Timaeus, I. M., Chackiel, J. & Ruzicka, L. (Editors). *Adult Mortality in Latin America.*
Oxford, U.K.: Oxford University Press, 1996.

9 Adult Mortality Decline in Costa Rica

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1. Introduction

Costa Rica is, along with Cuba, the country with the best health indicators in Latin America. Life expectancy at birth in Costa Rica was 77.9 years for women and 72.7 years for men in 1990, figures which are comparable with those for Western Europe and the USA. Study of the epidemiologic transition in Costa Rica has usually focused on children, reflecting the fact that the main component of mortality decline has been the prevention and control of premature deaths (Behm, 1976; Rosero-Bixby, 1986; CELADE *et al.*, 1987; Cervantes and Raabe, 1991). The greater availability of information on child health and the young age-structure of the population (in 1960, 47 per cent of the population were children under 15 years of age) have reinforced the emphasis on studying the young.

This chapter shifts the previous emphasis on childhood to focus on adult mortality. The purpose is to describe the mortality transition at adult ages, to identify its key components, and to make inferences about its likely determinants. The chapter has five sections: socio-economic and public-health background of Costa Rica; the data and methods used; decline in risks of dying in two age intervals (20–49 and 50–79 years); analysis of risks of dying by cause of death; and areal analysis of adult mortality and its correlate across 100 small geographical units.

2. Background Information on Costa Rica

2.1. Socio-Economic Background

Costa Rica is a small Central American country with a population of about 3 million. Its economy is dependent on export of tropical crops, predominantly coffee and bananas. Per capita income in 1990 was about US $1900, slightly

This paper is part of a collaborative research project into health policy of the University of Costa Rica and the Nordic School of Public Health. The project was partially supported by a grant of the Swedish Agency for Research Cooperation with Developing Countries (SAREC). Dr Leonardo Mata contributed to this paper with helpful comments.

lower than the Latin American average. Approximately one half of the population resides in rural areas and a third of the labour force is employed in agriculture. The country has had greater social than economic development: only 7 per cent of adults are illiterate, almost all children attend school, 79 per cent of the population is covered by the social security system, and 94 per cent enjoy a piped water supply (Table 9.1).

After World War II, Costa Rica enjoyed more than three decades of vigorous economic growth. The real growth in gross domestic product (GDP) was greater than 6 per cent per annum (more than 3 per cent in per capita terms) between 1950 and 1980. Moreover, welfare-oriented institutions helped to distribute the product of such progress comparatively evenly among the various social strata (González-Vega, 1985). In the early 1980s, however, international and domestic circumstances brought this continuous progress to an end. The country experienced an acute economic crisis in the 1980s, from which it has not yet recovered. Consequently, GDP and expenditure on public health per capita in 1990 were lower than in 1980. Although the main indicators of health status of the population did not deteriorate during this decade, other social indicators, such as school attendance, have decayed (Table 9.1).

2.2. *The Health Sector*

Significant public health programmes began in Costa Rica in the 1920s, with the creation of the Sub-Secretariat of Hygiene and Public Health in 1922; the Sub-Secretariat was promoted to ministerial level in 1929 (Meza-Lago, 1985). An ambitious social security system started in 1941 which provided, among other benefits, medical and hospital care to workers in the formal sector and, since 1955, to their families. The health sector was substantially reorganized in the early 1970s. All hospitals were transferred to the social security system, which, in turn, expanded its coverage from 39 to 70 per cent of the population over a ten-year period (Table 9.1). The Ministry of Health established a programme of primary health care to reach rural areas and urban slums (Saenz, 1985). By 1980, this programme covered 60 per cent of the Costa Rican population with services that included quarterly visits to every household by a health worker.

At present, Costa Rican medicine is highly socialized. Only 1.2 per cent of the hospital discharges come from the private sector. Coverage of public medical services is high: for example, 97 per cent of births occurred in hospitals in 1990. However, the quality of the service may be questioned. The budget outlay for health in the public sector peaked at 7.6 per cent of the GDP in 1980 and today represent 5.6 per cent of GDP (Table 9.1).

2.3. *Demographic Trends*

Mortality probably started to decline in Costa Rica before the end of the nineteenth century, after the cholera epidemic of 1856. In contrast, the birth

Table 9.1. Demographic, socio-economic and health characteristics of Costa Rica, 1950–90

Indicators	1950	1960	1970	1980	1990
Demographic					
Populations (1000s)	862	1236	1731	2284	3015
Natural growth (%)	3.2	3.8	2.6	2.7	2.3
Total Fertility Rate	6.7	7.3	4.9	3.7	3.2
Under age 15 (%)	43	47	46	38	35
Socioeconomic					
Per capita GDP in 1990-US$	808	1103	1527	1999	1937
Male work force in agriculture (%)	63	59	49	35	33
Illiteracy (% in ages 15+)	21	16	13	10	7
Enrolment in primary and secondary school (% ages 5–19)	39	52	61	64	60
Health (general)					
Life expectancy at birth	55.6	62.6	65.4	72.6	75.2
Infant mortality rate (1000s)	95	80	67	20	16
Public health expenditure					
Per capita in 1990-US$	19	33	78	152	109
As % of GDP	2.2	3.0	5.1	7.6	5.6
Hospital care					
Beds per 1000 population	5.1	4.6	4.1	3.3	2.5
Discharges per 1000 population	95	101	111	117	105
Births in institutions (%)	20	49	70	91	97
Medical care					
Physicians per 10,000 people	3.1	2.8	5.6	7.8	8.9
Medically certified deaths (%)	60	65	71	84	96
Health insurance coverage (%)	8	15	39	70	79
Outpatient consultations per capita (public health services)	—	1.1	2.0	2.9	2.5
Primary health care					
Administrative coverage (%)	0	0	0	60	57
Sanitation					
Population with piped water (%)	53	65	75	83	94
Population with faeces disposal (%)	48	69	86	94	97

Source: Updated from Rosero-Bixby (1985*b*).

rate remained high until 1960 and even increased briefly in the 1950s. Consequently, population growth accelerated, reaching 3.8 per cent in 1960—one of the highest growth rates in the world. By 1960 the birth rate began to decline, which resulted in a reduced population growth (Table 9.1).

In contrast with its present very low mortality, Costa Rica's population growth (2.3 per cent) and total fertility rate (3.2 births per woman) remained moderately high in 1990. The low mortality level and a transitional age-structure with relatively large population at ages at which the risk of death is minimal, result in a crude death rate below 4 per 1000, one of the lowest in the world.

2.4. The Epidemiologic Transition

Early data suggest that at the beginning of this century mortality was lower in Costa Rica than in Latin America as a whole (Rosero-Bixby, 1985*a*). Social homogeneity inherited from colonial times, a more egalitarian distribution of land, the absence of militarism, and an emphasis on education by governments of all parties are some factors that seem to account for this initial advantage of Costa Rica (Mata and Rosero-Bixby, 1988). As in the rest of the continent, the most rapid improvement in life expectancy took place after World War II. Costa Rica's life expectancy rose sharply from 46 to 63 years between 1940 and 1960. This progress has been linked with the adoption of cost-effective technologies, such as antibiotics, DDT, and vaccines, as well as to government initiatives, such as the social security system established in 1941. The standard of living in Costa Rica also increased substantially during this period (Rosero-Bixby, 1991*a*).

After modest gains in life expectancy in the 1960s, a breakthrough in the trend took place in the 1970s (Caldwell, 1986). Life expectancy rose from 65 to 73 years between 1970 and 1980, owing to a dramatic decline in the infant mortality rate from 67 to 21 per 1000. This decline has been linked mainly to the implementation of cost-effective primary health care programmes among rural populations. Conventional health interventions, favourable socio-economic circumstances, and a substantial fertility reduction have also been identified as significant factors in the improvement of child health in the 1970s (Rosero-Bixby, 1986).

In spite of the economic recession, mortality continued falling during the 1980s, but at a slower pace. Life expectancy increased from 72.6 to 75.2 years and infant mortality declined from 21 to 16 per 1000 between 1980 and 1990 (Table 9.1). This progress is intriguing since it occurred under difficult socio-economic circumstances and declining public health expenditure and services (Table 9.1).

3. Data and Methods

Most analyses in this paper are based on the risk of dying in the age groups 20 to 49 years and 50 to 79 years. These risks measure the probability of dying in those age intervals by a person that has reached the initial age of the interval.

