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Chapter 3

THE FIGHT AGAINST DIARRHOEAL DISEASES: THE CASE OF COSTA RICA

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INTRODUCTION

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 (Mata, 1981). San José, the capital city; had a population of about 25,000 at the turn of the century and an estimated mortality rate from all causes of 41 per 1000 population; the city was described as one of the filthiest in the world (Jiménez and Jiménez, 1901). The diarrhoeal disease death rate for 1900 was 239 per 100,000, almost surely an underestimate, and clinical descriptions from 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 those in parts of contemporary Asia and Africa, where poverty and malnutrition are still highly prevalent.

The trends of diarrhoeal disease mortality and infant mortality rates during this period as shown in Figure 1 reveal a remarkable yearly correspondence of their peaks, falls and plateaus. This correlation can be seen for both neonatal and postneonatal mortality rates throughout the entire observation period, although since 1968 the fall in diarrhoea deaths has not been matched by a fall in neonatal deaths. From 1926 through to 1942, the diarrhoeal disease death rate did not decline, but a decrease was evident during 1942-1948, coinciding with a period of social and economic reforms including 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, caused a certain exodus of people from the country, increased migration from rural to urban centres, and resulted in a population explosion as well as the widespread adoption of bottle-feeding.

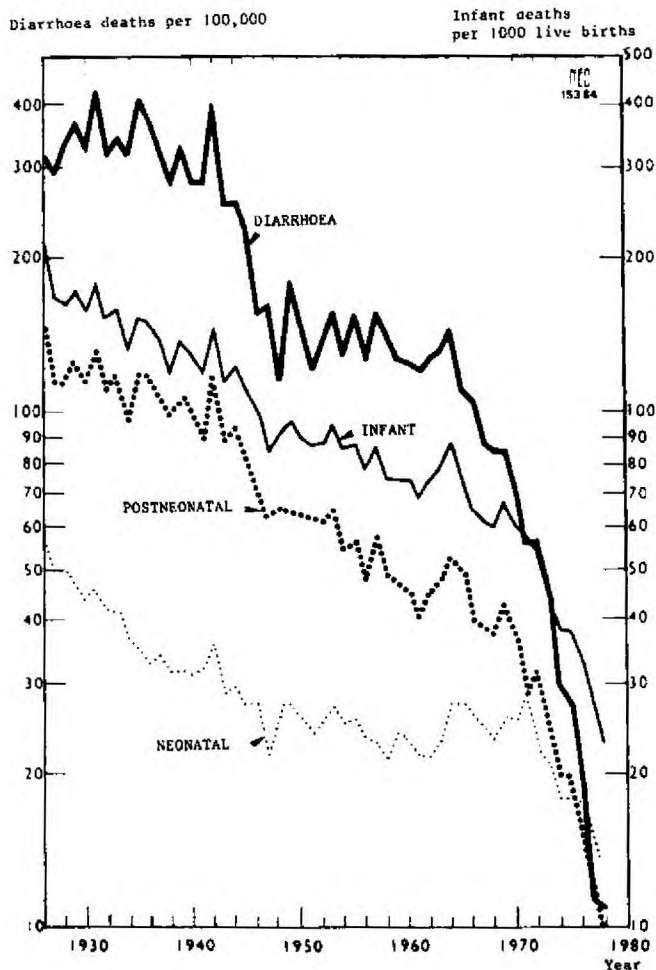


Figure 1

Infant mortality and diarrhoeal disease mortality, Costa Rica, 1926-1978

During the 15 years after the civil war, the diarrhoeal disease mortality rate and the infant mortality rate remained high, with diarrhoea accounting for 10 to 15 % of all deaths. It is possible that part of this phenomenon was due to an improvement in vital statistics, although this is difficult to determine. By the middle of the 1960s, both the diarrhoeal disease death rate and infant mortality began to decline again, with the decline accelerating during the 1970s. These declines affected all age groups except those aged 15 to 44 years, and were more striking in children under 5 years of age and among adults aged 45 and over.

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 (ICD 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

The marked decline in diarrhoeal diseases in Costa Rica undoubtedly brought about an improvement in nutritional status, since diarrhoeal disease and malnutrition are strongly correlated, as has been repeatedly shown by long-term prospective studies of rural children. Diarrhoea is associated with anorexia, nutrient loss, wastage and stunting (Mata, 1978a, 1982; Mata et al., 1983). Also, diarrhoea may precipitate the severe forms of protein-energy malnutrition. Furthermore, diarrhoea may be accompanied by toxemia and dehydration and these, with or without underlying chronic malnutrition, may result in death if not treated.

The strong correlation between diarrhoeal disease deaths and infant deaths in Costa Rica during the period of social reforms between 1943 and 1948 (Figure 2) is, therefore, not surprising. The weaker correlation during the preceding period (1926-1942) could have been due to faulty registration during particular years. Significant correlations can also be observed for the periods 1949-1964 and 1965-1978. Today, more than 90 % of all diarrhoea deaths still occur in infants.

