative for enteric pathogens, and who enjoy a better level of education and hygiene than Cauqué mothers. Due to early neonatal interventions effected in the hospital, Puriscal neonates also were exclusively breast-fed for several months.[13]

With weaning on contaminated foods and loss of passive immunity, the incidence of infectious diseases, particularly diarrhoea, attained rates of the order of seven to eight episodes per child per year in Cauqué children, during the first three years of life. Acute infections, mainly of the upper respiratory tract, were the most common, followed by diarrhoea, but the latter was more important in view of its adverse effect on host nutrition. Furthermore, the lack of protection from vaccination in conjunction with crowded and unsanitary conditions favoured the transmission of measles, pertussis, rubella, varicella and other infectious diseases at a rather early age, inflicting serious damage to the host nutrition. The implications of diarrhoea and other infectious diseases are: reduced food consumption, nutrient losses, metabolic alterations, hormonal imbalance, and alterations in immune function; they manifest themselves as wasting, stunting, reduced activity, impaired learning and creativity, and acute malnutrition and death.[14]

To illustrate this process, the natural history of diarrhoea and the physical growth of Cauqué child no. 34—who was no exception within the cohort—is shown in Figure 2. This child had a low birth weight, but grew satisfactorily during the first five months on exclusive breast-feeding when compared with

the 50th percentile curve of the National Center for Health Statistics. Then began a sequence of periods of growth deceleration, growth arrest, and weight loss, mostly in conjunction with diarrhoeal and respiratory diseases. Diarrhoeal episodes were associated, more often than not, with pathogenic enteric infectious agents acquired in an unsanitary environment with low personal hygiene, but were quite independent of the nutritional status. Diarrhoeas were outstanding events in most cohort children, and eventually resulted in progressive wastage and stunting. Furthermore, diarrhoea and lower respiratory infection, measles, and pertussis, independently or in combination, or associated with malnutrition, accounted for

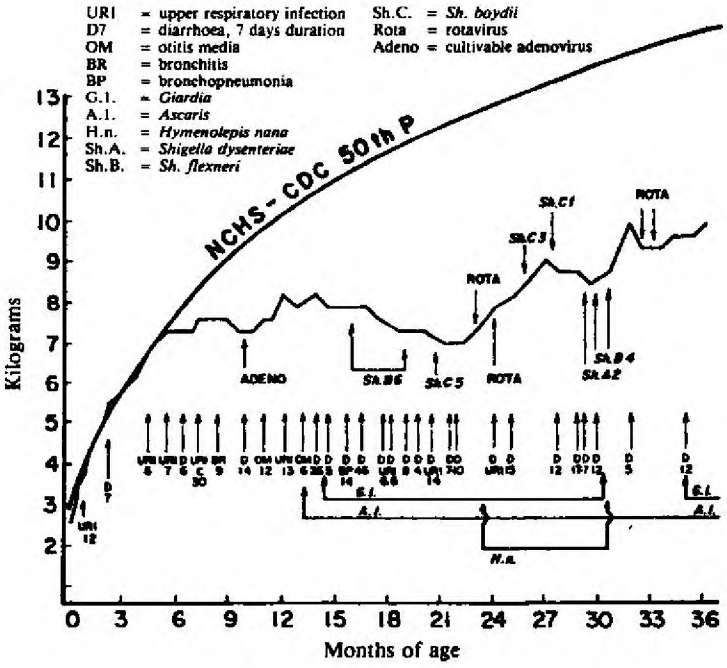


**Fig. 2: Enteric infections, diarrhoeal episodes and weight curve of a low-birth-weight child exclusively breast-fed for several months**

At 5 months, a sequence of illnesses associated with growth deceleration, growth arrest, or weight loss started.

most deaths in infants and children of preschool age in Santa María Cauqué. But since the proposition is that malnutrition primarily results from foetal growth retardation and postnatal infections, a reinterpretation of the orthodox cause-effect (of malnutrition and death) relationships, for instance of the PAHO international study of childhood mortality,[15] is mandatory.

**TABLE 5**

**Incidence of infectious diseases per 100 person-months, Cauqué and Puriscal infants**

| Age in months | Number of infants | Person-months | Diarrhoea and dysentery | Lower respiratory infection |
|---|---|---|---|---|
| Cauqué, 1964-1969 | | | | |
| 0-5 | 45 | 270 | 33.3 | 15.9 |
| 6-11 | 45 | 270 | 63.0 | 23.0 |
| Puriscal, 1979-1981 | | | | |
| 0-5 | 115 | 690 | 4.2 | 5.5 |
| 6-11 | 114 | 684 | 7.5 | 7.7 |

Source: Leonardo Mata, Malnutrition and concurrent infections, in *Viral diseases in South-East Asia and the Western Pacific*, ed. by R. Mackenzie, Academic Press Australia, 1982.

