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Levels and Trends in Child and Adult Mortality in Peru

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1 Introduction

Peru, with a surface area of $1\frac{1}{4}$ million sq km, is the fourth largest country in Latin America. According to the provisional results of the 1981 census (INE 1981) the population size is just over 17 million, which gives an average population density of around 13 per sq km. The population was 2 million in the middle of the 19th century, 10 million in 1961, and 13.5 million in 1972. Recent population growth has been rapid, about 2.6 per cent per annum, largely as a result of a falling death rate which has occurred without much decline in the birth rate. The US Bureau of the Census (1980) estimated a crude death rate of 13 per 1000 and a crude birth rate of 38 per 1000 for 1975.

Peru can be divided into three broad geographic regions (figure 1). The narrow ribbon of desert which stretches for 2250 km down the coast comprises 11 per cent of the area of Peru but holds 47 per cent of the population; this is the centre of commerce and the economic heart of the country. The Sierra, characterized by high mountains and deep canyons, with altitudes often well over 3000 metres, occupies a quarter of the land, but holds 43 per cent of the population. The, almost entirely, Indian population lives at subsistence level, mostly outside the market economy; they produce what they can from poor land at high altitudes, growing the staple crops, potatoes and maize. Wealthier families may have sheep, llamas or alpacas, which provide them with wool, meat, fuel and transport. There is some mining. Many people live without running water or sanitation (94 per cent of the national rural population), without electricity (97 per cent of the rural population) and speak only Quechua (50 per cent of the rural population over the age of five),[1] a language until recently given no official status in Peru.

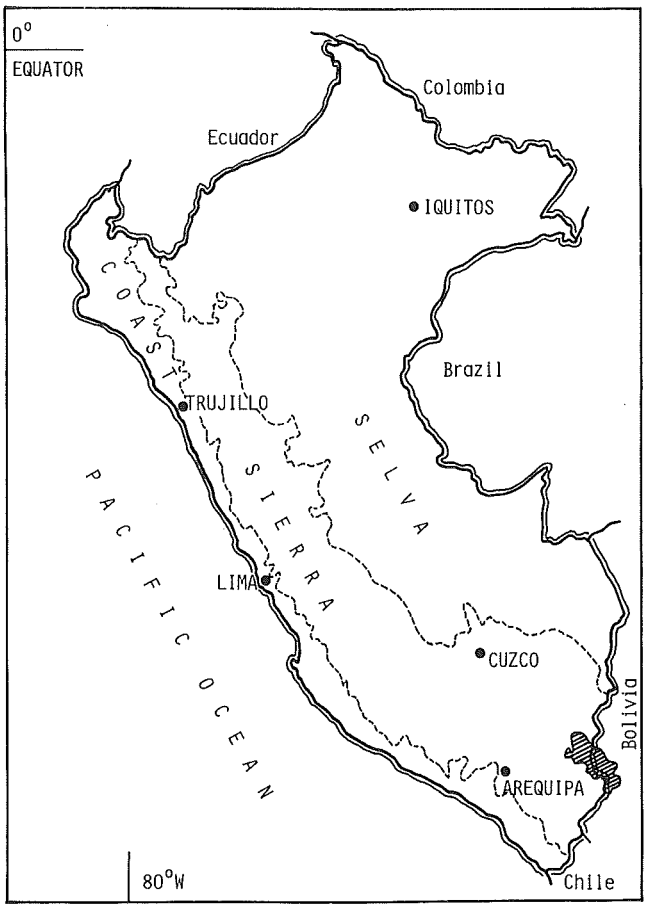

Figure 1 Map of Peru

The forested eastern half of the Andes and the tropical forest and jungle beyond constitute almost two-thirds of the surface area of Peru, but contain only 10 per cent of the population. The area is very rich in rubber, jute, rice, fruits, coffee and oil. Communication is difficult and mainly by river although a few roads are now being built into the area.

The distribution of the population outlined above for the early 1970s (CICRED 1974) hides the enormous shifts in distribution that have occurred since the 1940s (table 1). In 1940 two-thirds of the population lived in the Sierra, and only 28 per cent in the coastal region (11 per cent in Lima–Callao). By the mid-1970s almost half the population lived on the coast (one quarter in Lima–Callao) and just over two-fifths in the Sierra. The percentage of the population living in the Selva has hardly changed over the past 30 years or so.

Table 1 Distribution of the population by natural regions (%)

	1940 census	1961 census	1972 census	1976 survey (retro)
Coast	28	38	47	49
Lima–Callao metropolitan area	(11)	(18)	(25)	(24)
Rest	(17)	(20)	(22)	(25)
Sierra	65	53	43	42
Selva	7	9	10	9

[1] These figures are from the 1972 census, quoted by Behm and Ledesma (1977).

2 Sources of data

Due to the incomplete registration of deaths in Peru, most of the information on mortality levels has to be obtained by asking retrospective questions on the survival of certain close relatives, in censuses and surveys. The 1940, 1972 and 1981 national censuses, as well as providing information on population size, age and sex structure, obtained details from all women on the number of live births they had ever had and how many of those children were still surviving. In 1972 and 1981 respondents were also asked whether their mother was still alive. These questions were omitted from the 1961 census.

During the 1970s there were two major surveys – the National Demographic Survey and the Peru Fertility Survey (PFS), conducted under the auspices of the World Fertility Survey. The National Demographic Survey was carried out in two stages. In October 1974, a multi-round prospective survey (EDEN) of the 9500 sampled households was started; about four visits were carried out over the next two years, and all births, deaths, changes in marital status and migratory movements occurring in each intervening period were recorded. The data on deaths recorded over these two years will be used in this analysis. Finally, towards the end of 1976, a retrospective survey (RETRO) was made of the same population (about 46 000 people), in which questions were asked (of women aged 12 and over) on children ever born and children surviving; (of all people aged 12 and over) on the survival of first spouse; and (of all respondents) on maternal and paternal survival.

The Peru Fertility Survey (1977–8) was also conducted in two stages. The household survey, which used a sampling fraction of $\frac{1}{100}$ in the eastern region (Selva) and $\frac{1}{400}$ for the rest of the country, resulted in the successful interview of 7400 households and gave a *de jure* population of 40 438. From these households all ever-married women aged 15–49 were selected for the individual survey.

In the household survey, all respondents were asked about the survival of their parents. Unfortunately the questions on children ever born, and children surviving, were only asked of single women aged 15–49 and all women aged 50 and over, so this information cannot be used to estimate levels of fertility and child mortality.

The 5640 women interviewed for the individual survey were asked for very detailed and extensive information on marriage histories, birth histories, breastfeeding, contraceptive use, etc. This provides the necessary details to calculate both fertility and child mortality levels; male adult mortality can be calculated from the information on widowhood.

3 Techniques of analysis

The information obtained from the retrospective questions on the survival of a close relative (child, parent, spouse) is used as an indicator of the level of mortality which is related to the age of respondent. Using mortality, fertility and nuptiality models, these indicators are then converted into specific probabilities of survival. These estimates of the level of mortality will be an average over the period during which 'the relative' has been exposed to the risk of dying; it is possible to locate the probabilities of survival at points of time in the past using methods first developed by Feeney, for child mortality (Feeney 1980), and by Brass and Bamgboye for adult mortality (Brass and Bamgboye 1981).

Where women are asked about the survival of their children, the proportions of children dead by age of mother are converted into a series of probabilities of dying by age x, (q(x)), using multiplying factors; these factors depend on the age group of the women and also on the age pattern of childbearing in the population, since both these affect the length of time the children are exposed to the risk of dying (Brass 1975). Where respondents are asked about the survival of their mothers, the proportions of respondents in each age group with surviving mothers are converted into probabilities of surviving from age 25, (1(25 + N)/1(25)) using multiplying factors which take into account the age group of the respondents and the mean age of mothers at the birth of their children ($\bar{M}f$). Similarly for paternal survival, proportions with father alive are used to obtain probabilities of survival from age 32.5, (1(35 + N)/1(32.5)), or from age 37.5, allowing for the age group of respondents and the mean age of fathers at the birth of their children ($\bar{M}m$) (Brass and Hill 1973).

In the case of child and adult mortality estimation from orphanhood data, the length of exposure to the risk of dying is determined by the timing of fertility in the population and the current age of the respondents. For the estimation of probabilities of survival from widowhood data, the time of exposure to risk depends on the marriage patterns of women and men, and the current age of respondents. Singulate mean age at first marriage (SMAM) values and the population weighted mean ages at first marriage are used to summarize the female and male nuptiality patterns (Hill 1977).

Additional estimates of the level of adult mortality can be obtained using reports of current deaths by age (obtained from deaths in a household in a recent period or from the vital registration system). These reported deaths are adjusted using the growth-balance equation and the population age distribution (Brass 1975, chap XVI). Further mortality estimates can be made by comparing two successive census age distributions to obtain some indication of the intercensal survivorship rates. For this method to work well, one needs to be dealing with a population where migration is not an important factor, where the age reporting is good, and where the completeness of the coverage of the two censuses is comparable (Brass 1975, chap XV).

Throughout the following analysis, mortality estimates are expressed in terms of alpha (α) values, the level of mortality parameter from the logit model life-table system (Brass 1975, chap XII). For child mortality, the equivalent q(5) values (the probabilities of dying by age five) are tabulated; the graphs are drawn using alpha values but also show the equivalent q(5) and infant mortality, (q(1)), levels. Adult mortality tables and graphs show both the alpha value and the corresponding expectation of life at age 15, $\mathring{e}_{15}$.

Mortality estimates are located in time using the Brass method for child mortality (Brass 1982) and the Brass and Bamgboye method for adult mortality (Brass and Bamgboye 1981).

4 Population Characteristics

The enumerated population in 1961 was just under 10 million, in 1972 it was 13.5 million, and in 1981, 17 million. The census figures for the second half of the 19th century were 2 million in 1850, 2.5 million in 1862 and 2.7 million in 1876 (CICRED 1974).

The relative age distributions by sex indicated by the 1961, 1972 and 1981 censuses, and the surveys of 1976 and 1977, are shown in figure 2 and table 2. All show the broad-based age pyramid characteristic of high fertility populations; between 40 and 45 per cent of the population is under age 15. A closer look at the single-year age–sex distribution for 1977 (figure 3) shows that although there clearly is age misreporting and age heaping at the ages ending in 0 and 5, it is not too serious and the overall impression is of relatively good reporting of age.