These observations strongly suggest that diarrhoeal disease is a principal factor in infant mortality. If the environment is unsanitary and personal hygiene is poor, and if this is compounded by minor seasonal fluctuations as in the tropics, then dissemination of diarrhoea agents and opportunities for their acquisition by infants and small children are optimized. Ingestion of adequate doses of pathogenic parasites, bacteria and viruses, produces diarrhoea regardless of the nutritional status of the host. This phenomenon has been clearly illustrated through the detailed prospective observation of a cohort of Mayan Indian children in their natural ecosystem, Santa María Cauqué, Guatemala (Mata, 1978a). Observations derived from this study can be compared with data from another field study in Puriscal, Costa Rica, where children live under much better environmental conditions (Mata et al., 1983). In these two studies, for which similar field methods and comparable clinical and laboratory techniques were used, other factors such as intrauterine growth retardation were found to be also related to postnatal growth failure, malnutrition and premature death. Some of these findings will be presented here in an attempt to better understand trends of diarrhoeal disease mortality.

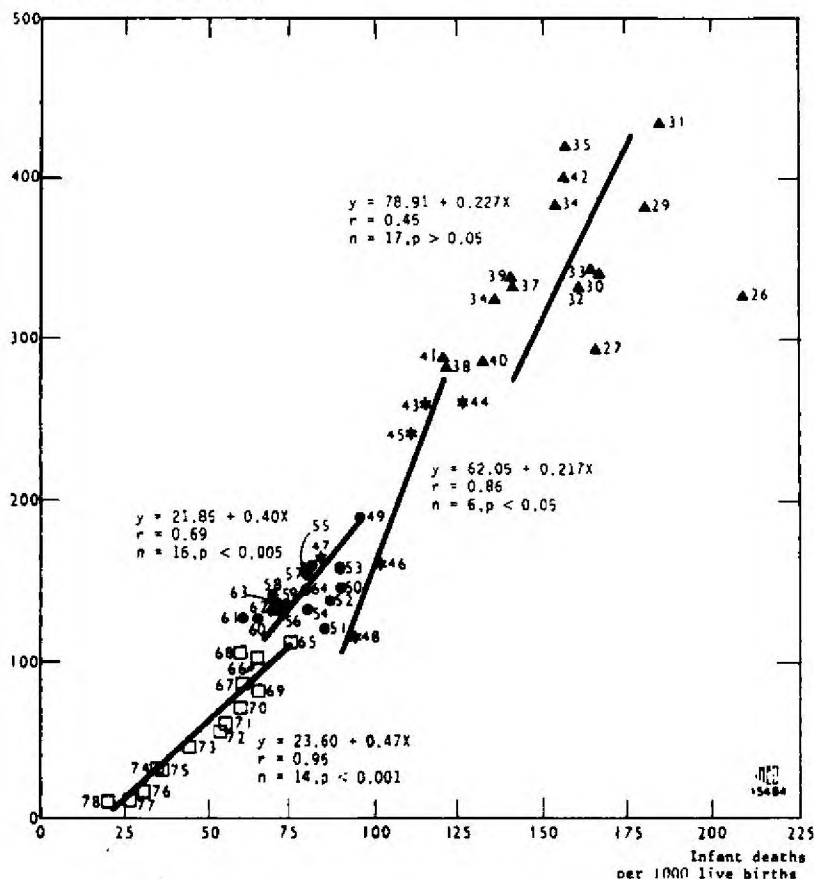


Figure 2

Simple correlation between infant mortality and diarrhoeal disease mortality, Costa Rica, 1926-1978

I. DETERMINANTS OF INFANT SURVIVAL

It is difficult to establish precisely which factors, conditions and interventions have accounted for the drastic decline in diarrhoeal disease and infant mortality rates in Costa Rica, especially over the last two decades. Based on current knowledge about the determinants of host susceptibility to death from diarrhoea, it would appear that the decline in diarrhoea deaths should have been due to an improved host resistance 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 the etiologic infectious agents of diarrhoea is brought about by improved hygiene, sanitation and education.

Foetal growth and infant mortality

The most striking observation of field studies in the contrasting Cauqué and Puriscal highland populations was the strong association of foetal growth and infant survival (Mata *et al.*, 1975): in Cauqué, despite an environment of overcrowding, poverty, poor sanitation, rampant infection, and lack of vaccination, no child died in the first year of life if its birth weight was at least 2750 grams and it was breast-fed. A better definition of the variable "birth weight" revealed that about 7 % of all births in Santa Maria Cauqué were preterm (PT), and an additional 34 % were term-small-for-gestational-age (TSGA) (Mata *et al.*, 1975; Mata, 1978a). If most TSGA had been prevented, the infant mortality would have been reduced by 30 %. Preterm delivery also carried a high risk of death in infancy, while foetal growth retardation is associated with an increased risk of death in later years (Table 2). 52 % of PT infants died in the first year of life, with no further deaths in the following three years. In contrast, fewer TSGA infants died in the first year of life, but an excess mortality prevailed throughout preschool age. While family factors undoubtedly would have affected the survival of TSGA children, a deficiency in T-cell function and probably an impaired amplification of immune responses in TSGA children largely explain their more fragile lives (Chandra and Newberne, 1977; Newmann, 1982).