The risks were derived from the age-specific mortality rates (${}_5m_x$) and the following approximate relations (Kleinbaum *et al.*, 1982: 107):

$$Q_{(20-49)} \approx 1 - \exp\left(-5.\sum_{x=20}^{45} {}_5m_x\right)$$

$$Q_{(50-79)} = 1 - \exp\left(-5.\sum_{x=50}^{75} {}_5m_x\right)$$

The risk of dying was also computed by specific causes of death. In this case, the risk represents the probability of dying of a particular cause (or group of causes) in the corresponding age interval in the absence of other causes of death. The following relation aggregates the risks of dying by k different causes i:

$$Q = 1 - \prod_{i=1}^{k}\left(1 - Q_i\right)$$

The proportional contribution of the *i-th* cause of death to the decline in the risk of dying by all causes—the 'attributable risk decline' D_i—was estimated using the following relation:

$$D_i \approx \frac{\Delta Qi}{\Delta Q} \cdot \frac{1-\overline{Q}}{1-\overline{Q}_i}; \qquad \sum_i D_i = 1$$

where $\bar{Q}$ is the mean risk in the period and the operator Δ indicates the amount of change (the first difference) during the period.

The data source from which the risk of dying by all causes is drawn is a series of life tables covering the period 1920–80 (Rosero-Bixby and Caamaño, 1984). These tables include corrections for under-registration of deaths. The series was updated with life tables computed for 1985 and 1990 (not shown) employing the same procedures and adjustments as for the 1980 life table.

Seventeen groups of causes of death were defined, based on the classification into twelve groups developed by Preston *et al.* (1972). Table 9.2 presents the definitions of these groups according to the International Classification of Diseases, 5th to 9th Revisions. The age-specific death rates by cause in 1951–2 and 1961–2 come from statistical yearbooks ('Anuario Estadístico') published by the Directorate of Statistics and Censuses. For 1971–2, 1981–2 and 1989–90 the data come from computer files obtained from the Directorate of Statistics and Censuses.

The areal analysis of adult mortality is based on two cross-sections centred in 1973 and 1984 for 100 counties. Mortality rates were computed with three-year averages of deaths (i.e. 1972–4 and 1983–5) from vital statistics computer files using the census population in the age intervals 20–49 years and 50–79

Table 9.2. Definition of the groups of causes of death. International Classification of Diseases, 5th to 9th Revisions

Groups of causes of death	International Classification of Diseases Revisions				
	5th (1938)	6th (1948)	7th (1955)	8th (1965)	9th (1975)
Respiratory tuberculosis	13	1	1–8	10–12	10-12
Malaria	28	37	111–116	84	84
Diarrhoeal disease	119–120	104	571–572	8–9	8–9
Acute respiratory infections	33, 106–9	88–93	480–502	466–491	466, 480–491
Other infectious and parasitic diseases	1–12, 14–27, 30, 34–44, 177	2–36, 38–43	9–111, 117–138	0–7, 13–83, 85–136	0–7, 13–83, 85–139
Malnutrition	67–71, 73	64–65	286–293	260–9, 280–5	260–9, 280–5
Maternal	141–150	115–120	640–689	630–678	630–678
Digestive cancer	46	45–48	150–159	150–159	150–159
Respiratory cancer	47	49–50	160–163	160–163	160–163
Uterus cancer	48	52–53	171–174	180–182	179–182
Other cancer	45, 49–57, 74	44, 51, 54–60	140–9, 164–170, 175–239	140–9, 170–9, 183–239	140–9, 170–8, 183–239
Cardiovascular	58, 83, 90–103	70, 79–86	330–34, 400–68	390–458	390–459
Diabetes	61	63	260	250	250
Cirrhosis	77, 124	105	581	571	571
Automobile accidents	170	138	810–835	810–825	810–825
Other accidents and violence	163–9, 171–6, 178–195	139–150	800–9, 840–999	800–7, 830–999	800–7, 830–999
Ill-defined, senility	162, 199, 200	136–137	790–795	790–795	790–795

years as denominators. Child mortality rates were estimated from the census data on the proportions of surviving children.

The analysis considers the following explanatory variables:

(a) Socio-economic development, as estimated by an index computed from a linear combination of census data on seven indicators. These indicators with their weights indicated in parentheses are household income (1), proportion of non-agricultural activities (1), urbanization (1), women in the labour force (3), literacy (3), school attendance (2), and school attainment (2). The weights were determined with exploratory factor analysis. Detailed information from this index and the definition of the 100 counties is presented elsewhere (Rosero-Bixby, 1991*b*: ch. V).

(b) Social security, an indicator of access to medical services, is the proportion of population covered by the social security system according to the 1973 and 1984 censuses.

(c) Medically assisted deaths, a proportion computed from vital statistics.

(d) Primary health care services, as estimated by the proportion of population living in areas administratively covered by the rural and community health programs in 1984 (these programmes started in 1972).

(e) Improvement in access to secondary health care, as estimated by the proportion of population living in the catchment areas of health centres or clinics opened between 1970 and 1983.

(f) Travel time to San José in 1970 and 1984, an indicator of access to health and other services only available in the capital, estimated as the average of the times for each census tract, as assessed by supervisors of the 1984 census (unpublished information).

Multiple regression models for this areal data set are estimated with Generalized Least Squares, using as a weighting variable the square root of the population (young or older adults) in the county. This procedure purges the distortion caused by the different variance of residuals due to the different demographic size of counties (Hanushek and Jackson, 1977: 150–68). The regression models were estimated using the computer package SHAZAM.

4. Level and Trend in Adult Mortality

In 1920, a 20-year-old Costa Rican had a 40 per cent chance of dying before reaching age 50; in 1990 the risk was only 6.1 per cent for men and 3.3 per cent for women, a fall of more than 80 per cent (Table 9.3). This decline is of similar magnitude to that observed in infant mortality, which fell from 200 to 16 per 1000 during this period (Rosero-Bixby and Caamaño, 1984). Young adult mortality diminished steadily during these 70 years except in the period 1960–5, when men's mortality increased slightly. The fastest decline occurred in the 1950s when Costa Rica benefited from discoveries associated with World War II, notably antibiotics and DDT. The risk of dying for young adults diminished by about 5 per cent a year during that decade. The second fastest decline took place in the 1940s, and was probably conditioned by factors similar to those operating in the 1950s. In addition, the 1970s were highly advantageous for women, probably due to improved reproductive health conditions.

The decline in the risk of dying at older ages (50 to 79 years) was not as dramatic as that at younger ages, but was still substantial. The probability of dying in this age interval was 54 per cent among men and 40 per cent among women in 1990, about 40 per cent lower than 70 years earlier (Table 9.3). The fastest decline in mortality at older ages took place in the late 1980s, which was a period characterized by adverse socio-economic conditions and reductions in expenditure on public health. The early 1970s is another period of accelerated reduction in the mortality of this age group (Table 9.3). The temporal sequence of mortality decline among older adults is thus different from that among young adults. There is, however, some coincidence in the cohort sequence of the transition. The beneficiaries of the accelerated decline at older ages in the 1980s were the same cohorts that experienced a fast decline at young adult ages in the 1950s.

The widening of the sex differential in adult mortality, especially among

Table 9.3. Risk of dying among adults in the age groups 20–49 and 50–79 years, Costa Rica 1920–90

Year	Mortality per 1000		Sex ratio	Annual change (%)	
	Male	Female		Male	Female
Young adults (20–49 years)					
1920	402	404	0.99	–4.2	–4.2
1930	264	265	0.99	–1.0	–1.1
1940	239	238	1.00	–4.3	–4.8
1950	155	148	1.05	–4.5	–5.1
1960	99	89	1.11	0.7	–1.8
1965	102	81	1.25	–1.1	–3.9
1970	96	67	1.43	–1.8	–4.3
1975	88	54	1.62	–2.9	–4.8
1980	76	43	1.78	–3.6	–3.6
1985	64	36	1.79	–0.9	–1.4
1990	61	33	1.84		
Old adults (50–79 years)					
1920	858	853	1.01	–0.7	–0.9
1930	797	782	1.02	0.0	–0.2
1940	793	771	1.03	–0.5	–0.9
1950	751	704	1.07	–0.8	–1.6
1960	690	598	1.15	–0.2	–0.3
1965	684	588	1.16	–0.7	–1.0
1970	660	560	1.18	–1.2	–1.9
1975	621	511	1.22	–0.7	–1.4
1980	601	475	1.27	–0.7	–1.3
1985	579	446	1.30	–1.5	–2.1
1990	538	401	1.34		

Source: updated from Rosero and Caamaño (1984).

young adults, is a noteworthy feature of the mortality transition in Costa Rica and elsewhere. Until 1940 there was almost no difference in the risk of dying by sex. Since then the pace of mortality decline has been slower for men, raising their relative risk of dying in respect to women. In 1990, men had a risk of dying 84 per cent higher than women at young adult ages and 34 per cent higher at older adult ages.