The sex ratios by age group (table 3) show a slight deficit of males for almost all age groups except the youngest. (Throughout the following analysis all calculations based on the PFS household data are made using the *de jure* population. The PFS individual data is, by definition, *de facto*; also, the 1976 survey and earlier censuses are all analysed on a *de facto* basis. Table 4 shows that the differences between the *de facto* and *de jure* populations in the PFS household survey are small; those who did not sleep in the house the night before the survey, but who do live there, amounted to about 300 females and 600 males, spread over all the age groups.)

According to the PFS, 63 per cent of the population live in the urban sector and 37 per cent in the rural sector; 26 per cent of the total population live in metropolitan Lima. This urban–rural distribution was virtually the same at the time of the 1981 census.

Table 5 indicates the educational level of the adult population (aged 15 and over) in 1977. Higher proportions of adult males than females have some education – 49 per cent males have some primary schooling and 41 per cent some secondary. In contrast, 28 per cent of adult females have never been to school, 42 per cent have some primary education and 30 per cent some secondary. The differences between the sexes seem to be declining in recent years. Educational level is linked with place of residence. For the population aged 15 and over, only 9 per cent of urban residents have no schooling, compared with 37 per cent of rural residents while 50 per cent of urban, but only 8 per cent of rural residents have some secondary schooling.

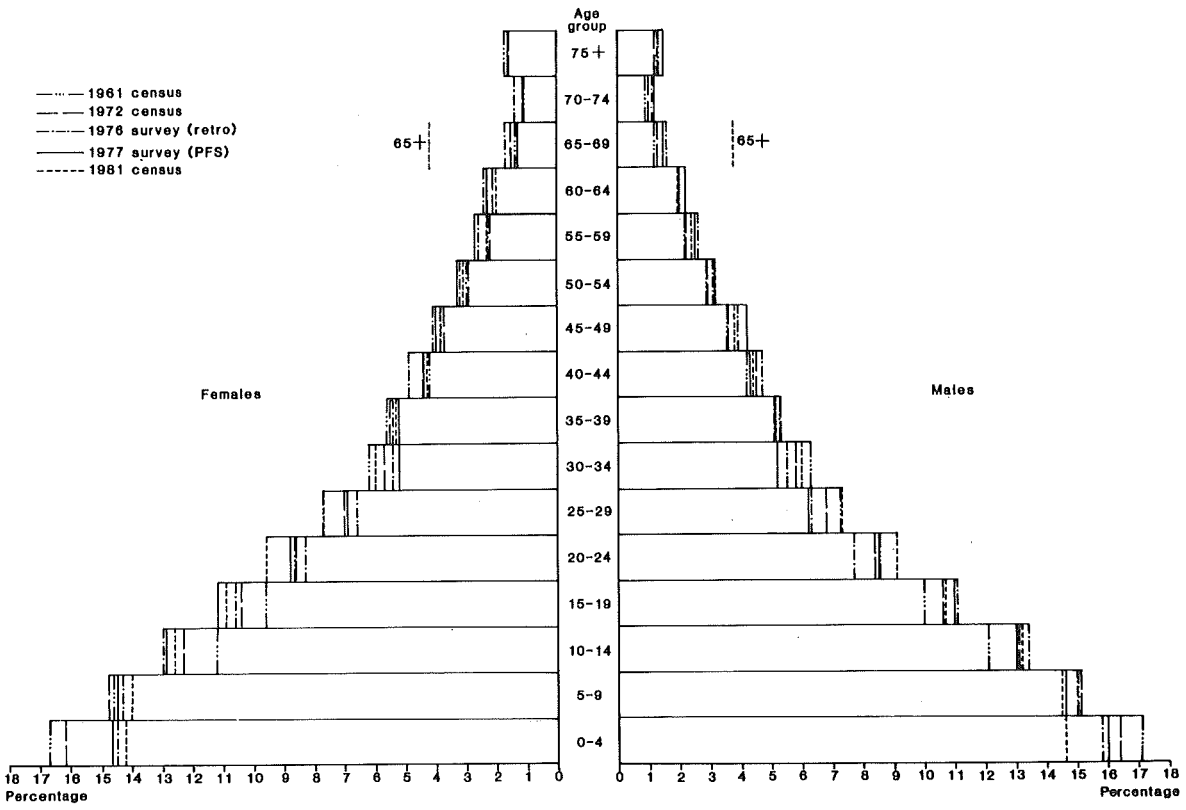

Figure 2 Age–sex distribution for 1961, 1972, 1976, 1977 and 1981

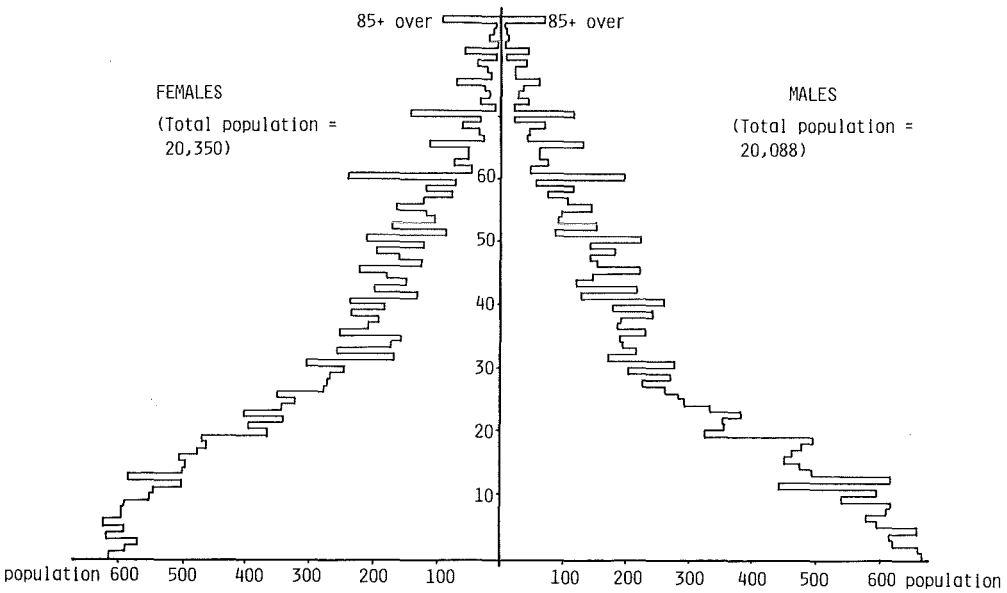

Figure 3 Age–sex distribution by single years of age, 1977 de jure population

Table 2 Percentage age distribution by sex (1961, 1972, 1976, 1977, 1981)

	1961 census		1972 census		1976 survey (retro)		1977 survey (PFS)		1981 census	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
0–4	16.7	17.1	16.2	16.4	14.5	15.8	14.7	16.0	14.2	14.6
5–9	14.6	15.0	14.8	15.1	14.3	15.0	14.5	14.6	14.0	14.5
10–14	11.2	12.1	12.3	13.1	13.0	13.4	12.9	13.0	12.6	13.2
15–19	9.6	10.0	10.4	10.6	10.6	11.1	11.2	11.0	10.9	10.7
20–24	8.6	8.5	8.6	8.4	8.3	7.7	8.8	8.5	9.6	9.1
25–29	7.7	7.3	7.0	6.8	6.6	6.3	6.9	6.2	7.7	7.3
30–34	6.2	6.3	5.7	5.8	5.4	5.5	5.2	5.2	6.0	6.0
35–39	5.6	5.3	5.5	5.3	5.4	5.1	5.2	5.1	5.3	5.1
40–44	4.2	4.2	4.4	4.5	4.9	4.7	4.4	4.3	4.3	4.4
45–49	3.8	3.6	3.7	3.6	4.1	3.9	4.0	4.2	3.8	3.8
50–54	3.0	2.9	2.9	2.9	3.2	3.1	3.3	3.2	3.1	3.2
55–59	2.3	2.2	2.2	2.2	2.6	2.6	2.7	2.5	2.3	2.4
60–64	2.3	2.0	2.1	2.0	2.4	2.0	2.3	2.2	2.0	2.0
65–69	1.4	1.2	1.5	1.3	1.7	1.6	1.3	1.5		
70–74	1.1	0.9	1.1	1.0	1.4	1.1	1.1	1.2	65+ 4.2	3.8
75+	1.7	1.3	1.6	1.2	1.6	1.3	1.6	1.5		
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Age stated	4 978 705	4 923 055	6 738 744	6 771 401	23 563	22 671	20 348	20 078	8 555 653	8 449 557
Age not stated	–	2 463	14 934	13 129	–	–	2	10	–	–
Total	4 978 705	4 925 518	6 753 678	6 784 530	23 563	22 671	20 350	20 088	8 555 653	8 449 557

Table 3 Sex ratios (males per female) by age group (1961, 1972, 1976, 1977, 1981)

Age group	1961 census	1972 census	1976 survey	1977 survey	1981 census
0–4	1.01	1.01	1.04	1.08	1.02
5–9	1.02	1.02	1.00	0.99	1.02
10–14	1.07	1.07	0.99	0.99	1.04
15–19	1.03	1.02	1.01	0.97	0.97
20–24	0.98	0.99	0.89	0.95	0.94
25–29	0.94	0.97	0.92	0.88	0.93
30–34	1.01	1.02	0.98	0.99	0.98
35–39	0.93	0.95	0.91	0.97	0.94
40–44	0.99	1.03	0.91	0.97	1.02
45–49	0.95	0.98	0.91	1.02	0.98
50–54	0.96	1.01	0.95	0.95	1.00
55–59	0.95	0.99	0.97	0.90	1.03
60–64	0.88	0.94	0.79	0.95	0.99
65–69	0.85	0.91	0.92	1.16	
70–74	0.77	0.86	0.73	1.08	65+ 0.90
75+	0.74	0.76	0.76	0.88	
All ages	0.99	1.00	0.96	0.99	0.99