TABLE 2

Mortality from birth to age four years, by foetal maturity,
Santa Maria 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: Mata (1978a)

The comparison of neonatal mortality rates adjusted for birthweight between Cauqué, 1964-1969 and Baltimore, 1960 (Chase, 1962) did not reveal any significant differences (Table 3). The divergence in overall infant mortality is thus accounted for by differences in the environment which affected all birthweight categories with more intensity in Cauqué than in Baltimore. The contrast is also evident in rural Puriscal (Table 4), where only 8 % of infants are of low birthweight, mainly PT, but living under better environmental conditions than in Cauqué (Mata *et al.*, 1982a). Again, infant mortality was similar in this transitional society if adjusted for birthweight, and differences in overall infant mortality can then be accounted for by differences in postneonatal mortality. It may 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 a greater need for prevention of intrauterine malnutrition and premature delivery than for more sophisticated neonatology. Furthermore, differentials in postneonatal mortality are strongly related 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	23	5	4.6	23	10	2.3

Key: SMC = Santa María Cauqué; Mata (1978)

B = Baltimore; Chase (1962)

TABLE 4

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

Birth weight (Kg)	Number of live births		Mortality per 1000 live births					
			Neonatal		Postneonatal		Total	
	SMC	P	SMC	P	SMC	P	SMC	P
< 2.5	179	100	78.2	80.0	83.8	0	162.0	80.0
≥ 2.5	251	1,146	8.0	0	39.8	2.6	47.8	2.6
Total	430	1,246	37.2	6.4	58.1	2.4	95.3	8.8
% deaths related to LBW			87.5	72.7	60.0	0	70.7	72.7

Key: SMC = Santa María Cauqué; Mata (1978a);

P = Puriscal; Mata *et al.* (1983)

Effect of infections on nutritional status

Another major determinant of infant death in less developed countries is the intensity of infection and infectious diseases. The Cauqué study showed that mothers commonly harbour enteric pathogenic organisms and are a potential source of infection from the beginning of life. This is exacerbated by traditional delivery in the squatting or kneeling position which exposes 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 (Mata, 1978a). By contrast, neonatal infection is practically non-existent 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 in the hospital, Puriscal neonates also were exclusively breast-fed for several months (Mata *et al.*, 1982b; 1983).

With weaning on contaminated foods and loss of passive immunity, the incidence of infectious diseases, particularly diarrhoea, averaged 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 most common, followed by diarrhoea, although the latter was more important in view of its adverse effect on the nutritional status of the host. Furthermore, the lack of 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 further serious nutritional damage to the host. The nutritional implications of diarrhoea and other infectious diseases included reduced food consumption, nutrient losses, metabolic alterations, hormonal imbalance, and alterations in immune function; these factors manifest themselves as wasting, stunting, reduced activity, impaired learning and creativity, acute malnutrition and, ultimately, death (Mata *et al.*, 1981; Mata, 1982; Mata *et al.*, 1983). As an illustration, the natural history of diarrhoea and physical growth of Cauqué child No. 34 - who was no exception within the cohort - is shown in Figure 3. This child had a low birthweight, 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. This point marked the beginning of 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 of 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 tract infection, measles, and pertussis, independently or in combination, or associated with malnutrition, accounted for most deaths among infants and children of preschool age in Santa Maria Cauqué. However, 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, as for instance those advanced in the PAHO international study of childhood mortality (Puffer and Serrano, 1973), is required.

The history of Puriscal children differed because of their lower incidence of low birthweight, better hygienic conditions, and marked ruralism (Mata *et al.*, 1982a, 1983). Diarrhoeal diseases were eight times less common in Puriscal than in Cauqué infants (Table 5) (Mata, 1982; Castro *et al.*, 1982). Interestingly, apart from the differences in incidence of low birthweight and of infectious diseases (and obviously in education, income and housing) already noted, 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 growth curves of Cauqué and Puriscal children shown in Figure 4 is revealing. Cauqué infants begin life with the handicap of high rates of foetal growth retardation which is aggravated by the negative effect of infection, especially diarrhoea, pertussis and exanthems (illustrated in Figure 3), similarly intensive on the curves of both TSGA and term-adequate-for-gestational-age (TAGA) infants. Puriscal children followed, in general, the American growth curves, and enjoyed a low rate of foetal growth retardation and were not exposed to a highly infectious environment.

It is thus 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 (Mata, 1982). Furthermore, there is sufficient evidence to suggest that growth deficits are mainly attributable to infection, as the Cauqué study showed, while an increased risk of

death has been clearly demonstrated for children with accentuated weight and height deficits (Chen *et al.*, 1980). The extremely low incidence of infections in Puriscal, as in several other counties of Costa Rica, further emphasizes the beneficial effect of controlling an infectious environment.