**TABLE 6**

**Nutrition of infants and women of Cauqué (Guatemala) and Puriscal (Costa Rica)**

| Variable | Cauqué, 1967 | Puriscal, 1981 |
|---|---|---|
| Weight, kg, 6 months | 6.3 | 7.1 |
| Height, cm, 6 months | 60.5 | 66.0 |
| Human milk intake, ml, 1-3 months | 674 | 652 |
| Energy intake, kcal, 6 months | 400 | 480 |
| Protein intake, g, 6 months | 7 | 9 |
| Energy intake, kcal, lactating women | 2078 | 2200 |
| Protein intake, g, lactating women | 59 | 60 |
| Height, cm, pregnant women | 143 | 153 |

Source: Leonardo Mata, Malnutrition and concurrent infections, in *Viral diseases in South-East Asia and the Western Pacific*, ed. by R. Mackenzie, Academic Press Australia, 1982.

The history of Puriscal children was different because of their lower incidence of low birth weight, better hygienic conditions, and marked ruralism.[16] Diarrhoeal diseases were eight times less common in Puriscal than in Cauqué infants (Table 5).[17] It is of particular concern that aside from the already noted differences in the incidence of low birth weight and of infectious diseases (and obviously in education, income, and housing), there were no striking differences between the two populations in the level of food consumption of infants and women (Table 6). Moreover, adequate growth was attained by Puriscal infants without necessarily emphasizing food intake. The comparison of the growth curves of Cauqué and Puriscal children shown in Figure 3 is eloquent. Cauqué infants begin with the handicap of high rates of foetal growth retardation, in part due to the mothers' marked deficits in height. This foetal growth retardation is aggravated by the negative effect of infection, especially diarrhoea, pertussis, and exanthems (illustrated in Fig. 2), similarly intensive on the curves of both TSGA and term-adequate-for-gestational age (TAGA) infants. Puriscal children followed, in general, the

TLGA = term-large-for-gestational age
TAGA = term-adequate-for-gestational age
TSGA = term-small-for-gestational age

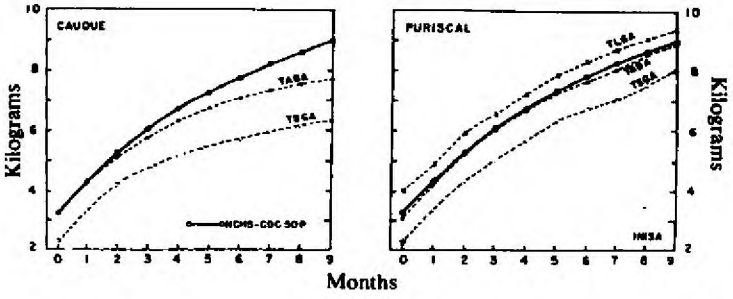


**Fig. 3: Mean weight curves of Cauqué and Puriscal cohort infants observed prospectively from birth to nine months of age, compared with the 50th percentile curve of the United States National Center for Health Statistics**

The same growth pattern persisted throughout the preschool age in both cohorts.

Source: Leonardo Mata, Malnutrition and concurrent infections, in *Viral diseases in South-East Asia and the Western Pacific*, ed. by R. Mackenzie, Academic Press Australia, 1982.

American growth curves, since they enjoyed a low rate of foetal growth retardation and were not exposed to an overwhelming infectious environment.

It is then evident that infection and infectious diseases are the main determinants of acute and chronic malnutrition and death among children in societies not suffering from persistent food shortages or famines.[18] Furthermore, there is sufficient evidence that, provided there is not a marked deficiency in the food supply nor a marked discrimination in access to food, growth deficits throughout the world are mainly attributable to infection, as the Cauqué study showed in that particular region, while an increased risk of death has been clearly demonstrated for Matlab children with accentuated weight and height deficits.[19] The occurrence of an extremely low incidence of infections in Puriscal, as in several other counties of Costa Rica, further emphasizes the beneficial effect of controlling the infectious environment.