Table 4 De facto and de jure age distributions by sex, 1977

Age group	Females				Males			
	De facto		De jure		De facto		De jure	
	No	%	No	%	No	%	No	%
0–4	2 990	14.9	2 984	14.7	3 230	16.6	3 220	16.0
5–9	2 938	14.7	2 958	14.5	2 907	14.9	2 939	14.6
10–14	2 616	13.1	2 629	12.9	2 569	13.2	2 612	13.0
15–19	2 256	11.3	2 272	11.2	2 106	10.8	2 202	11.0
20–24	1 756	8.8	1 798	8.8	1 608	8.3	1 700	8.5
25–29	1 379	6.9	1 402	6.9	1 185	6.1	1 237	6.2
30–34	1 031	5.1	1 048	5.2	1 004	5.2	1 040	5.2
35–39	1 025	5.1	1 055	5.2	958	4.9	1 022	5.1
40–44	853	4.3	888	4.4	817	4.2	863	4.3
45–49	780	3.9	818	4.0	785	4.0	838	4.2
50–54	655	3.3	678	3.3	616	3.2	642	3.2
55–59	523	2.6	545	2.7	474	2.4	493	2.5
60–64	449	2.2	458	2.3	412	2.1	437	2.2
65–69	252	1.3	260	1.3	286	1.5	301	1.5
70–74	213	1.1	222	1.1	231	1.2	239	1.2
75+	326	1.6	334	1.6	228	1.5	294	1.5
Total (age stated)	20 044	100.0	20 348	100.0	19 477	100.0	20 078	100.0

Table 5 Level of education of the adult population by age group and sex, 1977 (%)

Age group	Females			Males		
	No schooling	Primary[a]	Secondary and above[b]	No schooling	Primary[a]	Secondary and above[b]
15–19	6.1	44.7	49.0	1.3	40.5	57.9
20–24	9.3	40.7	49.8	2.3	33.8	63.7
25–29	15.9	45.8	38.1	3.5	39.0	56.8
30–34	22.9	46.9	30.0	5.1	53.0	41.4
35–39	35.8	46.5	17.7	8.0	60.4	31.2
40–44	37.4	45.8	16.6	12.7	62.0	24.4
45–49	42.9	41.5	15.4	12.8	62.8	23.7
50–54	47.3	35.6	16.9	17.1	57.9	24.1
55–59	55.0	33.0	11.2	20.0	61.0	18.8
60–64	59.5	31.7	8.0	25.4	55.3	18.3
65–69	60.3	32.7	6.2	30.3	54.8	14.9
70–74	67.5	27.2	3.5	34.0	50.6	12.6
75+	71.9	24.4	3.0	43.7	49.0	6.0
15+	27.8	41.7	30.3	9.6	48.8	41.0

[a]Primary corresponds to between 0 and 5 years of education.
[b]Secondary and above corresponds to 6 years and over of education.

5 Marriage and Fertility

These topics are not investigated fully in this study. They are mentioned, however, since the pattern of childbearing by age, and the timing and extent of marriage in the population, are used in assessing the period of exposure to the risk of dying of children, parents and spouses, and thus the probabilities of survival of these relatives.

5.1 MARRIAGE

Table 6 shows the proportions single by age group and sex.[2] The information for 1976 and 1977 is very consistent and shows that the SMAM for females is about $2\frac{1}{2}$ years lower (23.3 in 1977) than for males (25.7 in 1977). Thirteen per cent of women aged 15–19 are married, and by 20–24, this has risen to 50 per cent. Only about 1 or 2 per cent of men in the youngest age group are married, and only one quarter by ages 20–24. The figures indicate almost universal marriage by age 50, with only about 5 per cent of women and men remaining single.

The data from the 1972 census indicate earlier marriage for both sexes, and a far higher proportion unmarried at older age groups: about 10 per cent of women and 8 per cent of men. It is improbable that marriage patterns changed so much over these four or five years since those women aged 40–44 in 1972 (10.2 per cent of whom are single) are those aged 45–49 in 1977 (of whom only 5.3 per cent are single); it is unlikely that there were so many late marriages in this short time. We may conclude that the more carefully and thoroughly collected survey information is nearer to the correct values, and that the census information is at fault, probably due to those who were widowed, divorced and separated reporting themselves as single.

For all three sets of data, it is possible to look at the marriage patterns for the urban and rural sectors separately (table 7).[3] In all cases the mean age at first marriage is higher for the urban population than for the rural population, but the extent of this difference varies between about $1\frac{1}{2}$ and 3 years for both females and males.

The differences in SMAMs by education level for 1977 (table 7) are not so clear, although the differentials across the three education categories are greater than those between urban and rural residents, for both sexes. Women with less than secondary education have a SMAM between 21.0 and 22.0 years, while those with secondary education have a SMAM of 25.4 years. Within the no schooling and primary education categories, there is hardly any difference in the female SMAM values by urban–rural residence. Men with secondary education have a SMAM of about 27 years, with that for those with no schooling only slightly lower, at 26.5, and those with primary schooling, 24 years. This pattern for men is slightly odd, but might be explained by the small numbers of men in the younger age groups who have no schooling; they are a very select group.

5.2 FERTILITY

In the censuses of 1972 and 1981 there was very high non-response to the questions on number of children ever born and children surviving – 24 per cent of women aged 20–34 in 1972, and 28 per cent of the same age group in 1981 did not answer questions on this subject. In 1972 this occurred because of the misleading layout of the questionnaire as a result of which the fertility questions

[2] Information on marital status from the 1981 census was not readily available at the time the analysis was done (1982).

[3] The definitions of urban and rural used in the 1976 and 1977 surveys are as defined for the 1972 census.

Table 6 Proportions never married by age and sex, and singulate mean ages at marriage (1972, 1976, 1977)

Age group	1972		1976		1977	
	Female	Male	Female	Male	Female	Male
15–19	0.8061	0.9257	0.8763	0.9829	0.8670	0.9764
20–24	0.4375	0.6739	0.4946	0.7217	0.4945	0.7437
25–29	0.2205	0.3432	0.2237	0.3554	0.2342	0.3446
30–34	0.1391	0.1761	0.1271	0.1405	0.1105	0.1385
35–39	0.1105	0.1192	0.0776	0.0863	0.0826	0.0712
40–44	0.1049	0.0962	0.0623	0.0549	0.0511	0.0519
45–49	0.1017	0.0848	0.0454	0.0452	0.0531	0.0455
50–54	0.1077	0.0810	0.0481	0.0365	0.0342	0.0483
SMAM	21.63	25.03	23.28	25.95	23.30	25.72

Table 7 Singulate mean ages at marriage by sex, place of residence (urban–rural) and education level (1972, 1976, 1977)

	1972	1976	1977
SMAM female			
All women	21.63	23.28	23.30
Urban	22.27	24.24	23.73
Rural	20.34	21.09	22.10
No schooling	–	–	21.56
Primary	–	–	21.25
Secondary and above	–	–	25.41
SMAM male			
All men	25.03	25.95	25.72
Urban	25.83	26.96	26.24
Rural	23.49	23.84	24.40
No schooling	–	–	26.51
Primary	–	–	24.03
Secondary and above	–	–	27.06

were only asked of the first two household members; so, the response rate was reasonable among household heads and spouses of the head, but low among other relatives and non-relatives in the household. Here the data have been analysed using only those women who answered these questions, since to include all non-responders would give severe underestimates of fertility levels. However, there are reasons to believe that the responders are not truly representative of all women in those age groups; they are likely to be biased in favour of married or cohabiting women.[4]

The El-Badry technique (El-Badry 1961) used on the 1981 data indicates that only 1.1 per cent of the non-responding women actually had children, the rest were the true childless women. The data was corrected by removing these non-childless non-responding women from the parity calculations.

Information on the mean number of children ever born by age of women is shown in table 8 and figure 4. There is quite good agreement between the survey data for 1976 and 1977, although for older age groups of women reported fertility is higher in the PFS (women 45–49 had an average of 6.6 births in the PFS data, and 6.2 births in the 1976 data). This is likely to be a result of better reporting since the PFS obtained a very detailed history of each woman interviewed.

The parities obtained from the 1981 census are similar to those from the earlier surveys for the two youngest age groups only; for all older age groups they are substantially lower (by as much as one birth per woman for those aged 45–49). The indications are that these discrepancies are a result of under-reporting rather than true declines in fertility. (Women aged 40–44 in 1976 had 6.02 births on average, while those aged 45–49 in 1981 had only 5.62 births.)

The 1972 data show higher parities for all age groups of women than do the later surveys. The differences are greatest among the younger women. This could, in theory, be due to a real decline in fertility levels around this time, brought about, for example, by a rising age at female marriage. Although the marital status data (see table 6) does support this suggestion, we have demonstrated that the 1972 data is not very reliable. A more likely explanation is the very high level of non-response to the fertility questions in the 1972 census.

Table 9 and figure 4 show the current fertility rates for 1972, 1976 and 1981. The same pattern as for the parities is evident; the 1972 data indicate substantially higher fertility levels than for 1976, and the 1981 data show still lower levels. Table 10 shows the urban–rural differences in lifetime fertility; urban levels are considerably lower than rural for all ages of women. The 1977 data indicate differences of over one child per woman among women aged 45–49 – 6.1 for urban women, 7.3 for rural. Similar differences are shown by both the 1972 and 1981 data. The differentials by education of women from the 1977 data (table 11) are far greater; among women aged 45–49, those with no schooling have an average parity of 7.6, those with primary 6.5, and those with secondary and above only 4.1. A substantial part of these differences can be explained by the different marriage patterns, as outlined in section 5.1, rather than differences in marital fertility.

[4] Behm and Ledesma compared q(2) values calculated from the reported parities with those calculated using corrected parities (assigning children to the non-responders on the basis of children ever born reported by the last woman of the same age, educational level and relationship to household head). They found that in two-thirds of the 18 groups studied (total, urban, rural, and regions by urban–rural differentials) the estimates varied by less than 5 per cent, and in the other six groups the variation was between 5 and 8 per cent. Concluding that these errors were tolerable, they proceeded to analyze the data for responders only (Behm and Ledesma 1977).