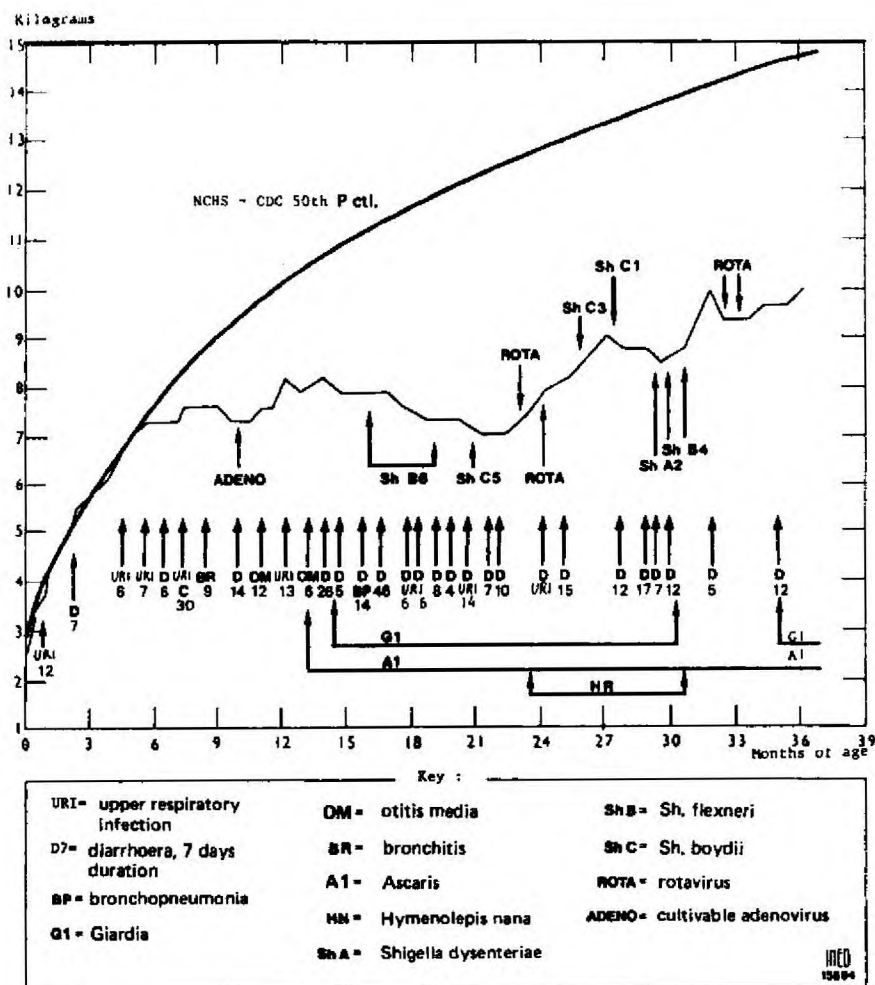


Figure 3
Enteric infections, diarrhoeal episodes and weight curve of a low birth weight child exclusively breastfed for several months

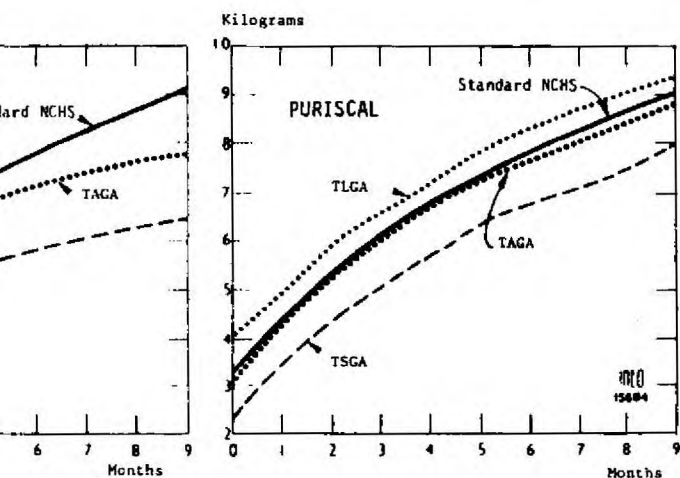


Figure 4

and Puriscal cohort infants observed prospectively from birth to nine months of age, percentile curve of the United States National Center for Health Statistics

TABLE 5

Incidence of infectious diseases among infants, Cauqué (Guatemala) and Puriscal (Costa Rica)

Number of infants	Person- months	Incidence per 100 person-months	
		Diarrhoea and dysentery	Lower respiratory
Cauqué, 1964 - 69			
45	270	33.3	15.9
45	270	63.0	23.0
Puriscal, 1979 - 81			
115	690	4.2	5.5
114	684	7.5	7.7

32)

TABLE 6

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

Variable	Cauqué, 1967	Puriscal, 1981
Weight (kg) at 6 months	6.3	7.1
Height (cm) at 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), lactation	2,078	2,200
Protein intake (g), lactation	59	60
Height (cm), pregnant women	143	153

Source: Adapted from Mata (1982)

II. ENVIRONMENTAL FACTORS INFLUENCING DIARRHOEAL DISEASE AND DEATH

It is difficult to assess the contribution of specific factors to the decline of diarrhoeal morbidity and mortality, particularly in countries like Costa Rica which have emphasized social development and which have effected many interventions simultaneously. These interventions are usually implemented with generally limited planning and often without evaluation. Obviously, interventions tend to be mutually interactive.

Income

This factor undoubtedly plays a role in diarrhoea causality; it is inversely correlated with diarrhoea mortality (Figure 5). 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 (awareness of concepts 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.