## Environmental factors influencing the rates of diarrhoeal disease and death

It is difficult to assess the contribution of specific factors to the decline of diarrhoea morbidity and mortality, particularly in countries like Costa Rica, which have placed an emphasis on social development, and which therefore have effected many simultaneous interventions. Such interventions are usually implemented with generally limited family planning and often without evaluation. Obviously, interventions tend to be mutually interactive.

### *1. Income and communications infrastructures*

This factor undoubtedly plays a role in diarrhoea causality; it is inversely correlated with diarrhoea mortality (Fig. 4). Costa Rica already exhibited a relatively high per capita income in the mid 1960s. Income is highly correlated with variables more directly related to diarrhoea such as personal hygiene (use of water, soap), environmental sanitation (availability of water, sewers, latrines, toilets), education (con-

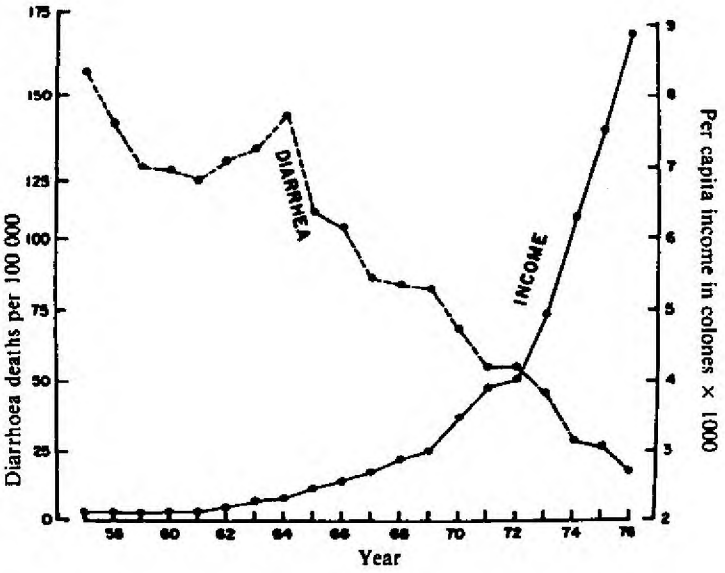


**Fig. 4: Income and diarrhoeal disease death rate in Costa Rica, 1956-1976**

A more accentuated inverse correlation was noted between income and kilometers of road and other indicators of national development.

cepts of causality, disease transmission, and hygiene), and government infrastructure (primary health care, delivery of medical services, water supply, roads). The latter are inversely and strongly correlated with the diarrhoeal disease death rate. The construction of a road in a community generally broadens opportunities for agriculture, commerce, a better diet, information, and political participation. Furthermore, the opening of a road secures other services such as transport, electricity, telephone, and health services.

### *2. Maternal environment and birth spacing*

There has been a significant improvement in the maternal environment in terms of income, education, emancipation, reproductive behaviour, and health. The proclivity of women

towards change was evident in the marked reduction in fecundity notorious in the decade of the 1960s, which was accelerated in the 1970s through family planning programmes. The trends in fecundity affected women of all age categories (Fig. 5).[20] An increase in the birth interval and a reduction in fertility among younger and older women undoubtedly resulted in a lower incidence of prematurity and foetal growth retardation. In effect, the 16% rate of low-birth-weight infants (<2.5 kg) in 1952-1954 in the San Juan de Dios Hospital decreased to 9% in 1970 and to 7% in 1980.[21] Furthermore, parity (mean deliveries per woman) decreased steadily in the Carit Maternity from 3.9 in 1965 to 3.0 in 1974, and the prevalence of low birth weight declined from 11.2 to 9.2% in the same period.[22]

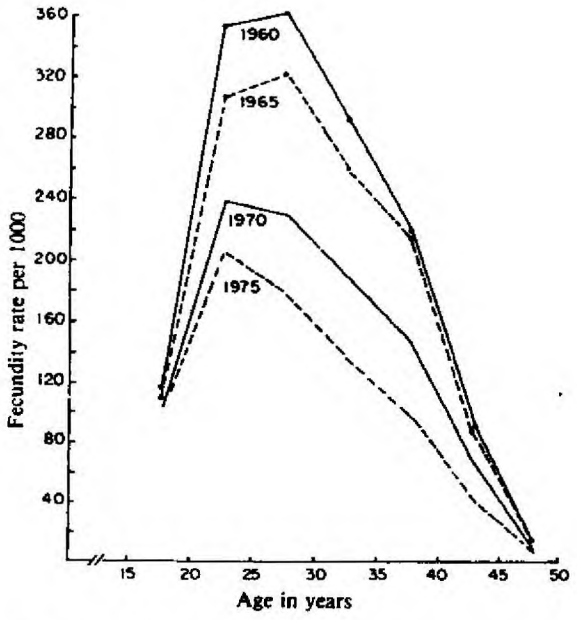


**Fig. 5: Fecundity rate in Costa Rica, by women's age, according to prevalence data obtained in indicated years**

Similar curves are obtained by social class. The decline was already evident in 1965, especially among women 20 to 30 years old.