How does the adult mortality transition in Costa Rica compare with other countries? The contrast with the United States suggests that the decline in Costa Rica has been extraordinary, particularly among men (Figure 9.1). In 1920, the risk of dying of young Costa Rican adults, men and women, was double that of US citizens. It was about 16 per cent higher at older adult ages. Costa Rican men closed this gap by 1960 and nowadays they have a 21 per cent

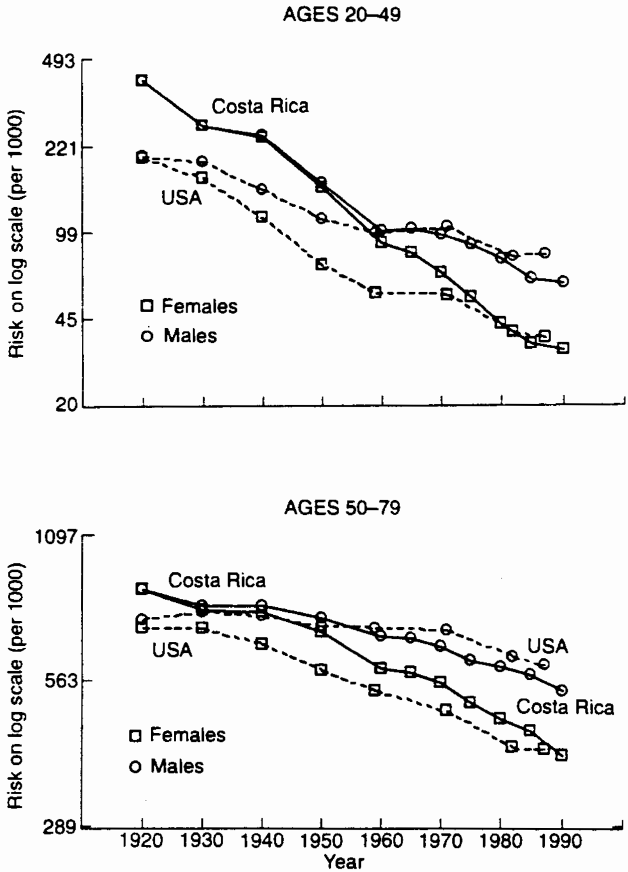

Fig. 9.1. Risk of dying in the age groups 20–49 and 50–79. Costa Rica and the USA, 1920–90
Source: Costa Rica: Table 9.2; US: National Centers for Health Statistics.

lower risk of dying than their US counterparts at young adult ages and 7 per cent lower risk at older ages (Figure 9.1). The mortality decline for Costa Rican women was relatively less steep (in spite of being faster than that of men), but it was fast enough for women to catch up with their US counterparts in the 1980s. At present, adult women in Costa Rica and the US experience approximately the same risks of dying.

A comparison with two European populations—France and the Czech Republic—suggests once again that the adult mortality decline in Costa Rica, especially among men, has been exceptional (Figure 9.2). In 1985, men's life expectancy at age 40 in Costa Rica was five years longer than in the Czech Republic and one year longer than in France, whereas that of women was two years longer than in the Czech Republic but about two years lower than in

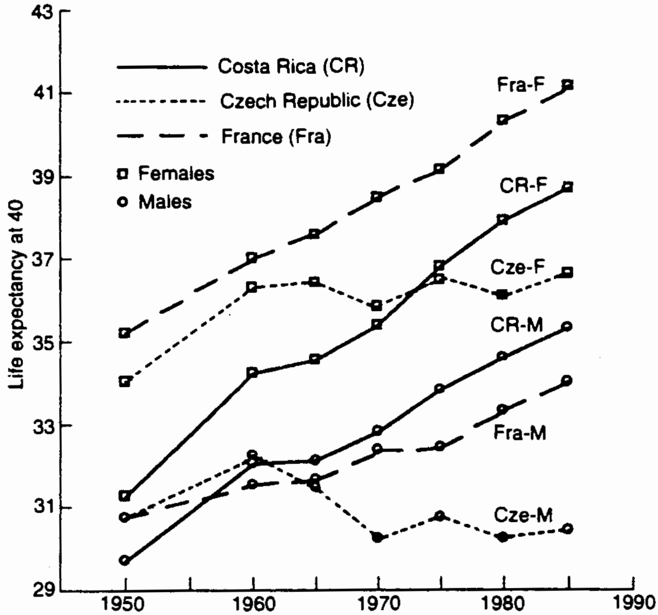

Fig. 9.2. Life expectancy at age 40 in Costa Rica, the Czech Republic and France, 1950–85
Source: Costa Rica: updated from Rosero-Bixby and Caamaño (1984); France and the Czech Republic: Rytchtaríková *et al.* (1990).

France. Figure 9.2 also illustrates that continuous progress in contemporary adult mortality is by no means the rule. In the Czech Republic, as in the rest of Eastern Europe and the former Soviet Union, adult mortality has stalled or deteriorated since the 1960s (Bourgeois-Pichat, 1985).

Another feature of adult mortality trends in Costa Rica is that the widening of the sex-gap has been less severe than in industrialized countries. Although progress in reducing adult male mortality in Costa Rica has been slower than for adult women, it was substantially faster than in industrialized countries. Conversely, although mortality decline among Costa Rican women has been substantially faster than among men, it has not been fast enough to catch up with the levels prevailing in industrialized countries.

5. Causes of Death

A salient aspect of the epidemiologic transition is the shift in cause of death patterns from infection and malnutrition to degenerative and man-made conditions as the leading causes of death (Omran, 1982). Mohs (1991) contrasts two paradigms in the explanation of this shift, the 'malnutrition paradigm' which emphasizes the improvement in living conditions, and the 'infectious diseases paradigm' which underscores the role of health interventions, especially in the lagged transitions of the less developed countries. How well does the Costa Rican cause-of-death pattern of decline in adult ages fit this picture of the epidemiologic transition?

Data available for the period since 1951 show that the cause of death profile has changed in Costa Rica in the expected direction: the importance of infections and malnutrition has declined, whereas that of degenerative and man-made conditions has increased (Figure 9.3). More specifically, the place left vacant by the decline in infectious and deficiency diseases was taken largely by accidents and violence at young adult ages (38 per cent of deaths in 1989–90) and by cardiovascular diseases at older adult ages (39 per cent of deaths in 1989–90). It is important to point out, however, that the contribution of infectious and deficiency diseases to adult mortality was somewhat limited in the past: 40 and 19 per cent of deaths in the age groups 20 to 49 years and 50 to 79 years, respectively, in 1951–2.

The proportion of ill-defined causes of death (including those classified as 'senility') gives an idea of the quality of cause of death data. This proportion was 9 and 12 per cent at young and older ages respectively in 1951–2, which is unusually low for a developing country four decades ago. Reflecting an improvement in data quality, the group of ill-defined causes declined to 2 per cent of deaths in 1989–90 in both age groups, a figure that is consistent with the fact that 96 per cent of deaths in Costa Rica were medically certified in 1990. The reduction in the proportion of ill-defined causes of death, in spite of being

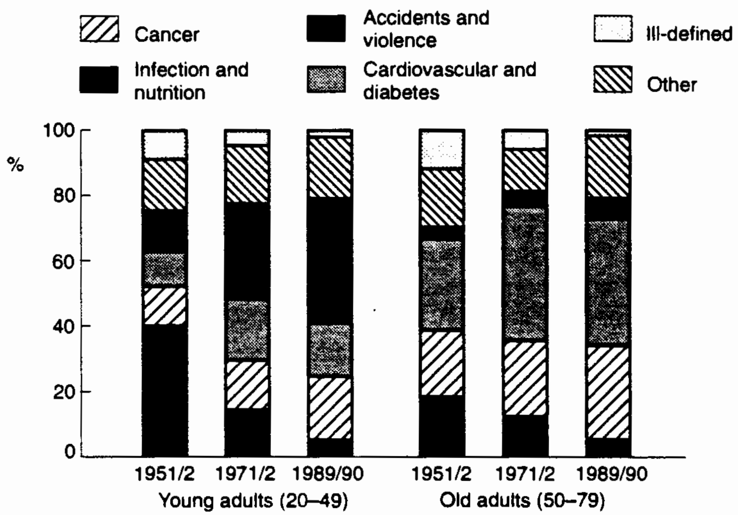

Fig. 9.3. Distribution of deaths by groups of causes: Costa Rica, adults, 1951–90

a favourable trend, is a nuisance for the study of cause-specific mortality over time. It is possible, for example, that a part of the decline in infections and malnutrition has been blurred by improved diagnosis, or that a part of the increase in the contribution of cardiovascular diseases has been an artifact of better diagnoses.