Table 8 Mean parities by age group of women (1940, 1972, 1976, 1977, 1981)

Age group	1940 census	1972 census	1976 survey	1977 survey	1981 census
15–19	0.1455	0.3380	0.1430	0.1381	0.1368
20–24	1.0597	1.6358	1.0051	1.0098	0.9745
25–29	2.3334	3.0875	2.5462	2.4813	2.2123
30–34	3.5714	4.4502	3.9282	3.9971	3.4275
35–39	–	5.6222	5.2155	5.3906	4.5942
40–44	–	6.2750	6.0234	6.2461	5.2862
45–49	–	6.5690	6.1536	6.6162	5.6248

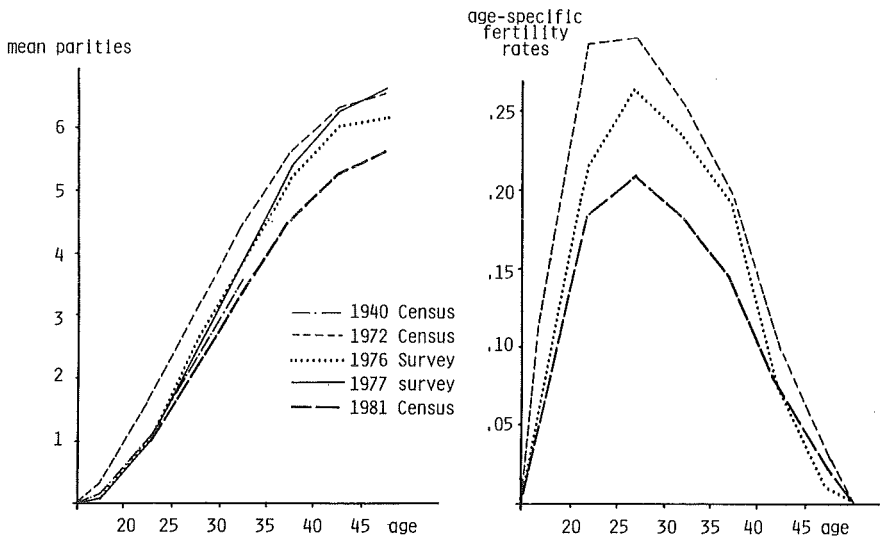

Figure 4 Mean parities and current fertility rates by age of women

Table 9 Current fertility rates by age and place of residence (urban–rural) of women (1972, 1976, 1981)

Age group	1972 census			1976 survey			1981 census		
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural
15–19	0.1223	0.1090	0.1415	0.0683	0.0470	0.1165	0.0539	0.0419	0.0788
20–24	0.2917	0.2746	0.3181	0.2143	0.1684	0.3339	0.1820	0.1527	0.2408
25–29	0.2950	0.2777	0.3209	0.2622	0.2140	0.3591	0.2086	0.1773	0.2661
30–34	0.2540	0.2277	0.2929	0.2328	0.1849	0.3249	0.1813	0.1505	0.2355
35–39	0.2004	0.1684	0.2440	0.1912	0.1350	0.2749	0.1426	0.1052	0.1964
40–44	0.1056	0.0840	0.1363	0.0762	0.0480	0.1208	0.0741	0.0493	0.1084
45–49	0.0350	0.0254	0.0476	0.0103	0.0111	0.0088	0.0216	0.0125	0.0344
TFR	6.5200	5.8340	7.5065	5.2765	4.0420	7.6945	4.3205	3.4470	5.8020

Table 10 Mean parities by age group and place of residence (urban–rural) of women (1972, 1976, 1977, 1981)

Age group	1972 census		1976 survey		1977 survey		1981 census	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
15–19	0.2993	0.3937	0.0962	0.2487	0.1223	0.1731	0.1030	0.2119
20–24	1.4699	1.8923	0.7742	1.6070	0.8551	1.4609	0.8025	1.3834
25–29	2.7958	3.5222	2.1296	3.3842	2.1966	3.1620	1.9010	2.9560
30–34	4.0568	5.0307	3.4202	4.9032	3.8073	4.4081	3.0367	4.3626
35–39	5.1226	6.3046	4.5701	6.1754	4.8067	6.3745	4.0811	5.5807
40–44	5.7138	7.0758	5.2740	7.2103	5.8325	6.9017	4.7803	6.2179
45–49	5.9733	7.3472	5.9618	6.5073	6.1095	7.3436	5.1495	6.4354

Table 11 Mean parities by age group and education of women, 1977

Age group	No schooling	Primary	Secondary and above
15–19	0.2636	0.2049	0.0626
20–24	1.6240	1.4741	0.5128
25–29	3.1113	3.0936	1.4942
30–34	4.9509	4.4486	2.5774
35–39	6.7206	5.3583	2.7739
40–44	7.2769	6.2496	3.8409
45–49	7.5676	6.5179	4.0735

6 Child Mortality

Retrospective questions on the number of children ever born and number surviving have been asked of women in Peru since the 1940 census, enabling estimates of childhood mortality over this period to be made. Although these questions were omitted from the 1961 census, they were asked in the censuses of 1972 and 1981, and both the 1976 retrospective survey and the individual survey of the PFS contain this information.

The 1976 and 1977 surveys provide the information by sex of child, so sex differentials in child mortality can be calculated. (Table 12 shows the sex ratios of reports on children ever born and dead children. The ratios seem plausible, and provide some encouragement on the quality of the data.) Differentials by urban–rural place of residence of the mother for the 1972, 1976, 1977 and 1981 data, by region of residence (Coast–Selva–Sierra) of the mother for the 1976 data, and by education level of mother for the 1977 data will also be considered.

The Brass multipliers were used to convert the proportions of children dead by age of mother into probabilities of dying by age x, (q(x)). The ratio of the mean parities of women aged 20–24 to that of women aged 25–29 (P_2/P_3) was used as a summary index of the age pattern of fertility in locating the multiplying factors. The General Standard model life table was used to express the probabilities of survival in terms of the equivalent level parameter, alpha (α), and also equivalent probabilities of dying in the first five years of life, q(5). The Brass method of locating these estimates in time was adopted.

The proportions of children dead by age of mother for 1940, 1972, 1976 and 1981 are shown in table 13, for all children, and by the sex of the child where this information is available. The estimates of child mortality levels (both sexes combined) are given in table 14 and the levels and trends are shown in figure 5 by plotting the α values against their location in time.

The overall picture is of reasonably consistent sets of estimates, showing declines in the level of child mortality in recent years, from an α of almost $+0.2$ in the mid-1930s (that is, an equivalent q(5) value of about 300 deaths per 1000) to an α just less than zero around 1960 (q(5) of 230 per 1000), and about -0.2 in the mid-1970s (q(5) of 160 per 1000). This indicates that the number of deaths in the first five years of life has almost halved in this 40-year period. The estimates from the 1981 data indicate lower child mortality levels than the earlier data

Table 12 Sex ratios of children (males per female) ever born and dead children by age of women (1976, 1977)

Age group	1976 survey		1977 survey	
	Children ever born	Dead children	Children ever born	Dead children
15–19	1.17	1.00	1.15	1.23
20–24	0.93	1.30	1.15	1.07
25–29	1.03	1.15	1.04	1.01
30–34	1.05	1.17	0.98	1.15
35–39	–	–	1.03	1.12
40–44	–	–	1.05	1.15
45–49	–	–	1.05	1.06

Table 13 Proportions of children dead by age of mother (1940, 1972, 1976, 1977, 1981)

Age group	1940 census[a]	1972 census	1976 survey (retro)[b]			1977 survey (PFS)			1981 census
	Both sexes	Both sexes	Both sexes	Females	Males	Both sexes	Females	Males	Both sexes
15–19	0.2067	0.1475	0.1517	0.1646	0.1406	0.1090	0.1050	0.1126	0.0871
20–24	0.2423	0.1755	0.1333	0.1122	0.1560	0.1246	0.1299	0.1200	0.1066
25–29	0.2751	0.1873	0.1435	0.1352	0.1516	0.1431	0.1453	0.1410	0.1192
30–34	0.2990	0.2042	0.1589	0.1501	0.1673	0.1563	0.1442	0.1686	0.1283
35–39	–	0.2312	0.1922	–	–	0.1932	0.1858	0.2004	0.1542
40–44	–	0.2562	0.2215	–	–	0.2141	0.2038	0.2240	0.1711
45–49	–	0.2905	0.2240	–	–	0.2510	0.2497	0.2521	0.1937

[a]Data are only available for the four age groups given.
[b]The proportions dead by sex of child are only given for the first four age groups in the published tables for 1976.

Table 14 Estimates of childhood mortality rates q(x)) and mortality levels (α)[a] (1940, 1972, 1976, 1977, 1981)

Age (x)	Both sexes			
	q(x)	α	q(5)	Date[b]
1940 census				
1	0.2116	0.209	0.3134	39.4
2	0.2506	0.168	0.2957	37.9
3	0.2771	0.176	0.2991	36.1
5	0.3027	0.184	0.3027	33.9
1972 census				
1	0.1377	−0.050	0.2136	71.1
2	0.1731	−0.067	0.2081	69.5
3	0.1835	−0.091	0.2001	67.5
5	0.2021	−0.085	0.2021	65.3
10	0.2307	−0.052	0.2129	62.8
15	0.2493	−0.038	0.2177	60.0
20	0.2821	−0.012	0.2267	56.6
1976 survey				
1	0.1777	0.101	0.2687	75.8
2	0.1463	−0.167	0.1770	74.6
3	0.1493	−0.215	0.1634	72.8
5	0.1646	−0.211	0.1646	70.6
10	0.2008	−0.141	0.1847	68.3
15	0.2273	−0.099	0.1978	65.7
20	0.2301	−0.149	0.1823	62.6
1977 survey				
1	0.1256	−0.103	0.1963	76.7
2	0.1359	−0.210	0.1649	75.5
3	0.1484	−0.218	0.1625	73.6
5	0.1616	−0.222	0.1616	71.5
10	0.2014	−0.139	0.1853	69.1
15	0.2192	−0.122	0.1904	66.5
20	0.2571	−0.075	0.2052	63.4
1981 census				
1	0.0909	−0.285	0.1453	80.4
2	0.1113	−0.324	0.1358	79.0
3	0.1207	−0.338	0.1325	77.2
5	0.1304	−0.347	0.1304	75.0
10	0.1583	−0.286	0.1450	72.6
15	0.1718	−0.273	0.1481	70.0
20	0.1943	−0.256	0.1525	66.8

[a]Brass method.
[b]The approximate date of estimate, 1939.4, 1937.9 etc.

sets; since the 1972, 1976 and 1977 results agree well with each other, we may conclude that the 1981 results are an underestimate of mortality.

It is difficult to give too much importance to the 1940 census information; it could well be an *under*estimate of the levels of mortality at this time, and since the next available information is from 20 years later, it is difficult to test its consistency and plausibility.