Source: A. Ortega, Situación demográfica actual de Costa Rica y perspectivas futuras, *Notas de Población*, CELADE, vol. 5, 1977.

The changes recorded at the national level in a span of 20 years are summarized in Table 7; they reflect steady socio-economic progress, improved maternal education, and reduced fecundity. Such progress was a direct result of improvements in the status of women in Costa Rica, which were well under way in the 1960s. In fact, the change was more abrupt for several variables in the decade of the 1960s than in the 1970s. For such changes in fecundity to occur, a significant gain in education and modernity was required.[23] In the 1960s the illiteracy rate was only 14% and the per capita income was approaching $800, both representing high rates if compared with most Latin American nations. The sharpest increase in institutionalized delivery had already occurred in the 1960s. Gains in this decade did not result in immediate changes in infant mortality, but undoubtedly had a spill-over beneficial effect on foetal growth and child survival at a later date. Furthermore, child spacing and a significant reduction in family size should have induced a wholesome effect in family well-being and economic solvency.

**TABLE 7**

**Changes in some maternal and infant indicators in Costa Rica**

| | | | | % change | |
|---|---|---|---|---|---|
| | 1960 | 1970 | 1980 | 1960-70 | 1970-80 |
| % literate | 84.4 | 88.4 | 90.1 | + 5 | + 2 |
| % attending school, ages 18-23 yr | 4.0 | 11.0 | 21.0 | +175 | +91 |
| Birth rate per 1000 | 48.3 | 33.2 | 31.2 | − 31 | − 6 |
| Global fecundity, children | 7.3 | 4.9 | 3.7 | − 33 | −24 |
| % newborns < 2.5 kg | 12.5 | 9.1 | 7.0 | − 27 | −23 |
| % deliveries in hospitals | 50.0 | 71.2 | 90.7 | + 42 | +27 |
| Mortality per 1000 | | | | | |
| maternal* | 1.4 | 1.1 | 0.3 | − 21 | −72 |
| infant | 68.6 | 61.5 | 19.1 | − 10 | −69 |
| neonatal | 23.3 | 25.2 | 11.2 | + 8 | −55 |

* Pregnancy, delivery and postpartum

Sources: General Directorate of Statistics and Census; Bureau of Social Security; Ministry of Education; United Nations.

Low social class and short stature are recognized to be major determinants of low birth weight,[24] and the mother's schooling is a strong correlate of low infant mortality.[25] An increase in birth interval is correlated with better foetal growth,[26] which is particularly significant in Costa Rica, and independent of an increase in consumption of protein or calories. An improved maternal environment, coupled with a low prevalence of smoking in women, with improved detection of high-risk women, and with institutionalized delivery would explain most of the reduction in neonatal mortality and part of the reduced post-neonatal mortality.

### *3. Water supply and waste disposal*

Costa Rica has maintained much of its ruralism in the last three decades (67% rural in 1950; 57% in 1978). Governments invested significant efforts in providing the rural population with potable water supplies and with adequate sewer systems, exceeding the goals set at the Punta del Este and Santiago Conferences. The existence of water connections in more than one-half of the rural homes is impressive in view of the sparseness of the rural population: in 1973, 13% of the people lived in communities with less than 200 people and an additional 20% lived in villages with 200 to 500 people. Water supply has been a political weapon in most presidential campaigns, but programmes received new impetus in 1961 with the creation of the Costa Rican Institute of Aqueducts and Sewers (AyA). As is well known, shortly after the creation of AyA the 1966 statistics indicated that 90% of the urban homes already had water connections, while in 1978 virtually all urban homes had a water connection (Table 8). The most striking change, however, was in the rural areas, where water connections in homes increased from 34 to 61% in 12 years. The programme for aqueducts and sewers contributed to the decline of diarrhoeal diseases depicted in Figure 1, and to the decrease in the incidence of water-borne diseases like typhoid, giardiasis, and shigellosis.