Figure 9.4 shows the evolution in the risks of dying from selected groups of causes of death, as defined in Table 9.2. The upper part of the figure presents conditions of infectious or nutritional origin. The dramatic declines in respiratory tuberculosis at young adult ages during the 1950s and in acute respiratory infections during the 1970s stand out. The virtual elimination of malaria in the 1950s was a notable achievement in both age groups. The reduction in maternal mortality in the 1960s, probably a byproduct of the fertility transition, was another noteworthy trend. The risk of dying from diarrhoeal diseases and nutritional conditions exhibits a sustained decline during the period, although it is not as fast as the aforementioned reductions. The only clear increase in mortality from diseases of infectious origin is for acute respiratory infections at older ages between 1951 and 1971. The risk of dying from these conditions rose from 33 to 60 per 1000 in these twenty years. Part of this increase could be an artifact of changes in diagnostic practices.

The lower part of Figure 9.4 shows the evolution in the risk of dying from degenerative and man-made conditions. There are several negative trends. The most serious are the increase in automobile accidents, cardiovascular diseases, and diabetes from 1951–2 to 1971–2. Mortality from automobile accidents at young adult ages underwent a seven-fold increase in this period, whereas that caused by diabetes at older adult ages underwent a three-fold increase. Mortality from respiratory cancer (chiefly lung cancer) also increases substantially, particularly for young adults in the 1960s and for older adults in the 1970s. The risk of dying from respiratory cancer in 1989–90 is three and two times greater than in 1951–2 at young and older adult ages, respectively.

The most notable trend in this group of causes of death was the sharp decline in cardiovascular mortality in the 1970s (Figure 9.4). The decline was one of 38 per cent and 25 per cent at young and older adult ages respectively during the decade. Major declines in diabetes, accidents and violence (including automobile accidents) also took place during this decade. The large reduction in mortality from cancer of the uterus (chiefly cervical neoplasms) in the 1960s has been linked to screening programmes implemented, in part, along with family planning services (Rosero-Bixby and Grimaldo, 1987). In turn, the decline in digestive cancer (chiefly stomach cancer) has a special significance, due to its extraordinarily high incidence in Costa Rica. The risk of dying from digestive cancer was 46 per cent lower in 1989–90 than in 1951–2 at young adult ages, and 18 per cent lower than in 1961–2 at older adult ages.

Table 9.4 shows the estimated contributions of each cause of death to the overall mortality decline. This 'attributable decline' depends on both the pace of change in a particular cause and its baseline level. About three-quarters of

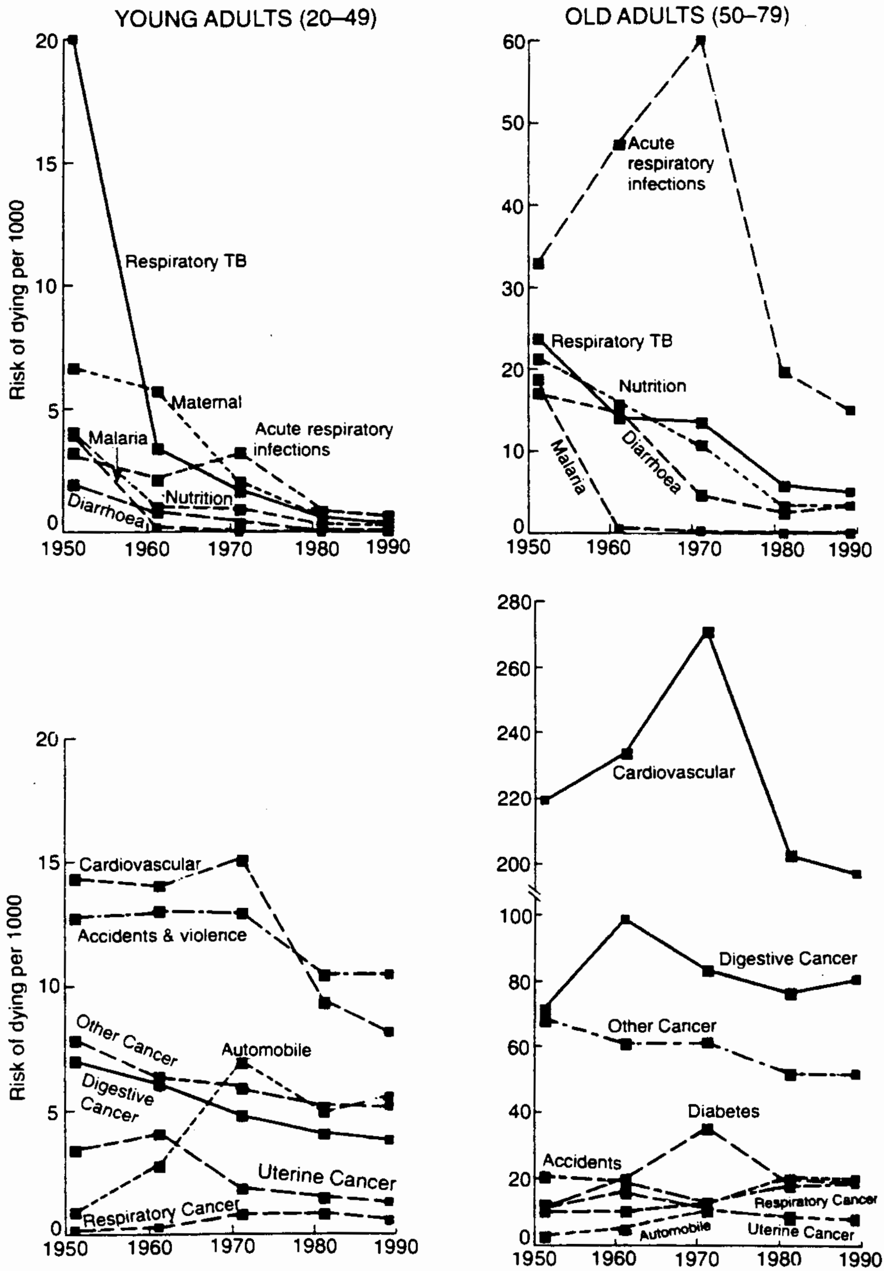

Fig. 9.4. Risk of dying by selected causes of death: Costa Rican adults, 1951–90
Source: Table 9.2 and 9.A1.