If, as we suspect, the parities estimated from the 1972 data are too high, especially for younger women, due to the bias against single women, the P_2/P_3 ratio will be too high; this will bring down the mortality estimates slightly. If P_2/P_3 is calculated from parities corrected using the El-Badry technique (see Ferrando and Fernández 1979), the derived child mortality estimates will show higher mortality, by an increase in the region of 0.02 in the value of α.[5]

As is often the case in the estimation of child mortality, the information obtained from women aged 15–19 and 20–24 indicates far higher mortality than is shown by older age groups of women. This probably occurs for various reasons including the high proportion of first births, and the young age of mothers, both of which tend to be associated with higher mortality of the children. Sampling fluctuations are not an adequate explanation since the mortality estimates from the first two age groups are so consistently higher than for the later age groups. When these first two points are excluded from each data set the trends are far clearer and more consistent.

6.1 SEX DIFFERENTIALS

The estimates of child mortality by sex of the child (table 15 and figure 6) show slightly higher male mortality, by a difference in the region of 10 to 20 per 1000 in the q(5) values. However, the picture is not very clear; there are few points of information available, and of these the ones derived from the younger age groups of women are very erratic.

Separate estimates of child mortality by sex for the 1972 and 1981 data and the few later points of the 1976 data were obtained using an average of the differences in the female and male α value for the points where this information was available. Information from women aged 15–19 and 20–24 was not used. The average difference of the female and male alphas of the remaining seven points was 0.042 which was then used as a separation factor on the other child mortality estimates. (The resulting α values by sex are as shown in figures 18 and 19.)

6.2 DIFFERENTIALS BY URBAN–RURAL RESIDENCE AND REGION OF RESIDENCE

Differentials in child mortality by place of residence are classified according to the mother's place of residence at the time of enumeration. Thus, recent migrants to the cities will be classified as urban but may reflect the different rural levels of mortality they have left behind. This is especially true of older women who had their children a long time ago, and have since moved. The effect of classifying women by present-day residence while investigating trends in child mortality over the previous 15 years or so, will be, if anything, to diminish the differentials. In the case of Peru where the majority of the migration is from rural to urban, and from the Sierra to the coast, the levels of child mortality estimated for urban areas, and the Coastal region, may be inflated.

[5]It has been shown (Behm and Ledesma 1977) that these data do not indicate important differences in child mortality by 'relationship of mother to household head' categories; small differences are evident among the highest education group (children of the head or spouse of head show lower mortality than children of other relatives).

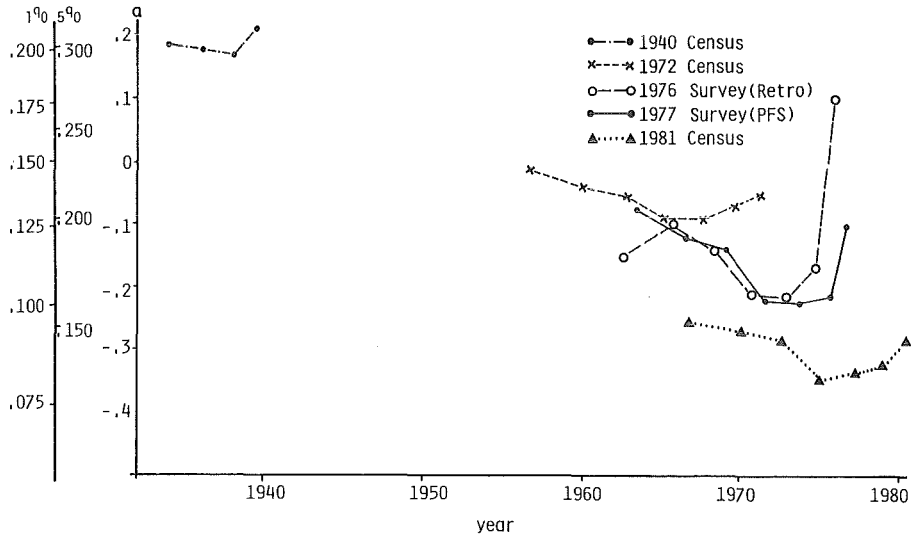

Figure 5 Trends in childhood mortality 1930–80

Proportions of children dead by urban–rural residence of the mother are shown in table 16 (1972, 1976, 1977 and 1981 data). The proportions dead in all age groups are far higher for rural women; these differences remain even when allowance is made for the different age patterns of childbearing (see table 17 and figure 7).

The 1981 results, while maintaining a clear urban–rural differential, are out of line with the other results; this is especially true of the rural sector. Around 1970 (excluding the information from the youngest two age groups of women) the rural q(5) value was about 230 per 1000 (α of 0.0), while urban q(5) levels were about 130 per 1000 (α of -0.35). A faster decline in mortality is shown among the urban population, from a q(5) of about 200 per 1000 in the late 1950s ie a decrease of almost 6 per 1000 each year on average; rural deaths in the first five years of life only fall from 260 deaths per 1000 in the late 1950s, to 230 per 1000 in 1970, or about $2\frac{1}{2}$ deaths per 1000 each year on average.

This quite rapid decline in urban mortality could be a result of real improvements, or it could be an artefact of the misclassification of women as urban whose children experienced rural mortality levels. It is interesting to note that the same fast declines are shown by the Coastal region, in contrast to the Sierra region where there is little change over the period, and the Selva, where there is a small decline.

The proportions dead by region of residence of mother are shown in table 18 and the estimates of mortality in table 19 and figure 8. Mortality levels in the Sierra are twice those on the coast – approximately 250 deaths per 1000 in the first five years of life compared to somewhere in the range of 130 (in the early 1960s) to 80 (in the early 1970s). The Selva has levels between these two extremes, 200 per 1000 in the early 1960s, falling to 150 per 1000 in the early 1970s.

6.3 DIFFERENTIALS BY EDUCATION OF MOTHER

Classification by education of mother refers to edu-

Table 15 Estimates of childhood mortality rates (q(x)) and mortality levels (α)[a], by sex of child (1976, 1977)

Age (x)	Females				Males			
	q(x)	α	q(5)	Date[b]	q(x)	α	q(5)	Date[b]
1976 survey								
1	0.1877	0.135	0.2821	75.6	0.1690	0.071	0.2570	75.7
2	0.1219	−0.272	0.1484	74.3	0.1731	−0.067	0.2081	74.5
3	0.1399	−0.253	0.1533	72.5	0.1586	−0.179	0.1735	72.8
5	0.1550	−0.247	0.1550	70.4	0.1740	−0.177	0.1740	70.6
1977 survey								
1	0.1245	−0.108	0.1947	76.8	0.1241	−0.110	0.1942	76.7
2	0.1433	−0.179	0.1735	75.6	0.1284	−0.242	0.1561	75.3
3	0.1516	−0.206	0.1659	73.8	0.1447	−0.233	0.1585	73.5
5	0.1497	−0.267	0.1497	71.7	0.1730	−0.181	0.1730	71.3
10	0.1944	−0.161	0.1787	69.3	0.2075	−0.120	0.1910	69.0
15	0.2096	−0.151	0.1818	66.7	0.2275	−0.098	0.1979	66.3
20	0.2570	−0.076	0.2051	63.6	0.2560	−0.078	0.2043	63.1

[a]Brass method.
[b]The approximate date of estimate, 1975.7, 1974.5 etc.

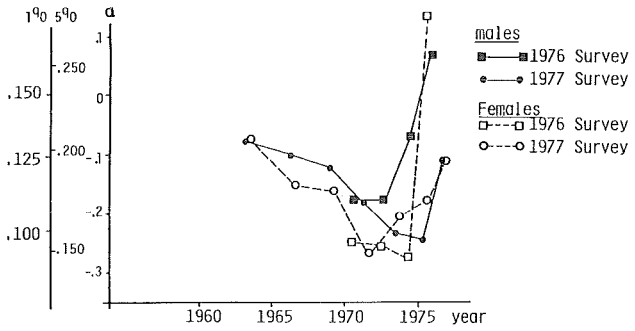

Figure 6 Trends in childhood mortality by sex of child

cational level at the time of the survey, but this will usually be the same as at the time the children were born. There have been considerable changes in availability and accessibility of education, especially for women, over the last few decades; older women who in 1977 had some secondary education were a very select group, and similarly there are very few women from the youngest age groups who in 1977 had no schooling (see table 5). The fact that a change from about one sixth with secondary education and above in age groups 35–54 to one half at 20–24 years occurred without significant narrowing of child mortality differentials, suggests that education is of direct significance rather than a proxy.

The proportions dead by age and education of mother (table 20) show huge differences according to education, in the expected direction. They are reflected in the child mortality estimates shown in table 21 and figure 9. Those with no schooling have q(5) values in the region of 250 per 1000 (α between 0 and $+0.1$), those with some primary education have q(5) values of near to 150 per 1000 (α between -0.2 and -0.3) and for those with secondary education and above, q(5) is about 50–60 per 1000. There is very little change over the period for any education category.