Maternal environment

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 from the marked reduction in fertility during the decade of the 1960s, which was accelerated in the 1970s through family planning programmes. The reduction in fertility was evident for women at all age between 20 and 45 years (Figure 6) (Ortega, 1977). Longer birth interval and a reduction in fertility among younger and older women undoubtedly contributed to the lower incidence of prematurity and foetal growth retardation. In effect, the

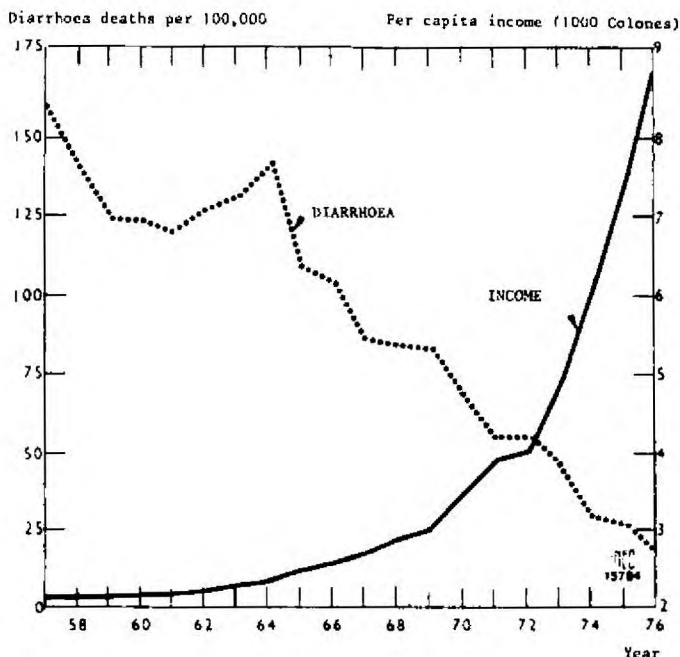


Figure 5
Income and diarrhoeal disease death rate in Costa Rica, 1957-1976

proportion of low birthweight infants (< 2.5 kg) in the San Juan de Dios Hospital declined from 16 % in 1952-1954 to 9 % in 1970 and to 7 % in 1980 (Mata *et al.*, 1978). Furthermore, average parity (deliveries per woman) decreased steadily in the Caril Maternity Hospital from 3.9 in 1965 to 3.0 in 1974; the prevalence of low birthweight declined from 11.2 % to 9.2 % over the same period (Mata *et al.*, 1977).

The changes recorded at a national level between 1960 and 1980 are summarized in Table 7 and reflect steady socio-economic progress, improved maternal education and reduced fertility, resulting from improvements in the status of women in Costa Rica already evident in the 1960s. In fact, the change for several variables was more abrupt in the 1960s than in the 1970s, reflecting the significant improvements in education and modernity (Gomez, 1979; Stykos, 1979). In the 1960s, the illiteracy rate was only 14 % and per capita income was approaching \$800, both being markedly better than in most Latin American nations. The sharpest increase in institutional deliveries had already occurred in the 1960s. The improvements during this decade did not result in immediate changes in infant mortality, but undoubtedly had a beneficial effect on foetal growth and child survival at a latter date. Furthermore, better child spacing and a significant reduction in family size should have led to an improvement in family well-being and economic solvency.

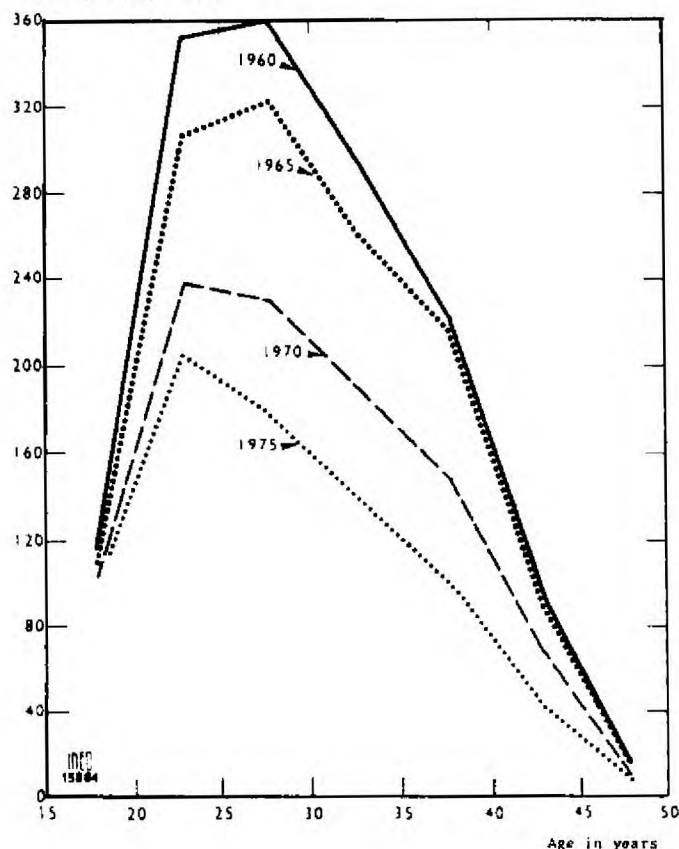


Figure 6
Age-specific fertility rates, Costa Rica, 1960-1975

Source: Ortega (1977)

Low social class and short stature are recognized as major determinants of low birthweight (Thompson *et al.*, 1968), and mother's schooling has been found to be strongly correlated with the level of infant mortality (Behm and Guzman, 1979). Longer birth intervals are associated with better foetal growth (Mata, 1978a). This has been particularly evident in Costa Rica and is independent of an increase in consumption of protein or calories. Thus the improved maternal environment, together with a low prevalence of smoking in women, improved detection of high risk women, and a higher frequency of institutional deliveries probably explains most of the reduction in neonatal mortality and part of the decline in postneonatal mortality.