**TABLE 8**

**Per cent population with water supply, Costa Rica, 1966-1980**

| Year | Urban | | Rural | | Total supplied |
|---|---|---|---|---|---|
| | With connection | Supplied | With connection | Supplied | |
| 1966 | 90 | 100 | 34 | 50 | 74 |
| 1970 | 93 | 100 | 39 | 56 | 77 |
| 1972 | 95 | 100 | 56 | 65 | 76 |
| 1974 | 95 | 100 | 58 | 66 | 78 |
| 1978 | 98 | 100 | 61 | 63 | 80 |
| 1980 | 98 | 100 | 62 | 65 | 82 |

Source: Costa Rican Institute of Aqueducts and Sewers (AyA).

**TABLE 9**

**Changes in intestinal parasitism rates in Costa Rica**

| Parasite | Prevalence in % | | | |
|---|---|---|---|---|
| | 1966, age in years | | | 1982, all ages |
| | 2-4 | 10-14 | 25-34 | |
| *Ascaris* | 21.7 | 31.3 | 12.5 | 3.5 |
| *Trichuris* | 56.7 | 57.1 | 32.1 | 4.6 |
| Hookworm | 10.2 | 22.4 | 18.5 | 2.9 |
| *Hymenolepis nana* | 5.6 | 3.6 | 1.2 | 0.8 |

Sources: For 1966, Instituto de Nutrición de Centro América y Panamá (INCAP), Office of International Research (OIR), Ministerio de Salud, Costa Rica, *Evaluación Nutricional de la Población de Centro América y Panamá: Costa Rica*, INCAP, Guatemala, 1969; for 1982, *National Nutrition Survey*, Ministry of Health, Costa Rica, 1982.

### *4. Latrine usage and health education*

A steady increase in the availability of latrines and toilets and in the use of shoes correlated with a diminished incidence and intensity of parasitism. Two surveys conducted 16 years apart in representative samples of the general population[27] revealed a ten-fold decrease in the prevalence of intestinal parasites (Table 9). Furthermore, deaths attributed to parasitic infections decreased notably, according to records of the National Children's Hospital.[28] The emphasis on water supply, latrines, toilets, and shoes has been the result of many decades

of health education coupled with governmental programmes and the provision of facilities for those sectors of the population not able to make the investment.

### *5. A rural community health programme*

The extension of the coverage of the health services was initiated by the government in 1973, as the malaria eradication programme became consolidated and its infrastructure could be utilized to implement the Rural Community Health Programme (RCHP).[29] Targeting on 600 000 rural persons (30% of the population) in scattered communities with less than 500 inhabitants each, health workers did the following: *(a)* update the census data on the rural area; *(b)* vaccinate against poliomyelitis, diphtheria-pertussis-tetanus (DPT), measles, smallpox, and tuberculosis; *(c)* treat malaria and intestinal parasites; *(d)* educate on the subjects of hygiene and maternal and child health; *(e)* promote family planning and distribute contraceptives; *(f)* refer cases of serious diseases; and *(g)* participate in community organization. The impact of the RCHP can not be questioned, as shown in Tables 10 and 11.[30] Within four years (1974-1977), this precursor of PHC had 125 000 children under surveillance from an original figure of 900; also, 10 000 pregnant women enrolled in the prenatal clinics, from a starting figure of 350. One activity of the RCHP which had a great impact on the rural population—especially on people's attitudes toward nutrition and growth—was the periodic weighing of preschool children. The use of growth charts was expanded to the national level after 1972. Polio and DPT immunizations increased by 220 and 180%, respectively, during that period. The results were obvious, for instance, in the reduction of deaths due to preventable diseases through vaccination (Table 10). It should be remembered that measles, pertussis, and other common communicable diseases are often complicated by, or in turn are complications of, diarrhoea, and therefore the prevention of these diseases must have contributed to reducing diarrhoeal morbidity and mortality. There was also an increase in life expectancy at birth (iLEB) which was directly proportional to the percentage of the population covered by the programme, as well as to its duration.[31] The

iLEB was smallest in the rural areas and in urban areas not covered by primary health services (Table 11).