The differentials are large. Not surprisingly, the child mortality levels of women with no schooling are very similar to those of rural women, and of women in the Sierra. But among the rest of the women, education seems to be a far better discriminator of child mortality levels than place of residence. The child mortality levels obtained for the most educated group of women, q(5) of

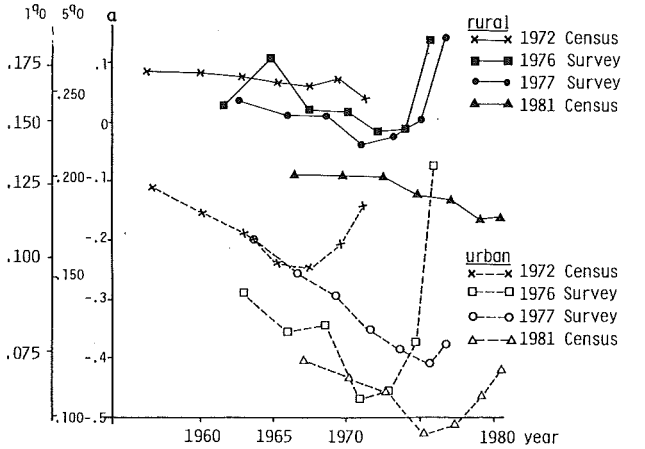

Figure 7 Trends in childhood mortality by place of residence of mother

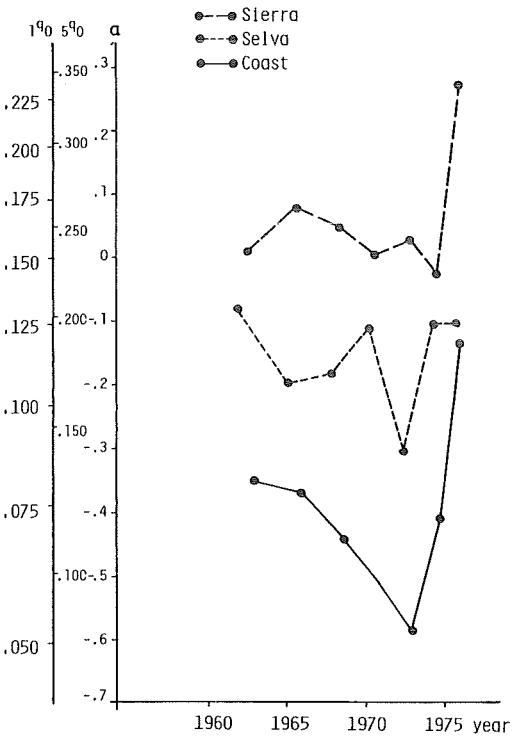

Figure 8 Trends in childhood mortality by region (Coast–Selva–Sierra), 1976

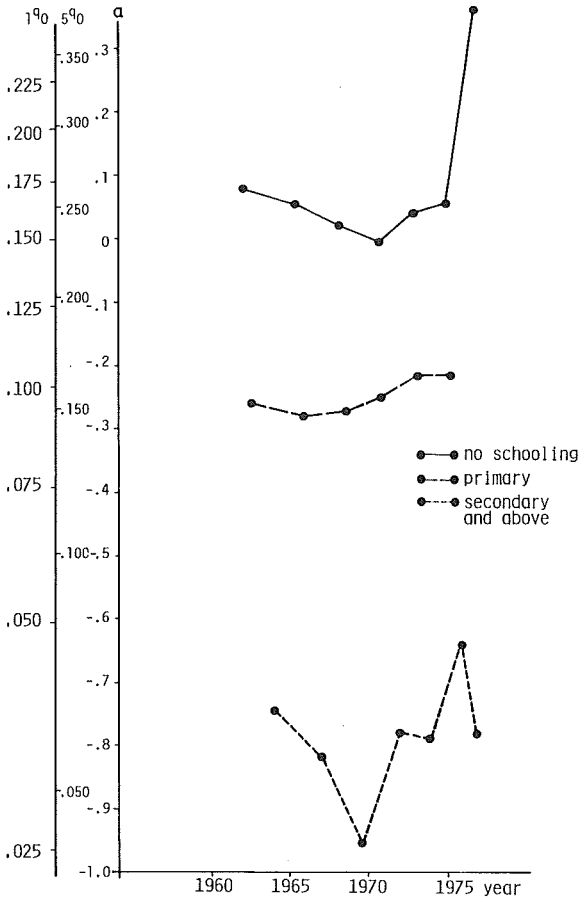

Figure 9 Trends in childhood mortality by education of mother, 1977

Table 16 Proportions of children dead by age of mother and place of residence (urban–rural) of mother (1972, 1976, 1977, 1981)

Age of mother	1972 census		1976 survey		1977 survey		1981 census	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
15–19	0.1247	0.1726	0.1084	0.1895	0.0647	0.1872	0.0632	0.1130
20–24	0.1380	0.2205	0.0914	0.1860	0.0869	0.1895	0.0800	0.1434
25–29	0.1437	0.2389	0.0933	0.2071	0.1067	0.2040	0.0853	0.1712
30–34	0.1586	0.2586	0.1011	0.2364	0.1247	0.2158	0.0920	0.1887
35–39	0.1870	0.2802	0.1362	0.2538	0.1485	0.2496	0.1130	0.2122
40–44	0.2131	0.3059	0.1449	0.3103	0.1724	0.2692	0.1285	0.2313
45–49	0.2506	0.3329	0.1781	0.3015	0.2065	0.3032	0.1495	0.2540

Table 17 Estimates of childhood mortality rates (q(x)) and mortality levels (α)[a] by place of residence (urban–rural) of mother (1972, 1976, 1977, 1981)

Age (x)	Urban				Rural			
	q(x)	α	q(5)	Date[b]	q(x)	α	q(5)	Date[b]
1972 census								
1	0.1170	−0.144	0.1839	71.1	0.1599	0.038	0.2445	71.1
2	0.1364	−0.208	0.1655	69.5	0.2165	0.072	0.2575	69.4
3	0.1410	−0.248	0.1545	67.5	0.2335	0.061	0.2533	67.5
5	0.1572	−0.238	0.1572	65.3	0.2553	0.066	0.2553	65.2
10	0.1868	−0.186	0.1716	62.9	0.2789	0.075	0.2586	62.7
15	0.2077	−0.156	0.1801	60.1	0.2968	0.082	0.2613	59.9
20	0.2437	−0.111	0.1938	56.7	0.3223	0.084	0.2619	56.5
1976 survey								
1	0.1325	−0.073	0.2062	75.8	0.1889	0.138	0.2837	75.6
2	0.1021	−0.372	0.1249	74.7	0.1898	−0.011	0.2272	74.1
3	0.0979	−0.455	0.1078	73.0	0.2070	−0.016	0.2252	72.2
5	0.1054	−0.468	0.1054	70.9	0.2379	0.019	0.2379	70.0
10	0.1431	−0.345	0.1309	68.5	0.2578	0.021	0.2385	67.6
15	0.1497	−0.355	0.1286	66.0	0.3081	0.109	0.2717	64.9
20	0.1842	−0.289	0.1442	62.9	0.2989	0.029	0.2413	61.6
1977 survey								
1	0.0764	−0.379	0.1233	76.7	0.1897	0.141	0.2848	76.6
2	0.0957	−0.408	0.1173	75.6	0.1950	0.006	0.2332	75.1
3	0.1112	−0.384	0.1223	73.7	0.2049	−0.023	0.2230	73.3
5	0.1293	−0.352	0.1293	71.6	0.2180	−0.037	0.2180	71.1
10	0.1553	−0.297	0.1422	69.3	0.2545	0.012	0.2354	68.7
15	0.1772	−0.255	0.1529	66.7	0.2684	0.012	0.2351	66.0
20	0.2124	−0.200	0.1675	63.6	0.3019	0.036	0.2440	62.7
1981 census								
1	0.0710	−0.419	0.1150	80.4	0.1137	−0.160	0.1791	80.4
2	0.0863	−0.465	0.1060	79.1	0.1469	−0.164	0.1778	78.9
3	0.0880	−0.514	0.0970	77.3	0.1716	−0.132	0.1874	77.0
5	0.0948	−0.527	0.0948	75.2	0.1903	−0.123	0.1903	74.8
10	0.1174	−0.459	0.1071	72.8	0.2160	−0.095	0.1990	72.4
15	0.1311	−0.433	0.1122	70.1	0.2302	−0.091	0.2004	69.7
20	0.1525	−0.403	0.1184	67.0	0.2523	−0.088	0.2012	66.4

[a]Brass method.
[b]The approximate date of estimate, 1971.1, 1969.5 etc.

about 50 per 1000, and infant mortality levels of about 35 per 1000, are really quite low while those for the uneducated women are extremely high.

It would be interesting to investigate to what extent these differentials in child mortality persist if the variation in parities between different education categories is controlled. There is considerable difference in mean children ever born by education (see table 11), and it is possible that some of the child mortality variation can be explained by the association between high parities and high child mortality. However, this association is unlikely to be sufficiently strong to account for much of the effect.

Table 18 Proportions of children dead by age of mother and region (Coast–Selva–Sierra), 1976

Age of mother	Coast	Selva	Sierra
15–19	0.0979	0.1250	0.2061
20–24	0.0858	0.1583	0.1716
25–29	0.0735	0.1280	0.2146
30–34	0.0933	0.1926	0.2261
35–39	0.1158	0.1843	0.2590
40–44	0.1422	0.1964	0.2900
45–49	0.1605	0.2565	0.2848

Table 19 Estimates of childhood mortality rates (q(x)) and mortality levels (α)[a] by region (Coast–Selva–Sierra), 1976

Age (x)	q(x)	α	q(5)	Date[b]
Coast				
1	0.1188	−0.135	0.1865	75.8
2	0.0956	−0.408	0.1172	74.7
3	0.0770	−0.587	0.0850	72.9
5	0.0971	−0.513	0.0971	70.8
10	0.1215	−0.439	0.1109	68.5
15	0.1467	−0.367	0.1259	65.9
20	0.1658	−0.353	0.1292	62.8
Selva				
1	0.1257	−0.103	0.1965	75.6
2	0.1622	−0.106	0.1955	74.2
3	0.1283	−0.303	0.1408	72.3
5	0.1942	−0.110	0.1942	70.1
10	0.1876	−0.183	0.1723	67.7
15	0.1955	−0.194	0.1692	65.0
20	0.2549	−0.081	0.2034	61.7
Sierra				
1	0.2330	0.271	0.3406	75.7
2	0.1858	−0.024	0.2227	74.4
3	0.2217	0.027	0.2408	72.6
5	0.2332	0.006	0.2332	70.4
10	0.2694	0.051	0.2495	68.1
15	0.2962	0.080	0.2607	65.4
20	0.2908	0.009	0.2343	62.3

[a]Brass method.
[b]The appropriate date of estimate, 1975.8, 1974.7 etc.