Table 9.4. Attributable decline in adults' risk of dying in 1951–71 and 1971–89

Cause of death	Percent attributable decline			
	Ages 20–49		Ages 50–79	
	1951–71	1971–89	1951–71	1971–89
Respiratory TB	37.0	4.4	16.5	4.1
Malaria	7.9	0.1	29.7	0.1
Diarrhoeal diseases	3.0	1.1	20.0	0.6
Acute respiratory infections	–0.1	8.7	–44.8	22.1
Other infections and parasitic	12.9	7.0	34.0	3.0
Malnutrition	6.3	2.3	17.2	3.4
Maternal	9.4	5.5	0.0	0.0
Subtotal: infection–nutrition	76.4	29.1	72.7	33.3
Digestive cancer	4.4	3.5	–19.4	1.2
Respiratory cancer	–1.2	0.7	–3.8	–3.5
Uterus cancer	3.1	1.9	2.3	1.7
Other cancers	3.9	2.7	11.5	4.6
Subtotal: cancer	10.2	8.8	–9.3	4.1
Cardiovascular	–1.5	23.4	–108.6	45.5
Diabetes	–1.7	0.7	–38.4	7.4
Subtotal: cardiovascular–diabetes	–3.2	24.1	–147.0	52.9
Automobile accidents	–12.1	4.7	–12.9	1.1
Accidents and violence	–0.5	8.4	12.3	–2.8
Subtotal: accidents–violence	–12.6	13.1	–0.6	–1.7
Cirrhosis	1.5	–2.4	–1.7	–2.4
Ill-defined, senility	15.0	11.0	92.1	19.7
Residual	12.7	16.4	93.8	–5.9
Total	100.0	100.0	100.0	100.0

Source: Table 9.A1.

the mortality reduction at both young and older ages from 1951–2 to 1971–2 can be attributed to the control of infectious diseases and malnutrition. This contribution declined to about 30 per cent in the 1970s and 1980s. In this later period, cardiovascular diseases accounted for approximately one-quarter of the decline at young adult ages and one-half at older adult ages. An increase in accidents and violence counteracted the adult mortality decline in the 1950s and 1960s by 13 per cent, whereas in the 1970s and 1980s external causes contributed 13 per cent to the decline. The contribution of tuberculosis and malaria to the early mortality transition is outstanding. The control of these two diseases alone explains about 45 per cent of the adult-mortality decline from 1951–2 to 1971–2 in the two age groups studied. A 9 per cent contribution of maternal deaths to the decline in young adult mortality in this early period is also noteworthy.

A large decline of ill-defined causes of death, which is almost as large as the decline in all other causes, confounds analysis of the components of the early mortality transition in the older age group (Table 9.4). Part of the negative contributions of cardiovascular diseases (–109 per cent), acute respiratory infections (–45 per cent), diabetes (–38 per cent), and digestive cancer (–19 per cent) is probably due to the reduction in ill-defined causes of death. However, this artifact could only explain a fraction of these negative contributions (44 per cent at the most). It seems that the increases in these causes of death and automobile accidents diminished by more than one-half the potential mortality decline brought about by other causes. This adverse effect may be ascribable to the negative influence of economic development and affluence: the increase in automobile accidents is a clear example of this. Part of the increase in diabetes, cardiovascular diseases, respiratory cancer and, perhaps, respiratory infections can be linked to modern lifestyles, including obesity, smoking, sedentary habits, and consumption of animal fats. It seems, however, that these deleterious consequences of progress were neutralized in the 1970s and 1980s.

Data by sex on the cause-specific mortality (Table 9.5), are only available for the period since 1971. They corroborate the aforementioned trends, such as the large contribution of cardiovascular disease to the mortality decline. At young adult ages, the most important factor in the mortality decline among men was the control of accidents and violence (23 per cent contribution). These causes of death made almost no contribution to the decline among women. Cardiovascular diseases played a more important role in women (29 per cent) than in men (18 per cent). Maternal mortality was the second most important component (12 per cent contribution) among women. At older adult ages, the contribution of digestive and respiratory cancer exhibits major sex-differences. Mortality from these tumours increased among men and made a negative contribution to the transition. Among women, there was almost no increase in respiratory cancer and digestive cancer decreased. Therefore, the widening of the sex differential in mortality at young ages was a result of the reduction in maternal mortality and a more rapid decline of cardiovascular mortality among women. At older adult ages, the increasing differential resulted largely from an increase in deaths from respiratory and digestive cancer among men.

How does the cause of death profile of Costa Rican adults compare with that of other populations? A comparison with Argentina and Chile has shown that infectious and parasitic diseases mortality (including pneumonia and bronchitis) is relatively low in Costa Rica, whereas men's mortality from accidents is higher (Arriaga, 1991; Table 9.4). Other international comparisons single out Costa Rica for its high mortality from stomach cancer and accidents and its relatively low mortality from lung cancer and cardiovascular diseases (Brouard and Lopez, 1985; Meslé, 1985).

Table 9.5. Risk of dying by sex for 17 groups of causes of death, young and older adults, Costa Rica, 1971–90

Cause of death	Male risk per 1000			Female risk per 1000			Attributable decline 1971–89 (%)	
	1971–2	1981–2	1989–90	1971–2	1981–2	1989–90	Males	Females
Young adults (20–49)								
Respiratory tuberculosis	1.7	1.1	0.5	1.7	0.6	0.2	3.6	5.3
Diarrhoeal diseases	0.5	0.1	0.1	0.3	0.1	0.1	1.5	0.6
Acute respiratory infections	3.6	1.0	0.7	2.8	0.7	0.5	8.9	8.6
Other infections and parasitic	2.8	1.1	1.0	3.1	0.8	0.7	5.4	8.8
Malnutrition	1.1	0.2	0.3	0.8	0.4	0.2	2.6	2.0
Maternal	0.0	0.0	0.0	4.0	1.2	0.7	0.0	11.9
Digestive cancer	6.2	4.3	4.5	3.4	3.8	3.0	5.3	1.4
Respiratory cancer	1.0	1.2	0.5	0.6	0.5	0.6	1.5	−0.2
Uterus cancer	0.0	0.0	0.0	3.7	3.0	2.6	0.0	3.9
Other cancer	4.8	4.5	4.4	7.2	5.9	5.9	1.3	4.5
Cardiovascular	15.8	10.8	9.8	14.3	7.9	6.3	18.5	29.0
Diabetes	0.9	0.9	1.0	1.8	1.1	1.3	−0.5	2.0
Cirrhosis	2.4	3.3	3.5	1.0	0.9	1.3	−3.4	−1.2
Automobile accidents	12.0	8.4	9.5	1.7	1.5	1.5	7.9	1.0
Other accidents, and violence	22.5	18.3	17.7	3.2	2.4	3.1	15.1	0.7
Ill-defined, senility	5.8	1.9	1.4	2.7	2.2	0.4	13.4	8.1
Residual	13.9	7.4	7.8	10.2	7.0	6.5	18.7	13.7
Total	91.4	62.7	61.2	60.8	39.3	34.3	100.0	100.0
Old adults (50–79)								
Respiratory tuberculosis	18.4	8.4	7.9	9.3	3.6	2.6	5.7	3.0
Diarrhoeal diseases	4.4	3.4	3.6	4.8	1.8	3.3	0.4	0.6
Acute respiratory infections	61.4	22.6	17.2	59.0	16.9	13.3	24.6	20.6
Other infections. and parasitic	15.9	8.4	9.0	9.9	7.1	4.2	3.8	2.5
Malnutrition	11.3	4.7	3.9	10.1	2.1	3.0	4.0	3.1
Digestive cancer	99.5	102.1	108.9	67.5	52.4	55.2	−5.6	5.7
Respiratory cancer	17.1	30.0	30.3	8.3	11.6	10.3	−7.2	−0.9
Uterus cancer	0.0	0.0	0.0	21.2	16.5	14.4	0.0	3.0
Other cancer	72.0	63.4	63.0	52.4	42.7	43.3	5.1	4.2
Cardiovascular	299.0	233.8	231.4	245.6	174.5	166.0	49.0	43.4
Diabetes	27.5	13.7	14.1	41.9	22.5	25.1	7.3	7.5
Cirrhosis	12.6	12.7	18.5	5.5	9.5	9.4	−3.2	−1.7
Automobile accidents	16.8	15.7	13.2	4.8	1.9	3.6	2.0	0.5
Other accidents, and violence	20.4	25.9	28.7	6.2	9.9	9.6	−4.6	−1.5
Ill-defined, senility	60.8	53.3	14.4	42.4	42.4	7.7	25.7	15.4
Residual	98.6	101.0	110.3	71.9	72.3	82.9	−7.0	−5.3
Total	597.6	526.5	514.6	507.3	400.5	378.9	100.0	100.0

Table 9.6 compares the risks of dying from selected causes in Costa Rica and the USA in the late 1980s. Heart disease and respiratory cancer are the key to the comparatively low mortality of Costa Rica (see risk-differences in Table 9.6). Consumption of cigarettes is substantially lower in Costa Rica than in the USA and is a likely explanation of some of this differential (Ravenholt, 1990). Other plausible explanations of lower heart disease mortality in Costa Rica are a less stressful lifestyle, less sedentary habits, particularly in rural areas, less fat and protein in the diet, and a lower prevalence of obesity among men. The sharp decline in cardiovascular mortality in both Costa Rica and the USA

Table 9.6. Risk of dying at ages 25–74 years for selected causes of death, comparison between Costa Rica, 1988 and the USA, 1987