**TABLE 10**

**Deaths from preventable infectious diseases, Costa Rica**

| Cause | 1970 | 1973 | 1976 | 1980 | % change |
|---|---|---|---|---|---|
| Poliomyelitis | 2 | 1 | 0 | 0 | −100.0 |
| Diphtheria | 16 | 5 | 0 | 0 | −100.0 |
| Measles | 242 | 61 | 12 | 7 | − 97.1 |
| Tetanus | 217 | 113 | 23 | 9 | − 95.8 |
| Pertussis | 49 | 50 | 12 | 12 | − 75.5 |

**TABLE 11**

**Per cent population served and duration of rural health programme, and increase in life expectancy at birth (iLEB), Costa Rica, 1970-1976**

| Population served: % | iLEB in years |
|---|---|
| 0 | 2.4 |
| < 25 | 2.4 |
| 25-49 | 3.5 |
| 50-74 | 4.0 |
| 75 + | 5.1 |
| **Duration, in years:** | |
| 0 | 2.4 |
| < 1 | 4.2 |
| 1 | 4.5 |
| 2 | 3.4 |
| 3 | 5.1 |

Source: CELADE, Costa Rica, 1978.

### *6. Oral rehydration therapy*

The need for electrolyte fluid therapy for children suffering from acute diarrhoea and dehydration has been recognized in Costa Rica since the 1960s; supplies of intravenous fluid solutions were made available to most hospitals and clinics throughout the country. The National Children's Hospital was created in 1964 and treatment of diarrhoeaic children improved

steadily. With oral rehydration therapy (ORT) at the National Children's Hospital[32] for about 90% of the dehydrated children, and with rapid intravenous fluid therapy for the rest, a sharp reduction in lethality was observed (Table 12).[33] The oral rehydration technology could be taught to women in an emergency service and rural women learned to rehydrate children under field conditions.[34] A programme of distribution of oral rehydration packets was established by the government in 1980 in 20 of the 80 Costa Rican municipalities. Packets of ORS were locally produced for a 240-ml volume (an 8-ounce bottle), since one-liter containers were not readily available. The potassium content was slightly increased.[35] The sachets were distributed free of charge to mothers with preschool children in the 20 experimental municipalities. The result, after one year of operation, was a 50% reduction of infant diarrhoea deaths in the 20 municipalities; no significant change was detected in the remaining municipalities where the intervention was not effected.[36] These results further support the reports on the beneficial effect of the free distribution of ORS sachets on the reduction of diarrhoea deaths and overall mortality in many countries.[37]

**TABLE 12**

**Diarrhoea case fatality ratio per 1000, National Children's Hospital, Costa Rica**

| Year | Rehydration route | Number of cases | Number of deaths** | Case fatality ratio |
|---|---|---|---|---|
| 1977 | Slow IV* | 5974 | 18 | 3.0 |
| 1978 | Oral and/or rapid IV | 6000 | 2 | 0.3 |

* IV = intravenous
** After 48 hours of internment

Source: Adapted from C. Odio y E. Mohs, Características actuales de la letalidad por diarrea, *Revista Médica del Hospital Nacional de Niños*, Costa Rica, vol. 15, 1980, pp. 181-187.

### *7. Interventions at birth conducive to breast-feeding*

Current world interest in breast-feeding stimulated a series of actions in Costa Rica such as rooming-in programmes,

human milk banks, and novel schemes for feeding neonates in the hospital. Interventions in the San Juan de Dios Hospital were parallel to the Puriscal study, and so the latter served to monitor the effect of the interventions on maternal behaviour and neonatal health and survival.[38] These interventions established in succession had a significant effect on the target population, as compared with the situation before the interventions were implemented (Table 13). As a result of rooming-in and early mother-infant stimulation, breast-feeding became universal in the hospital, from a basal rate of 20 to 30% failure to breast-feed. Furthermore, breast-feeding in Puriscal increased significantly and more than 90% of infants were breast-fed for more than one month, while more than 80% remained at the breast at the age of 3 months; furthermore, the rate of abandonment of infants also declined.[39]

**TABLE 13**

**Neonatal morbidity and mortality attributed to diarrhoea, as a function of hospital interventions, Costa Rica**

| Year | Intervention, San Juan de Dios Hospital | Number of live births | Number (rates per 1000 l.b.) Cases | Deaths |
|---|---|---|---|---|
| 1976 | Mother-infant separation (a) | 7629 | 135(17.7) | 3(3.9) |
| 1977 | Rooming-in (b) | 8582 | 72 (8.3) | 1(1.2) |
| 1978 | (a) + colostrum (c) | 8931 | 62 (6.9) | 0 |
| 1979 | (b) + (c) + early stimulation (d) | 8638 | 55 (6.4) | 0 |
| 1980 | (b) + (c) + (d) | 8978 | 14 (1.6) | 0 |
| 1981 | (b) + (c) + (d) | 8879 | 1 (0.1) | 0 |
| % change, 1976-1980 | | | 99.4 | 100 |

Source: Adapted from L. Mata, M. A. Allen, J. R. Araya, J. J. Carvajal, M. E. Rodríguez, y M. Vives, Estudio de Puriscal, VIII. Efecto de intervenciones hospitalarias sobre la lactancia y la salud en el período neonatal, *Revista Médica del Hospital Nacional de Niños*, Costa Rica, vol. 17, 1982, pp. 99-116.