Table 20 Proportions of children dead by age of mother and education of mother, 1977

Age of mother	No schooling	Primary	Secondary and above
15–19	0.2826	0.1074	0.0284
20–24	0.2126	0.1320	0.0552
25–29	0.2303	0.1496	0.0498
30–34	0.2305	0.1531	0.0567
35–39	0.2586	0.1597	0.0444
40–44	0.2929	0.1713	0.0628
45–49	0.3288	0.1947	0.0801

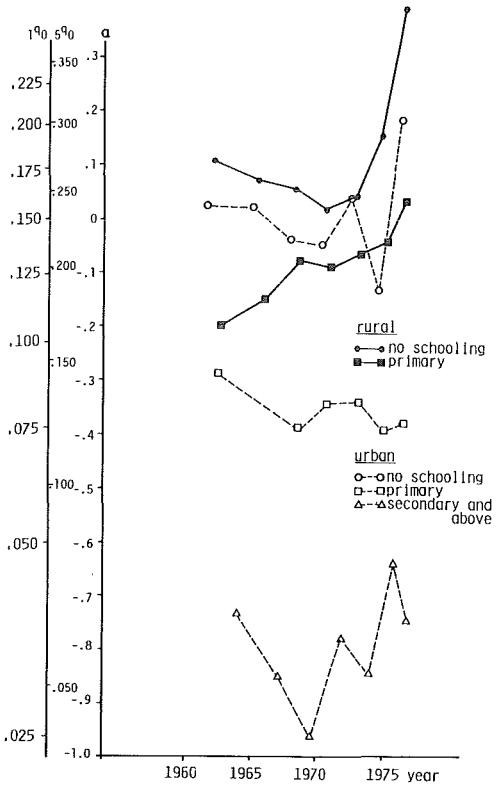

Figure 10 Trends in childhood mortality by place of residence and education of mother, 1977

Table 21 Estimates of childhood mortality rates (q(x)) and mortality levels (α)[a] by education of mother, 1977

Age (x)	q(x)	α	q(5)	Date[b]
No schooling				
1	0.2663	0.360	0.3817	76.4
2	0.2106	0.055	0.2509	74.8
3	0.2263	0.041	0.2457	72.8
5	0.2287	−0.006	0.2287	70.6
10	0.2587	0.023	0.2394	68.1
15	0.2858	0.055	0.2511	65.4
20	0.3202	0.079	0.2601	62.0
Primary				
1	0.1068	−0.195	0.1690	76.5
2	0.1345	−0.216	0.1632	75.1
3	0.1494	−0.215	0.1636	73.2
5	0.1540	−0.250	0.1540	71.0
10	0.1621	−0.272	0.1485	68.6
15	0.1700	−0.280	0.1465	65.8
20	0.1929	−0.261	0.1513	62.5
Secondary and above				
1	0.0357	−0.781	0.0592	76.8
2	0.0624	−0.640	0.0771	75.8
3	0.0526	−0.790	0.0582	74.0
5	0.0593	−0.781	0.0593	72.0
10	0.0468	−0.957	0.0424	69.6
15	0.0651	−0.819	0.0551	67.1
20	0.0832	−0.745	0.0634	64.1

[a]Brass method.
[b]The approximate date of estimate, 1976.4, 1974.8 etc.

Further analysis looked at the differentials in child mortality by place of residence *and* education of mother. Table 22 shows the proportions of children dead by education level among urban and rural women from the PFS data. Only 55 rural women (aged 15–49) had secondary education or above, so no further analysis was done on this group. Table 23 and figure 10 show the child mortality estimates. It is interesting to note the similarity between both the urban and the rural no schooling categories; the urban mortality levels are lower by only a small amount. For women with primary education the differential between urban and rural is large. In the early 1970s q(5) levels of the rural primary-educated women were around 200 per 1000, whereas urban women of the same education level had child mortality levels of about 130 per 1000. The rural women with primary education appear to have increasing child mortality levels over the previous 15 years; some of this could be explained by the fact that rural women who 25–30 years ago had some primary education were quite a select and privileged group.

Table 22 Proportions of children dead by age of mother and place of residence (urban–rural) and education of mother, 1977

Age of mother	Urban			Rural		
	No schooling	Primary	Secondary and above	No schooling	Primary	Secondary and above
15–19	0.2222	0.0777	0.0305	0.2916	0.1559	1.0000
20–24	0.1599	0.0972	0.0553	0.2462	0.1757	0.0547
25–29	0.2318	0.1212	0.0448	0.2296	0.1914	0.1503
30–34	0.2185	0.1307	0.0567	0.2385	0.1987	0.0574
35–39	0.2383	0.1312	0.0439	0.2701	0.2169	0.0556
40–44	0.2818	0.1549	0.0593	0.2987	0.2106	0.1304
45–49	0.3078	0.1866	0.0813	0.3392	0.2138	0.0556

Table 23 Estimates of childhood mortality rates (q(x)) and mortality levels (α)[a] by place of residence (urban–rural) and education of mother, 1977

Age (x)	Urban				Rural			
	q(x)	α	q(5)	Date[b]	q(x)	α	q(5)	Date[b]
No schooling								
1	0.2029	0.183	0.6979	76.3	0.2800	0.395	0.6019	76.5
2	0.1557	−0.130	0.8120	74.6	0.2464	0.156	0.7090	74.9
3	0.2252	0.037	0.7555	72.6	0.2270	0.043	0.7536	72.9
5	0.2148	−0.047	0.7852	70.3	0.2378	0.019	0.7622	70.7
10	0.2360	−0.038	0.7821	67.9	0.2717	0.057	0.7483	68.3
15	0.2718	0.020	0.7618	65.0	0.2934	0.074	0.7419	65.5
20	0.2963	0.023	0.7609	61.6	0.3325	0.107	0.7290	62.2
Primary								
1	0.0764	−0.379	0.8767	76.5	0.1586	0.033	0.7573	76.6
2	0.0985	−0.392	0.8794	75.0	0.1811	−0.039	0.7827	75.2
3	0.1207	−0.338	0.8674	73.1	0.1924	−0.062	0.7904	73.3
5	0.1311	−0.344	0.8689	70.9	0.2009	−0.089	0.7991	71.1
10	0.1328	−0.388	0.8787	68.5	0.2213	−0.079	0.7960	68.7
15	0.1533	−0.341	0.8683	65.7	0.2102	−0.149	0.8177	66.0
20	0.1843	−0.289	0.8557	62.4	0.2131	−0.198	0.8319	62.8
Secondary and above								
1	0.0381	−0.747	0.9369	76.8	There are only 55 women in this category			
2	0.0623	−0.641	0.9230	75.8				
3	0.0472	−0.847	0.9477	74.0				
5	0.0593	−0.781	0.9407	71.9				
10	0.0462	−0.964	0.9581	69.6				
15	0.0615	−0.850	0.9479	67.1				
20	0.0844	−0.737	0.9356	64.0				

[a]Brass method.
[b]The approximate date of estimate, 1976.5, 1974.9 etc.

7 Adult Mortality

7.1 ORPHANHOOD

Questions on maternal survival were asked in the 1972 and 1981 censuses, and in the surveys of 1976 and 1977, giving four sets of estimates on female adult mortality. Questions on survival of fathers were included in both the 1976 and 1977 surveys. For the 1972 census and the 1977 survey, data on parental survival tabulated by sex of respondent are available. All the sets of data contain information on place of residence of the respondent, enabling us to calculate urban–rural differentials in adult mortality. Parental survival is available by education of the respondent from the PFS (1977).

To convert the proportions with mother/father alive[6] into conditional survivorship values from age 25 for females – $1(25+N)/1(25)$ – and from age 32.5 for males – $1(35+N)/1(32.5)$ – the Brass method using weighting factors was used. These weights were selected using the mean age of mothers ($\bar{M}f$) or fathers ($\bar{M}m$) at the birth of their children (as described below). The conditional survivorship values were expressed as equivalent α values using the General Standard model life table; equivalent expectations of life from age 15, $\mathring{e}_{15}$, were also calculated. The method suggested by Brass and Bamgboye (1981) was used to locate these values in time.

Estimation of the mean age of mothers/fathers at the birth of their children

The mean age of mothers at the birth of their children ($\bar{M}f$) is calculated from the births in the 12 months preceding the survey. The $\bar{M}f$ for 1972 is 28.63, for 1976 28.00, and for 1981 27.79. Since the information is not available for the PFS household survey and is not easily accessible for the individual survey, the 1976 value was used with the 1977 data. The 1976 and PFS surveys were only separated by just over a year, and there is unlikely to have been any great change in timing of fertility in this short period. The marriage patterns for women as summarized by the SMAM values are almost identical. So, any change in $\bar{M}f$ will be due to changes in the timing of fertility within marriage. The estimates of $1(25+N)/1(25)$ do not appear to be very sensitive to the value of $\bar{M}f$ used, eg comparing the estimates obtained from the PFS maternal survival data using an $\bar{M}f$ of 28.00 and 27.00, the former gives slightly higher survivorship from age 25, by, at the most, just over 3 per cent in the range of N from 10 to 45.

It is more complicated to estimate the mean age of fathers ($\bar{M}m$) since data are not available here on births in the last year by age of fathers. The usual solution is to add to the $\bar{M}f$ value an amount reflecting the difference in age at marriage of women and men. Here, the difference in the median ages of the currently married female and male populations was used. This method was chosen, rather than the difference in the female and male SMAMS, for several reasons. It reflects the ages of the currently married, rather than the ever-married population, and is therefore more related to current patterns of childbearing by age; it is more appropriate if there is much remarriage since SMAMs are based on first marriages; and because the median, rather than the mean, is used, the result is *not* affected by age-reporting errors at older ages. For 1976 the $\bar{M}m$ based on SMAMs is 30.67, and that based on the currently married 32.26, so the differences are large. The male conditional survivorship values are sensitive to the value of $\bar{M}m$ used; those based on the currently married population indicate considerably lower mortality. By using the difference in the median ages of the currently married female and male populations, $\bar{M}m$ values of 32.26 in 1976 and 32.61 in 1977 were obtained.

Separate estimates of $\bar{M}f$ and $\bar{M}m$ were made for the urban and rural sectors for each set of data. For the analysis of the parental survival information by education, from the 1977 data, the $\bar{M}f$ (28.00) and $\bar{M}m$ (32.61) values for the whole population for 1977 were used, as no information was available on births in the last year by education of respondent.

It is interesting to look at the differential reporting on parental survival by sex of the respondent. Reports on maternal survival in 1972 and 1977 (table 24) and reports on paternal survival in 1977 (table 26 below) show males as reporting higher proportions of surviving parents in all age groups except the youngest two or three. The differences increase with age and in the PFS data are in the region of a 7 or 8 per cent higher proportion of males aged 40–44 with surviving mothers/fathers than females. The 1972 census data are more comparable between the sexes.