Cause of death (ICD Codes[a])	Mortality per 1000			
	CR-1988	US-1987	Difference CR-US	Ratio CR/US
Males				
Heart disease (390–429)	117.8	204.5	–86.7	0.58
Respiratory cancer (162)	18.8	68.5	–49.7	0.27
Other cancer (140–208, exc. 151, 162)	72.9	101.1	–28.2	0.72
Diabetes (250)	11.3	10.7	0.6	1.05
Other accidents and violence (800–9, 820–999)	38.5	35.2	3.3	1.09
Cirrhosis (571)	17.7	14.1	3.6	1.25
Automobile accidents (810–819)	18.4	12.7	5.7	1.45
Stroke (430–438)	34.0	26.6	7.4	1.28
Stomach cancer (151)	47.8	5.8	42.0	8.30
Females				
Heart disease (390–429)	71.7	99.9	–28.2	0.72
Respiratory cancer (162)	5.7	28.5	–22.9	0.20
Other cancer (140–208, exc. 151, 162, 180)	67.6	86.5	–19.0	0.78
Other accidents and violence (800–9, 820–999)	9.2	10.9	–1.7	0.85
Automobile accidents (810–819)	3.9	5.3	–1.5	0.72
Cirrhosis (571)	6.8	6.2	0.6	1.09
Stroke (430–438)	27.0	21.1	5.9	1.28
Cervical cancer (180)	11.0	2.8	8.3	3.96
Diabetes (250)	20.0	9.7	10.3	2.06
Stomach cancer (151)	18.5	2.4	16.1	7.56

[a] International Classification of Diseases (ICD), 9th Revision.

Source: PAHO, 1990, Vol. I, Tables III-9.

in the 1970s and 1980s is an encouraging development, suggesting that progress need not necessarily result in an increase in such mortality. The future of mortality from respiratory cancer in Costa Rica is less appealing. An increase in smoking in young generations in the 1960s, which probably took place because of the boom in television and communications, will have an impact on mortality from respiratory cancer thirty to fifty years later, that is after 1990.

In the group 'other cancer' Costa Ricans are again fortunate (Table 9.6). The differences from the USA under this rubric come mostly from bladder and prostate cancer in men and breast cancer in women. The future evolution of bladder and prostate cancer in Costa Rica is uncertain, but breast cancer will probably increase substantially. A slight increase of breast cancer mortality has already been observed and a substantial increase (32 per cent in twenty years) in the incidence of this cancer has been projected just as a consequence of past fertility reductions (Rosero-Bixby *et al.*, 1987).

Mortality from stomach cancer is eight times higher in Costa Rica than in the USA. Nevertheless, an encouraging decline has already occurred in Costa Rica and will probably continue in the future. Stomach cancer mortality has been decreasing dramatically in the USA (more in women than in men) for several decades: in 1973–4, this rate was one-fifth its level in 1935 among white females (Devesa and Silverman, 1978; Table 9.4). Although the causes of this decline are still unknown, it seems reasonable to expect a similar trend in Costa Rica.

The comparison with the USA also suggests that Costa Rica could achieve important mortality reductions from the death rates due to stroke in both sexes, automobile accidents in men, and diabetes and cervical cancer in women. Several technologies are already available to intervene against these causes of death.

6. Areal Variation in Adult Mortality

The data examined so far have shown puzzling relationships between socio-economic development, expenditure on health services and adult-mortality transition in Costa Rica. National indicators of adult mortality, socio-economic progress, and health interventions follow disparate trends. Moreover, adults in Costa Rica face similar, or even lesser, mortality risks than their counterparts in the USA, despite the enormous differences between them in income, social organization, and availability of health facilities. The analysis of causes of death offers hints about the forces that reduced adult mortality in Costa Rica but also raises questions regarding the possible determinants of cardiovascular mortality trends. An examination of areal variation in adult mortality and its correlates might provide additional clues about the role that socio-economic development and health interventions play in determining adult mortality in Costa Rica.

The areal (or ecological) analysis uses a territorial division of Costa Rica into 100 'counties' defined for other purposes (Rosero-Bixby, 1991*b*). Four-fifths of the counties are in the range of 6000 to 60,000 population. The analysis covers two three-year periods centred on the census years 1973 and 1984. The adult mortality rates at young ages (20 to 49 years) and older ages (50 to 79 years) are analysed separately. Three mortality rates are studied in each age group: all causes of death; infectious diseases and malnutrition; and cardiovascular diseases and diabetes. It is important to keep in mind the considerable random variation existing in these county-level rates because of the small numbers involved, particularly in the young adult age group.

Are there geographical regularities in adult mortality in Costa Rica? The choropleth map of cardiovascular mortality at older ages in 1973 (Figure 9.5) suggests geographical clustering: counties with higher cardiovascular mortality tend to line up along an interoceanic axis between the ports of Puntarenas and Limón, including the Central Valley and the capital city, San José. It is precisely along this axis that Costa Rica traditionally concentrated its socio-economic and demographic development (Hall, 1985). The map therefore suggests a correspondence between cardiovascular mortality and development. Other choropleth maps (1984, all causes of death, young adult ages) present less clear geographical clustering. Maps (not shown) for the young adult ages and infection-malnutrition conditions, in particular, resemble a chess board, without spatial regularities.

Figure 9.5 also includes a map describing the pace of decline in cardiovascular mortality between 1973 and 1984. The geographical pattern is less clear in this than in the 1973 mortality level map. Nevertheless, a 'regression to the mean' phenomenon is clearly present: those counties with the lowest rates in 1973 tend to be the ones where the rate increases most in the following decade.

Pearson correlation coefficients (r) can be used to check the existence of ecological covariations between adult mortality in Costa Rican counties and their socio-economic and health status (Table 9.7). To illustrate, correlation coefficients smaller than 0.20 in absolute value indicate lack of, or non-significant, association; coefficients between 0.20 and 0.39 indicate a modest but significant association; and coefficients of 0.40 or larger indicate a close association. Mortality rates at young and older adult ages are weakly correlated (Table 9.7). The largest correlation coefficient between young and adult mortality is a modest 0.31 for infections and malnutrition in 1973. In addition, neither young nor older adult mortality rates are correlated meaningfully with infant mortality. The only two correlations with infant mortality of a significant magnitude are negative in sign. Mortality from cardiovascular disease tends to be high in counties with low infant mortality in 1973, a pattern consistent with that shown in Figure 9.5. The lack of a positive association