TABLE 7

Changes in some maternal and infant health indicators in Costa Rica, 1960-1980

	Year			% change	
	1960	1970	1980	1960 - 70	1970 - 80
% of women literate	84.4	88.4	90.1	+ 5	+ 2
% of women attending school, ages 18 to 23 years	4	11	21	+ 175	+ 91
Birth rate per 1000	48.3	33.2	31.2	- 31	- 6
Global fertility (no. of 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 live births:					
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.

Water supply and sewers

The proportion of the population of Costa Rica living in rural areas has remained relatively high over the last three decades (67 % rural in 1950; 57 % in 1978). Successive governments have invested considerable resources to provide the rural population with potable water supplies and with adequate sewer systems, exceeding goals set at the Punta del Este and Santiago Conferences. Facilities for obtaining piped water now exist in more than one half of the rural homes, which is impressive in view of the sparseness of the rural population: in 1973, 13 % of the population 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 Rica Institute of Aqueducts and Sewers (AyA). Five years later, in 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

TABLE 8

Percentage of the population with water supply, Costa Rica, 1966 - 1972

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)

8). The most striking change, however, was in the rural area, where water connections in homes increased from 34 % to 61 % in 12 years. The programme of aqueducts and sewers contributed to the decline of diarrhoeal diseases depicted in Figure 1, and to the decrease in incidence of water-borne diseases such as typhoid, giardiasis and shigellosis.

Latrine usage and sanitary education

A steady increase in the availability of latrines and toilets and in the use of shoes is associated with a lower incidence and intensity of parasitism. Two representative surveys conducted 16 years apart revealed a ten-fold decrease in the prevalence of intestinal parasites (Table 9) (INCAP, 1969; Min. of Health, 1982). Furthermore, according to records of the National Children's Hospital, the number of deaths attributed to parasitic infections has decreased markedly (Mohs, 1982). The emphasis on clean water supply, latrines, toilets and shoes has evolved over many decades of health education coupled with government programmes and the provision of facilities for those sectors of the population not able to make the investment.

TABLE 9

Changes in the prevalence of intestinal parasites in Costa Rica,
1966 - 1982

Parasite	Prevalence (in percent)			
	1966 (age in years)			1982 (all ages)
	2 - 4	10 - 14	25 - 34	
<i>Ascaris</i>	21.7	31.3	12.5	3.5
<i>Trichuris</i>	56.7	57.1	32.1	4.6
hookworm	10.2	22.4	18.5	2.9
<i>Hymenolepis nana</i>	5.6	3.6	1.2	0.8

Sources : 1966 Nutrition Survey (INCAP - OIR - MS);
1982 Nutrition Survey (Ministry of Health)

Primary health care (PHC)

A move to extend the coverage of primary health services was initiated by the government in 1973 using the infrastructure from the malaria eradication programme for implementing the Rural Health Programme (Villegas, 1977; Mohs, 1980). This programme, which served 600,000 persons (30 % of the population) living in scattered rural communities of less than 500 inhabitants each, provided health workers for the following tasks: (a) to update the census of the rural area; (b) to vaccinate against poliomyelitis, diphtheria-tetanus-pertussis (DPT), measles, smallpox and tuberculosis; (c) to treat malaria and intestinal parasites; (d) to provide health education, especially for maternal and child health; (e) to promote family planning and the distribution of contraceptives; (f) to refer cases of serious diseases; and (g) to participate in community organization. The impact of this programme can be assessed from Table 10 and 11. Within four years (1974-1977), the PHC programme had 125,000 children under surveillance from an original figure of 900; also, 10,000

TABLE 10

Deaths from preventable infectious diseases, Costa Rica, 1970 - 1980

Cause of death	Number of deaths in :				% change (1970 - 1980)
	1970	1973	1976	1980	
Poliomyelitis	2	1	0	0	- 100
Diphtheria	16	5	0	0	- 100
Measles	242	61	12	7	- 97.1
Tetanus	217	113	23	9	- 95.8
Pertussis	49	50	12	12	- 75.5

TABLE 11

Proportion of the population served and time served by the rural health programme, and increase in life expectancy at birth (iLEB), Costa Rica, 1970 - 1976

Population served (%) :	iLEB (years)
0	2.4
< 25	2.4
25 - 49	3.5
50 - 74	4.0
75 +	5.1
Time served (years) :	
0	2.4
< 1	4.2
1	4.5
2	3.4
3	5.1

pregnant women were enrolled in prenatal clinics compared with 350 at the beginning of the programme. One activity of the programme which had a great impact on the rural population - especially on people's attitudes towards nutrition and growth - was the periodic weighting of preschool children. Furthermore, poliomyelitis and DPT immunizations increased by 220 % and 180 %, respectively, during this period. Table 10 shows the magnitude of the reduction in deaths due to preventable diseases through vaccination. In addition, since measles, pertussis and other common communicable diseases are often complicated by, or in turn are complications of, diarrhoea, the prevention of these diseases undoubtedly contributed to the fall in morbidity and mortality from diarrhoea. The resulting increase in life expectancy at birth was directly proportional to the percentage of the population covered by the programme, as well as to its duration (Villegas, 1977). The gain in life expectancy at birth was smallest in rural areas and in urban areas not covered by PHC.