A marked reduction in neonatal diarrhoea morbidity and mortality and in other infectious diseases was observed in connection with the hospital interventions (Table 13). The familiarity of physicians with human colostrum and milk eventually resulted in a change in norms: glucose solution was eliminated and the use of milk formulae was reduced to a

minimum as human milk and colostrum were fed to neonates. It is highly probable that the very low incidence of diarrhoea in Puriscal (shown in Table 5) was partly due to the protection afforded by breast-feeding.[40]

### *8. Food supplementation interventions*

Improper use of the Gomez classification, utilization of the Boston-Iowa standard, and undue emphasis on a possible relationship between weight deficit and mental retardation prompted the government to establish food distribution programmes in rural areas and city slums. However, no conclusive evidence exists of any effect of such programmes on nutritional status. Data from the 1966 National Nutrition Survey indicate that the nutritional status in Costa Rica was not so bad that year, and that significant improvements had already occurred, judging by the decline in infant mortality (Table 14). Furthermore, the comparison of anthropometric data from the National Nutrition Surveys conducted in 1966, 1975, 1977, and 1982 revealed a significant improvement in the height of preschool children, predicting further gains in nutrition and survival (Table 14).[41] These findings were all the more surpris-

**TABLE 14**

**Evolution of the nutritional status and mortality in preschool children, Costa Rica, 1966-1982**

| Year of survey | Number of children** | % with II and III degree "malnutrition" (<75% wt/age) | Mortality per 1000 Infant | 1-4 yr |
|---|---|---|---|---|
| 1966 | 791 | 13.5 | 69.8 | 5.5 |
| 1975 | 1910 | 12.3 | 37.1 | 2.0 |
| 1978* | 3069 | 8.6 | 22.3 | 1.1 |
| 1982 | 1871 | 4.1 | 17.7*** | 0.7*** |

* Economic crisis beginning in 1978 worsens in 1981-1982.

** Representative national sample, children less than 6 years old, except in 1975 (under-fives).

*** 1981 figures.

Source: Ministry of Health of Costa Rica.

**TABLE 15**

**Daily dietary consumption per person, rural Costa Rica, 1966-1978**

| | Nutrition survey | | |
|---|---|---|---|
| | 1966 | 1978 | % change |
| Energy, kcal | 1894 | 2020 | + 6.6 |
| Protein, g | 53.6 | 54.0 | + 0.7 |
| Iron, mg | 15.4 | 14.4 | − 6.5 |
| Retinol, µg | 206 | 326 | +58.2 |

Sources: For 1966, Instituto de Nutrición de Centro América y Panamá (INCAP), Office of International Research (OIR), Ministerio de Salud, Costa Rica, *Evaluación Nutricional de la Población de Centro América y Panamá: Costa Rica*, INCAP, Guatemala, 1969; for 1978, *National Nutrition Survey*, Ministry of Health, Costa Rica, 1982.

**TABLE 16**

**Coverage of nutrition programmes, Puriscal, Costa Rica, 1982**

| Programme | Registered number of children | % weight for age | | | | |
|---|---|---|---|---|---|---|
| | | >110 | 90-109 | 75-89 | 60-74 | < 60 |
| Milk and cereal | Yes (338) | 12.4* | 60.9 | 25.7 | 0.6 | 0.3 |
| | No (204) | 21.6 | 59.3 | 18.6 | 0.5 | 0.0 |
| Nutrition Education Center (CEN) | Yes (29) | | | | | |
| | No (576) | | | | | |

* Prevalence (%) in category

Source: L. Mata, P. Jiménez, B. Castro, M. E. García, M. Vives, S. Jiménez, y F. Sánchez, Estudio de Puriscal, IX. Estado nutricional y supervivencia del niño lactante, *Revista Médica del Hospital Nacional de Niños*, Costa Rica, vol. 17, 1982.