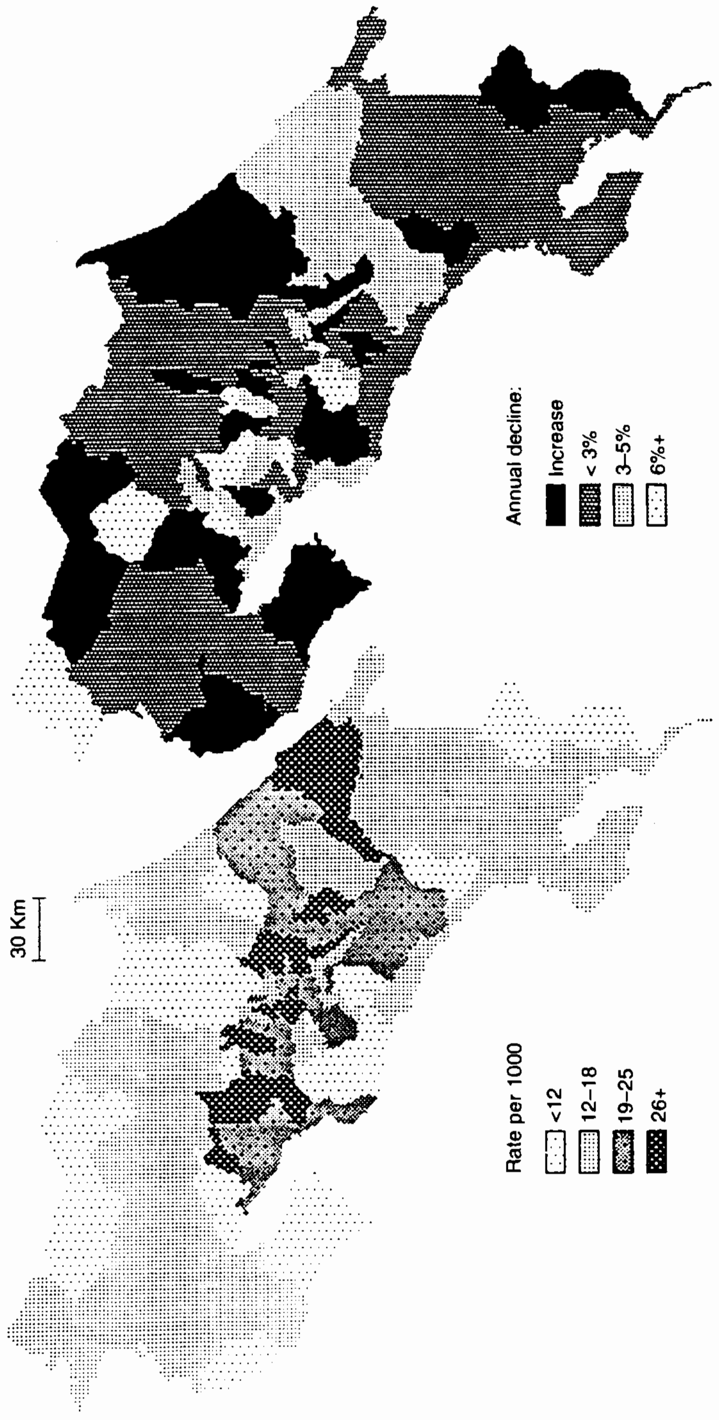

Fig. 9.5. Level and change in the mortality rate from cardiovascular diseases and diabetes at ages 50–79

Table 9.7. Relationship between adult mortality and selected variables, 100 Costa Rican counties, 1973 and 1984

Variable[a]	All causes		Infection–nutrition		Cardiovascular–diabetes	
	1973	1984	1973	1984	1973	1984
Correlations between young adult mortality and:						
Mortality among:						
Older adults (50–79 years)	0.18	−0.06	0.31	−0.08	0.21	0.22
Infants	0.06	0.04	0.14	0.08	−0.10	−0.02
Socioeconomic development:						
10 years earlier	0.12	0.02	0.16	0.04	0.29	0.22
contemporary	0.11	0.01	0.16	0.04	0.32	0.23
Social security	0.14	−0.06	0.10	0.03	0.33	0.06
Medically assisted deaths	0.08	−0.18	0.20	−0.08	0.38	−0.09
Primary care	—	−0.05	—	−0.03	—	−0.12
Travel time to San José	−0.3	0.08	−0.02	0.17	−0.27	−0.14
Correlations between older adult mortality and:						
Mortality among:						
Young adults (20–49 years)	0.18	−0.06	0.31	−0.08	0.21	0.22
Infants	−0.31	0.01	0.15	−0.01	−0.35	−0.06
Socioeconomic development:						
10 years earlier	0.52	0.48	0.19	0.28	0.60	0.59
contemporary	0.49	0.46	0.22	0.26	0.58	0.59
Social security	0.53	0.43	0.21	0.29	0.59	0.57
Medically assisted deaths	0.48	0.42	0.17	0.11	0.67	0.54
Primary care	—	−0.24	—	−0.17	—	−0.24
Travel time to San José	−0.48	−0.44	−0.17	−0.21	−0.51	−0.53

[a] For definitions see text.

between adult and infant mortality suggests that conclusions from previous studies about the determinants of the breakthrough in the Costa Rican infant mortality in the 1970s cannot be extrapolated to explain the adult mortality transition.

Young adult mortality shows almost no association with indicators of development and health services (Table 9.7). In contrast, older adult mortality, especially cardiovascular deaths, correlates closely with socio-economic and health indicators, with mortality tending to be lower in backward counties and areas farther away from San José. These inverted correlations are modest for death rates linked to infection and nutrition (about 0.20 to 0.30), whereas they are substantial (0.50 to 0.60 at older ages) for cardiovascular diseases and diabetes.

Data errors, such as differential integrity in the registry of deaths or biased reports of the place of residence of the dead, are unlikely explanations for the odd behaviour of adult mortality rates, since the problem is not present in infant mortality rates based on the same data source. For example, an earlier study shows that the infant mortality rate in 1972–5 and 1982–4 was negatively and significantly correlated with such characteristics as the proportion of deaths medically-certified, coverage of social security, and proportion of dwellings with plumbing (Cervantes and Raabe, 1991; Tables 9.1 and 9.2).

One plausible explanation of the inverse association is reverse causality between adult mortality and place of residence: sick adults may tend to migrate to places with better health facilities and higher levels of development, artificially increasing mortality rates in the better-off counties. The targeting of health interventions on backward areas could also generate reverse causality since high mortality counties would appear as being better-off in terms of health services. Another explanatory mechanism is the existence of 'frailty', or selection effects: backward counties may have low adult mortality rates because historically high child mortality eliminated the frail children in each cohort, leaving alive a select group of more resistant individuals (Vaupel *et al.*, 1979). A more straightforward explanation is that economic progress and modern lifestyles indeed raise adult mortality, particularly that of cardiovascular origin.

A further step in the analysis is modelling mortality decline, rather than its level, as a function of changes in the potential explanatory variables. An analysis based on changes rather than levels has advantages like controlling the effect of unmeasured variables (e.g. the 'targeting' problem); in addition, some data errors neutralize each other by the computation of changes (Liker *et al.*, 1985). Random and other errors, however, can be magnified by the computation of changes, and the 'regression to the mean' phenomenon can introduce considerable noise into the variance of changes (Bohrnstedt, 1969). Due to these problems, the magnitude of correlations for changes is usually lower than for levels (Freedman and Takeshita, 1969).

Table 9.8 shows the results of estimating, with generalized least squares, multiple regression models of the percentage decline in mortality during 1973–84 for: young adults, all causes of death; older adults, all causes; older adults, infection and malnutrition; and older adults, cardiovascular diseases and

Table 9.8. Standardized regression coefficients (t-ratios) on the relative decline in adult mortality from 1972–4 to 1983–5, 100 Costa Rican counties

Explanatory variables	Young adults (20–49 years)	Older adults (50–79 years)		
		All causes	Infection-nutrition	Cardio-vascular
Initial mortality level (1972–74)	0.159 (1.45[a])	–0.059 (–0.55)	0.158 (1.54[a])	0.007 (0.07)
Pace of socioeconomic development				
A decade earlier (1963–73)	0.102 (0.81)	–0.040 (–0.32)	0.219 (1.80[b])	–0.028 (–0.23)
Contemporary (1973–84)	–0.002 (–0.02)	–0.014 (–0.11)	0.027 (0.22)	–0.163 (–1.32[a])
Relative decline in travel time to San José 1970–84	–0.107 (–0.86)	–0.091 (–0.74)	–0.146 (–1.24)	0.113 (0.93)
Increase in Social Security System coverage 1973–84	–0.099 (–0.73)	–0.233 (–1.78[b])	–0.158 (–1.25)	–0.047 (–0.36)
Increase in the proportion of MD assisted deaths	–0.144 (–0.96)	–0.086 (–0.74)	–0.106 (–0.94)	0.126 (–1.10)
Increase in primary health care services 1972–84	0.077 (0.51)	0.009 (0.06)	0.061 (0.42)	–0.153 (–1.04)
Improvement in access to secondary health care 1970–84	–0.055 (–0.41)	–0.022 (–0.17)	–0.055 (–0.43)	–0.030 (–0.23)
Adjusted R^2	0.033	0.006	0.059	0.014

[a] Significant at 0.90.
[b] Significant at 0.95.

diabetes. Cause-specific mortality decline at young adult ages cannot be analysed because the small number of deaths involved yields highly unreliable estimates.

In the four multiple regression models in Table 9.8 only a few regression coefficients appear statistically significant. Initial mortality levels exert a positive and significant influence on the declines in young adult and in older adult mortality from infections and malnutrition. These significant effects are manifestations of the regression to the mean trend: mortality is easier to lower where it is high initially. The speed of socio-economic progress ten years earlier appears to be a significant factor in the speed of decline in older age mortality from diseases of infectious and nutritional origin, whereas contemporary progress exerts a negative influence on the decline in mortality from cardiovascular disease. Social security coverage also has a significant negative effect on older age mortality from all causes.

A perturbing result in Table 9.8 is that the data fail to show any meaningful impact of interventions like the development of new clinics or the expansion of primary health coverage upon adult mortality. This is in sharp contrast with the findings of earlier studies that showed a clear linkage between these interventions and the infant mortality decline in the 1970s (Rosero-Bixby, 1986).