Rehydration activities

The need for aggressive electrolyte fluid therapy for children suffering from acute diarrhoea and dehydration has been recognized in Costa Rica since the 1960s when 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 leading to a steady improvement in treatment for children with diarrhoea. Oral rehydration therapy at the Hospital was given to about 90 % of dehydrated children and rapid intravenous fluid therapy was provided for the remainder, leading to a sharp reduction in lethality (Table 12) (Odio and Mohs, 1980). Oral rehydration technology could be taught to women working in an emergency service and rural women learned to rehydrate children under field conditions (Pizarro *et al.*, 1979; Jiménez *et al.*, 1982). A programme for the distribution of oral rehydration salts was established by the government in 20 of the 80 Costa Rican municipalities; after one year of operation, this programme had reduced mortality from diarrhoea among infants in the 20 municipalities by 50 % whereas no significant change was detected in the remaining municipalities where no intervention had been made (Lopez, personal communication). These results provide further support for the beneficial effect of free distribution of oral salts in reducing diarrhoea deaths and overall mortality (Rahman *et al.*, 1979; Parker *et al.*, 1981).

TABLE 12

Diarrhoea case fatality ratio, National Children's Hospital,
Costa Rica, 1977 - 1978

Year	Rehydration route	Number of cases	Number of deaths **	Case fatality ratio (per 1000)
1977	Slow I.V. *	5,974	18	3.0
1978	Oral and/or Rapid I.V.	6,000	2	0.3

* I.V. = intravenous

** After 48 hours of internment

Source : Adapted from Odio and Mohs (1980)

Interventions at birth

The current world interest in breast-feeding has stimulated a series of maternal and child health benefits in Costa Rica including rooming-in programmes, human milk banks, and novel schemes for feeding neonates in the hospital. Interventions in the San Juan de Dios Hospital were concurrent with the Puriscal study, and thus the latter can be used to monitor the effect of these interventions on maternal behaviour and neonatal health and survival (Mata *et al.*, 1982c). Successive interventions had a significant effect on the health of the target population 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 whereas previously 20 % to 30 % had failed 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 three months; the rate of abandonment of infants also declined (Mata *et al.*, 1983; Mata *et al.*, 1982c).

TABLE 13

Neonatal morbidity and mortality attributed to diarrhoea as a function of hospital interventions, Costa Rica, 1976 - 1981

Year	Intervention, San Juan de Dios Hospital	Number of live births	Neonatal mortality	
			Number (rate per 1000 live births)	
			Cases	Deaths
1976	Mother-infant separation (A)	7,629	135 (17.7)	3 (3.9)
1977	Rooming-in (B)	8,582	72 (8.3)	1 (1.2)
1978	B+Colostrum (C)	8,931	62 (6.9)	0
1979	B+C+Early stimulation (D)	8,638	55 (6.4)	0
1980	B+ C+D	8,978	14 (1.6)	0
1981	B+C+D	8,879	1 (0.1)	0
% Change, 1976 - 1980			99.4	100

Source : Adapted from Mata *et al* (1982).

A marked reduction in neonatal morbidity and mortality from diarrhoea and other infectious diseases was observed in connection with the hospital interventions (Table 13). The familiarity of physicians with breast secretions eventually resulted in a change in norms: glucose solution was eliminated and milk formulae were 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 (see Table 5) was partly due to the protection afforded by breast-feeding.

Food supplementation intervention

Improper use of the Gomez classification, utilization of the Boston-lowia 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, there is no conclusive evidence of an effect of these programmes on nutritional status. Data from the 1966 National Nutrition Survey indicated that the nutritional status of the Costa Rican population was adequate in that year, and that significant improvements had already occurred judging by the decline in infant mortality (Table 14). Furthermore, a comparison of anthropometric data from National Nutrition Surveys conducted in 1966 and 1975 indicates that there has been a significant improvement in average height of preschool children, suggesting further gains in nutrition and survival (Mata, 1978b; Mata and Mohs, 1978). These findings were all the more surprising in view of the lack of a demonstrable increase in food intake over the period (Table 15). An evaluation of the free distribution of powdered milk and cereal in Puriscal revealed that 64 % of families benefited from the programme (Table 16) (Mata *et al.*, 1982b), although the nutritional status of children from these families was no better than that of children who did not benefit from the programme. A similar finding emerged from the Nutrition-Education Center (CEN) programme which covers only 2.8 % of preschool children living within walking distance of the CEN; no difference in nutritional status could be detected between children attending the CEN and those who did not (Munillo and Mata, 1980).