ing in view of the lack of a demonstrable increase in food intake within a lapse of 16 years (Table 15). Still more, the evaluation of the free distribution of powdered milk and cereal in Puriscal showed that 64% of the families benefited from the programme (Table 16),[42] but that the nutritional status of the children of these families was indistinguishable from that of the children not benefiting from the programme. It appears that under conditions of low incidence of infectious diseases, and no shortage of food supplies, no measurable effect on the

nutritional status of children can be ascribed to food distribution programmes. Furthermore, the Nutrition Education Center (CEN) programme covers only 2.8% of the preschool children—that is, the children living within walking distance of the CEN—and again, no nutritional difference is detected between the children attending the CEN and those not attending it.[43]

## Conclusions

It is difficult to demonstrate the contribution of specific interventions to the reduction of diarrhoea and childhood mortality in Costa Rica, in view of the complex web of causality of these parameters.[44] Nevertheless, it can be assumed that the gains in Costa Rica resulted from a combination of actions effected simultaneously or sequentially but with a character of permanency.[45] It appears logical that democracy, political stability, and priority support for education, health, and agriculture (in part because there are no expenditures on an army) led to the prompt establishment and maintenance of interventions.[46] The change in government every four years by popular vote has forced politicians to fulfill some basic demands, and, with time, education and health have become politicized.

While the first slight but steady decline in mortalities was recorded in the decade preceding the Second World War, the first marked reduction (1942-1948) coincided with a period of political decision and social reform, briefly interrupted by a short civil war.[47] The stagnation of mortalities that followed (1948-1964) may have been related to social disruption, poverty, the introduction of bottle feeding, and the population explosion. Costa Rica exhibited the highest demographic growth rate in the Americas during part of that period. The rapid population growth shortened the birth interval, and this presumably impaired foetal growth, resulting in many low-birth-weight infants and premature deaths. However, even in this period social progress continued, and by mid 1960 much effort had been already invested in education and socio-economic development. The 1960s were characterized by im-

provements in administration and economic stability; the country fared well in per capita income in Latin America while illiteracy among persons older than 9 years had been reduced to 14%.

It appears that significant segments of the Costa Rican population enjoyed an adequate level of health and education in the 1960s. However, the "sparse" rural communities and certain poverty urban sectors had remained unassisted until new political decisions permitted the implementation of interventions oriented toward what is now called primary health care, with emphasis on family planning, prenatal care, and the control of infectious diseases.[48] Primary health care is internationally recognized as the best cost-benefit health action today.[49] The decade of the 1970s was then characterized by an emphasis on primary health care interventions;[50] the Rural Health Programme which started in 1973 had already advanced significantly by 1974. Furthermore, institutional medicine was significantly strengthened in the second half of the 1970s, along with oral rehydration, breast-feeding, and milk banks. It is hard to determine whether these programmes would have been as effective had significant socio-economic development not preceded,[51] especially as they influence maternal education and behaviour. It appears under some conditions that for primary health care to have an optimum effect, a preceding advance in the education and community status of women of reproductive age is required along with some gains in other aspects of social development. However, health policies and programmes giving greater emphasis to public health measures, preventive actions, and paramedical personnel can result, in many settings, in substantial reductions in mortality even without marked changes in income.[52]

The decade of the 1970s was also characterized by social interventions of a paternalistic nature such as food distribution and housing programmes for the poor. Food distribution did not appear to have been effective and cost-beneficial in Costa Rica; coverage was poor and no differences were detected in the nutritional status of children benefiting from the programme as compared to that of children outside of the programme.[53] Furthermore, land distribution, housing, and social aid programmes did not correct or ameliorate poverty, as the

often were distorted by the rich to their own advantage.[54] Land tenure and unemployment in fact were aggravated in the last decade and especially during the present crisis. It then appears that these measures were incapable of solving social and developmental inequity in Costa Rica.

What seems evident from field observations is that the holistic approach is the best avenue to improving people's health and securing national development.[55] Such a holistic approach would include significant advances in maternal education and behaviour. The case of Costa Rica provides a successful example of this type of development, which also allowed the creation of a stable infrastructure for the implementation of health interventions within an integrated framework. The current world economic crisis, aggravated by large national and foreign debts, inflation, and recession may offer a grim prospect for Costa Rica at a time in which further political decisions are mandatory in order to protect natural resources, intensify land reform, stabilize food prices and wages—in sum, promote further gains in social justice. The goal ahead is to continue the struggle for better socio-economic development, avoiding a return of unwanted pregnancy, low birth weight and repeated infectious diseases, malnutrition, and premature death. In setting priorities for the future, Costa Rica must emphasize all actions aimed at a better coverage of pregnant women, better family planning, and the prevention of infectious diseases. A setback of such actions would result in an inevitable increase in malnutrition and infant mortality.

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