7. Conclusions

Mortality at young adult ages has declined during the present century to a similar degree to infant mortality (80 per cent from 1920 to 1990). The proportional decline at older adult ages was also substantial but represented only about one half of that at younger ages. Women's mortality decreased more than men's, giving rise to a widening sex differential. The most fruitful period in the control of young adult mortality was after the Second World War; at older adult ages it was the late 1980s. This exceptionally fast decline has allowed Costa Rica to close the gap with industrialized countries. At present, adult men in Costa Rica face lower risks of dying than men in countries such as the USA and France (women face similar or slightly higher risks than their counterparts of these nations).

It is hard to trace an association between the pace of adult mortality decline and trends in socio-economic development and in health interventions in Costa Rica. The decade of fastest economic growth and expansion of expenditure on health was the 1960s. Most of the Costa Rican fertility transition also occurred in these years. It was precisely in this decade, however, when the mortality transition presented signs of stagnation. Conversely, it was in the decade of stalling, or even deteriorating, socio-economic conditions and public health interventions—the 1980s—that the greatest reductions in older adult mortality occurred. On the other hand, the most fruitful period for young adult mortality—the 1950s—was the decade with the fastest progress in educational enrolment and sanitation, as well as in the expansion of basic hospital care like institutional childbirth. The existence of cohort effects, long latency periods, and complex lagged reactions might be the cause for these puzzling temporal relationships. It is also possible that some degree of independence actually exists between adult mortality and the socio-economic and programmatic environment. In this case, the key factors explaining adult mortality trends might be the diffusion of innovations among health professionals and of life styles (good and bad) and health practices among the general population.

Areal analyses of adult mortality suggests that cardiovascular and diabetes mortality is higher in more prosperous communities. Moreover, the decline in such mortality between 1973 and 1984 correlated negatively—and significantly—with socio-economic improvement. In contrast, the decline in mortality from infections and malnutrition was positively associated with ten-year lagged improvements in well-being. This, of course, is not a conclusive proof that development has a negative effect on adult mortality. Bad data, frailty, and the reversed causal linkages discussed already could explain all or part of this correlation. A longitudinal study in selected communities would give more conclusive answers about the impact of progress and health interventions upon the components of adult mortality and, in particular, cardiovascular deaths. Nevertheless, the results of this somewhat simplistic exercise match other pieces of evidence, such as the higher mortality rates in the USA and the adverse trends in some causes of death in the 1950s and 1960s. They suggest a picture in which socio-economic development does not necessarily enhance survival chances at adult ages.

The analysis of mortality trends by cause of death gives additional insights into the existence of a dark side to the development of the epidemiologic transition. The period from 1951–2 to 1971–2 saw substantial mortality increases from cardiovascular diseases, diabetes, automobile accidents, respiratory cancer, and respiratory infections. These probably offset more than one half the mortality decline generated by the control of other conditions. Improved diagnoses alone can hardly explain these mortality increases. Some increases were probably linked to affluence and features of modern lifestyles like smoking, sedentary habits, obesity, consumption of animal fats, and an increase in the use of motor-vehicles. It seems, however, that these deleterious consequences of progress were largely neutralized during the 1970s and 1980s.

A comparison with causes of death in the USA showed that Costa Rica's adult mortality is comparatively low because of substantially lower risks of dying from heart disease and respiratory cancer. Cigarette smoking, a habit associated with modernity, seems likely to play a central role in this difference.

The classic shift in the cause of death profile from infectious diseases and malnutrition to degenerative and man-made conditions is observed in the adult mortality transition in Costa Rica. At present, the leading causes of death are accidents and violence at young adult ages and cardiovascular diseases at older adult ages (each represents almost 40 per cent of deaths in the corresponding age group). In the early stages of Costa Rica's epidemiologic transition, the control of infections and malnutrition was the key factor of mortality decline. About three-quarters of the decline between 1951 and 1971 at both young and older adult ages can be ascribed to infectious and nutritional diseases. In particular, respiratory tuberculosis and malaria account for about 45 per cent of the decline in the two age groups, an outstanding contribution linked to the importation of cost-effective technological advances (chiefly streptomycin and DDT). The contribution of infections and malnutrition to the adult-mortality decline shrank to about 30 per cent during the period from 1971–2 to 1989–90. During this second stage, the control of cardiovascular diseases became the key factor in the decline at older ages, whereas both cardiovascular disease and accidents and violence fuelled the decline at young ages.

Trends under way and a comparison with the epidemiological profile of the USA suggest that substantial adult reductions in mortality might come in the future from control of stomach cancer, as well as from mortality from stroke, automobile accidents, diabetes (particularly in women), and cervical cancer. In addition, it is an important challenge for Costa Rica to keep its comparative advantage in heart disease mortality. Increases must be expected in lung and breast cancer mortality as consequence of past rises in smoking and reduced fertility respectively.

Shifting the focus from infant to adult mortality has exposed new facets of the epidemiologic transition in Costa Rica. Trends in the pace of adult mortality decline differ from those in infant mortality. Geographical patterns and ecological correlates are also different. The determinants of these disparate trends and geographical patterns are thus probably different as well. In particular, while the breakthrough in child survival in the 1970s can be ascribed largely to programmatic interventions, the explanation for the recent decline in adult mortality is more elusive.

Appendix 9.1

Table 9.A1. Risk of dying for 17 groups of causes of death, young and old adults, Costa Rica 1951–90

Causes of death	Risk of dying per 1000				
	1951–2	1961–2	1971–2	1981–2	1989–90
Young adults (20–49)					
Respiratory tuberculosis	19.94	3.37	1.70	0.86	0.38
Malaria	3.95	0.17	0.03	0.00	0.00
Diarrhoeal diseases	1.91	0.80	0.40	0.10	0.07
Acute respiratory infections	3.19	2.16	3.24	0.86	0.61
Other infections and parasitic	9.35	2.80	2.94	0.95	0.84
Malnutrition	4.06	1.01	0.95	0.28	0.26
Maternal	6.68	5.74	1.99	0.61	0.34
Digestive cancer	6.99	6.07	4.82	4.07	3.76
Respiratory cancer	0.20	0.29	0.79	0.85	0.58
Uterus cancer	3.42	4.06	1.88	1.49	1.31
Other cancer	7.87	6.37	5.94	5.20	5.14
Cardiovascular	14.31	14.08	15.06	9.37	8.09
Diabetes	0.51	0.67	1.36	0.97	1.15
Cirrhosis	2.43	1.02	1.69	2.10	2.41
Automobile accidents	0.92	2.79	6.94	4.97	5.52
Other accidents, and violence	12.74	12.99	12.98	10.44	10.47
Ill-defined, senility	11.67	4.92	4.23	2.03	0.92
Residual	18.29	12.92	12.05	7.20	7.14
Total	121.21	79.28	76.26	51.15	47.96
Old adults (50–79)					
Respiratory tuberculosis	23.9	14.0	13.6	5.8	5.0
Malaria	18.7	0.5	0.2	0.0	0.0
Diarrhoeal diseases	17.1	15.1	4.6	2.6	3.4
Acute respiratory infections	33.1	47.4	60.0	19.6	15.1
Other infections and parasitic	33.7	17.5	12.7	7.7	6.4
Malnutrition	21.4	16.1	10.7	3.3	3.4
Digestive cancer	71.6	98.6	82.9	76.1	80.5
Respiratory cancer	10.1	10.4	12.5	20.3	19.7
Uterus cancer	12.6	15.8	11.2	8.7	7.6

Table 9.A1. *Continued*

Causes of death	Risk of dying per 1000				
	1951–2	1961–2	1971–2	1981–2	1989–90
Other cancer	68.2	60.7	61.4	52.3	52.2
Cardiovascular	219.4	234.1	271.1	202.9	197.0
Diabetes	11.5	19.8	35.1	18.3	20.0
Cirrhosis	7.8	10.4	8.9	11.1	13.8
Automobile accidents	2.5	5.1	10.6	8.5	8.2
Other accidents, and violence	20.7	19.2	13.1	17.7	18.9
Ill-defined, senility	104.7	63.3	51.1	47.4	10.7
Residual	137.3	140.3	84.6	85.8	95.8
Total	579.6	569.7	552.2	463.3	446.3

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