TABLE 14

Changes in nutritional status and mortality among preschool children,
Costa Rica, 1966 - 1975

	1966	1975	% change
	N = 791	N = 1910	
% with < 90 % Ht/Age ("stunted")	16.9	7.2	- 59
Infant mortality per 1,000	65.1	37.1	- 51
Mortality at ages 1 - 4 per 1,000	6.3	1.9	- 70

Source: Adapted from Mata (1978a)

TABLE 15

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

Nutrition survey			
	1966	1978	% change
Energy (kcal)	1,894	2,020	+ 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: INCAP-OIR-MS (1969); Ministry of Health, Costa Rica (1980)

TABLE 16

Coverage of nutrition programmes, Puriscal, Costa Rica, 1982

Programme	Registered (number of) children)	% weight for age				
		≥ 110	90-100	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
Nutrition- Education Center (CEN)	Yes (29)					
	No (576)					

Source: Mata *et al* (1982c)

* Prevalence (%) in category

CONCLUSIONS

Given the complex web of causality surrounding diarrhoeal diseases, it is difficult to demonstrate what has been the contribution of specific interventions in reducing childhood mortality in Costa Rica. Nevertheless, it can be assumed that the gains in Costa Rica have resulted from a combination of either simultaneous or sequential actions of a reasonably long-term nature. Democracy, political stability, and priority support for education, health and agriculture (in part because there were no expenditures on an army) led to the prompt establishment and maintenance of interventions. The change in government every four years by popular vote has encouraged politicians to fulfill many basic demands and, with time, education and health have become politicized.

While a slight decline in mortality was recorded in the decade preceding the Second World War, the first marked reduction in death rates (1942-1948) coincided with a period of political decision and social reform, briefly interrupted by a short civil war. The stagnation of mortality decline that followed (1948-1964) may have been related to social disruption, poverty, introduction of bottle feeding and the population explosion - Costa Rica exhibited the highest population growth rate in the Americas during part of this period. This rapid population growth was accompanied by shorter birth intervals and this presumably impaired foetal growth, resulting in many low birthweight infants and premature deaths. However, even during this period social progress continued, and by the mid-1960s a considerable investment in education and socio-economic development had already been made. The 1960s were characterized by improvements in administration and economic stability; per capita incomes were among the highest in Latin America while illiteracy among persons aged nine years or older had been reduced to 14 %.

It appears that a significant proportion of the Costa Rican population enjoyed an adequate level of health and education in the 1960s. However, the "sparse" rural communities and certain poorer urban sectors remained underserved until new political decisions led to the implementation of interventions in the 1970s oriented towards primary health care, with an emphasis on family planning, prenatal care, and the control of infectious diseases. The Rural Health Programme which was introduced in 1973 had already made significant progress by 1974. Furthermore, institutional medicine was substantially strengthened in the second half of the 1970s, along with oral rehydration, breast-feeding and milk banks. It is, however, difficult to say whether these programmes would have been as effective in the absence of significant socioeconomic development (Mosley, 1983), especially in so far as they influence maternal education and behaviour. It appears that for primary health care to be effective, some progress must already have been made in education and community involvement of women in reproductive ages (Bell, 1983), as well as in other aspects of social development.

The decade of the 1970s was also characterized by social interventions of a paternalistic nature such as food distribution, land reform, and poor housing programmes. Food distribution did not appear to have been effective or cost-beneficial in Costa Rica; coverage was poor and no differences were detected in the nutritional status of children who benefited from the programme compared with those who did not. Furthermore, land distribution, housing, and social aid programmes did not ameliorate poverty, land tenure, or unemployment, which were in fact aggravated over the last decade (Seligson, 1980) and especially during the present crisis. It thus appears that such paternalistic measures were incapable of redressing social and developmental inequity in Costa Rica.

What does seem evident from field observations is that the holistic approach is the best and perhaps the only avenue to improving the health status of the population and securing national development. 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 has also enabled the creation of a stable infrastructure for the implementation of health interventions within an integrated framework. The current world economic crisis may well have severe financial implications for further health and social development in Costa Rica which will require political decisions in order to protect natural resources, intensify land reform, and stabilize food prices and wages - in sum, to promote further gains in social equity. The good ahead is to continue the struggle for better socioeconomic development and to avoid a return to high rates of unwanted pregnancy, low birthweight babies, repeated infectious diseases, malnutrition and premature death. In setting priorities for the future, Costa Rica must emphasize those programmes which will improve the coverage of pregnant women, secure better family planning, and prevent infectious diseases. Any failure to do so would result in an inevitable increase in malnutrition and infant mortality.

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SUMMARY

The infant mortality rate in Costa Rica has recently fallen to 18 per 1,000 which is one of the lowest in the Third World. The decline in diarrhoeal diseases has played a major role in this extraordinary progress. This decline has not been due exclusively to specific health measures, however. On the contrary, the favourable economic and political context which has enabled health services to be extended to all sectors of the population, especially the poorer classes, has played a more decisive role.

It is because of this favourable context that the following specific measures have had greater impact:

- extension of the network providing drinkable water;
- promotion of health education across the country;
- launching of a rural health programme including vaccination and the use of growth charts;
- adoption by the hospitals of oral rehydration salts in certain municipalities;
- promotion of breast-feeding practices in hospitals.

To consolidate this success and improve the situation even further, Costa Rica, which today is in the midst of an economic crisis, must continue to reduce social inequalities and strengthen appropriate health measures in favour of pregnant women, family planning, and the prevention of infectious diseases.

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