It could be argued that respondents are more likely to under-report the mortality of their parents, than to exaggerate it; so, we should accept the reports of female respondents as more reliable, since they indicate higher proportions orphaned. Also, in 1977, we are dealing with the *de jure* population, where more male household members are not actually present to report for themselves, thus making the information obtained less reliable; the number of not-stated cases on the orphanhood question is higher for male respondents. However, the differential reporting by sex could also be explained by age misreporting. Either systematic exaggeration of age by male

[6] In calculating these, the not-stated respondents were excluded from the denominator.

Table 24 Proportions of respondents with mother alive by sex of respondent (1972, 1976, 1977, 1981)

Age group	1972 census			1976 survey (retro)	1977 survey (PFS)			1981 census
	Both sexes	Females	Males	Both sexes	Both sexes	Females	Males	Both sexes
5–9	0.9733	0.9731	0.9735	0.9709	0.9759	0.9757	0.9762	0.9782
10–14	0.9476	0.9486	0.9467	0.9482	0.9525	0.9540	0.9510	0.9579
15–19	0.9122	0.9132	0.9112	0.9316	0.9320	0.9317	0.9323	0.9302
20–24	0.8579	0.8561	0.8597	0.8883	0.8881	0.8809	0.8957	0.8908
25–29	0.7900	0.7876	0.7925	0.8287	0.8144	0.8116	0.8175	0.8395
30–34	0.7087	0.7069	0.7105	0.7369	0.7453	0.7376	0.7531	0.7652
35–39	0.6108	0.6050	0.6168	0.6415	0.6379	0.6271	0.6490	0.6712
40–44	0.5099	0.5022	0.5173	0.5216	0.5172	0.4966	0.5383	0.5589
45–49	0.4028	0.3946	0.4112	0.4265	0.4268	0.4088	0.4444	0.4467
50–54	0.2924	0.2825	0.3023	0.2870	0.2831	0.2552	0.3139	0.3349
55–59	0.2010	0.1955	0.2065	0.1890	0.1874	0.1544	0.2240	0.2381
60–64	0.1259	0.1207	0.1314	0.1009	0.1028	0.0961	0.1098	0.1491

respondents or understating of age by female respondents would produce the observed differences.

As it is difficult to decide which of these two explanations to accept as more plausible, the following analysis of the orphanhood data was done using the combined results from female and male respondents.

Proportions of respondents with mother alive for 1972, 1976, 1977 and 1981 are given in table 24 and the corresponding adult female mortality estimates in table 25. These results are shown in figure 11 where α is plotted against time. The four overlapping sets of estimates appear to be very consistent, thus reinforcing our belief in their validity. (The 1981 census results indicate slightly higher mortality.) They indicate quite a rapid decline in adult female mortality between the late 1950s and late 1960s from an α level of about -0.43 to almost -0.70 ie an increase in $\mathring{e}_{15}$ from about 50 to 54 years.

In contrast to the values from 1972 and 1981 which lie on very smooth lines, the points from the 1976 and 1977 surveys are more erratic. In both cases high mortality levels are indicated by the youngest two groups of respondents (ie those up to age 20) compared with the trend shown by older respondents. Since these measures are based on a relatively small number of deaths over a limited age range, the deviations are likely to be a product of sample fluctuations or an inadequacy of the model for specifying death rates for the youngest respondents.

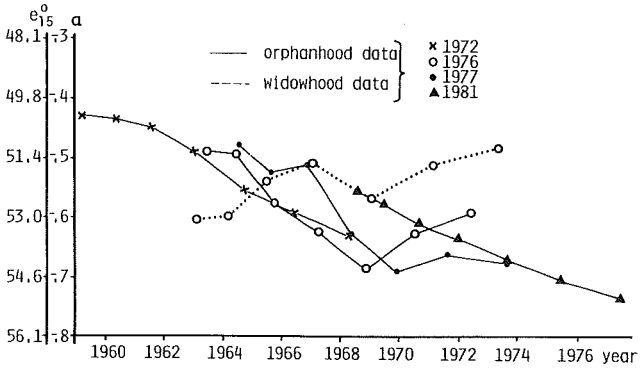

Figure 11 Trends in adult female mortality estimated from orphanhood and widowhood data

Table 26 shows the proportions of respondents with father alive in 1976 and 1977. The conditional survivorship values from age 32.5 are given in table 27 and the equivalent α values and their location in time in figure 12. There is good agreement between the two sets of estimates except for the points obtained from the youngest respondents which diverge from each other. Apart from these points, a rapid decline in mortality levels is shown, from α of about -0.30 in the early 1960s to about -0.58 in the late 1960s; this is equivalent to $\mathring{e}_{15}$ rising from 48 to 53 years over this period.

Substantial, though decreasing, sex differentials in adult mortality are indicated by these data; in the late 1960s female adult mortality is lower by about $1\frac{1}{2}$ years in $\mathring{e}_{15}$; in the early 1960s the difference is about two years. The vulnerability of the male estimates to the model assumptions must, however, be remembered.

Differentials by urban–rural residence of respondent

Parents are classified as urban or rural residents according to the place of residence of the respondents (ie their children). Since place of residence may easily have changed over the previous generation, in cases of recent migration to the cities, the rural-based mortality of parents will be classified as urban. As with childhood

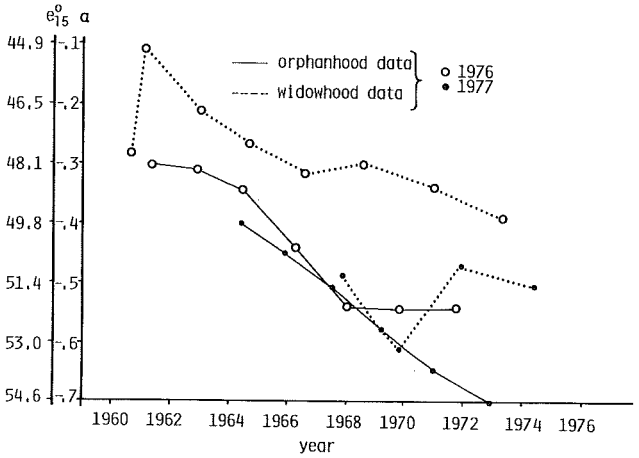

Figure 12 Trends in adult male mortality estimated from orphanhood and widowhood data

Table 25 Estimates of female survivorship from age 25 and mortality level (α) from orphanhood data[a] (1972, 1976, 1977, 1981)

Age N	1972 census				1976 survey (retro)				1977 survey (PFS)				1981 census			
	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]
10	0.9656	−0.630	53.51	68.3	0.9635	−0.594	48.55	72.4	0.9683	−0.677	54.25	73.6	0.9714	−0.736	55.16	77.3
15	0.9420	−0.594	48.55	66.4	0.9449	−0.626	53.45	70.5	0.9484	−0.665	54.06	71.6	0.9520	−0.706	54.70	75.4
20	0.9107	−0.554	47.95	64.7	0.9282	−0.688	54.42	68.8	0.9285	−0.690	54.45	69.9	0.9264	−0.673	54.18	73.6
25	0.8634	−0.489	46.96	63.0	0.8892	−0.627	53.46	67.2	0.8893	−0.627	53.46	68.3	0.8905	−0.633	53.56	72.0
30	0.8028	−0.449	46.35	61.5	0.8360	−0.580	48.34	65.7	0.8199	−0.514	47.34	66.8	0.8436	−0.611	53.22	70.6
35	0.7300	−0.437	46.16	60.3	0.7491	−0.495	47.05	64.4	0.7591	−0.527	47.54	65.6	0.7745	−0.576	52.66	69.5
40	0.6323	−0.432	46.09	59.2	0.6548	−0.490	46.98	63.4	0.6513	−0.481	46.84	64.5	0.6799	−0.556	52.33	68.5
45	0.5292	−0.480	46.82	–	0.5276	−0.476	46.76	–	0.5229	−0.465	46.59	–	0.5617	−0.556	52.34	–
50	0.4049	−0.553	47.93	–	0.4111	−0.568	48.16	–	0.4110	−0.568	48.16	–	0.4299	−0.613	53.24	–
55	0.2721	−0.674	54.20	–	0.2522	−0.616	53.29	–	0.2491	−0.607	53.15	–	0.2967	−0.742	55.26	–
$\bar{M}f$	28.63				28.00				28.00				27.79			

[a]Brass method.
[b]The approximate date of estimate, 1968.3, 1966.4 etc.

Table 26 Proportions of respondents with father alive by sex of respondent (1976, 1977)

Age group	1976 survey (retro)	1977 survey (PFS)		
	Both sexes	Both sexes	Females	Males
5–9	0.9594	0.9662	0.9678	0.9645
10–14	0.9166	0.9370	0.9379	0.9360
15–19	0.8824	0.8860	0.8827	0.8893
20–24	0.8130	0.8228	0.8185	0.8273
25–29	0.7017	0.7221	0.6979	0.7496
30–34	0.5801	0.6218	0.6218	0.6219
35–39	0.4636	0.4877	0.4715	0.5044
40–44	0.3432	0.3540	0.3420	0.3663
45–49	0.2331	0.2620	0.2424	0.2811
50–54	0.1452	0.1602	0.1313	0.1909
55–59	0.0854	0.0765	0.0643	0.0892
60–64	0.0320	0.0347	0.0328	0.0366

mortality, this will have the effect of diminishing any real urban–rural differentials.

The proportions of respondents with mother alive by urban–rural residence are shown in table 28 and the female survivorship values in table 29 and figure 13. Again there is good agreement between the four data sets (1972, 1976, 1977 and 1981), showing considerably higher rural than urban mortality. The 1972 and 1981 information is far smoother than the two sets of survey estimates which, although they fit generally into the same picture, are far more erratic, especially for the two youngest groups of respondents. Without these youngest points, urban mortality around 1970 can be summarized by an α value of -0.70 and rural mortality an α of about -0.50, ie a difference of about three years in $\mathring{e}_{15}$, between about $54\frac{1}{2}$ and $51\frac{1}{2}$ years respectively. The 1960 levels were nearer to 51 years for urban and 49 years for rural.

The information on paternal survival and the derived male survivorship values from age 32.5 are given in tables

Table 27 Estimation of male survivorship from age 32.5 and mortality level (α) from orphanhood data[a] (1976, 1977)

Age N	1976 survey (retro)				1977 survey (PFS)			
	$\frac{l(35+N)}{l(32.5)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{l(35+N)}{l(32.5)}$	α	$\mathring{e}_{15}$	Date[b]
10	0.9368	−0.544	52.13	71.7	0.9514	−0.705	54.69	72.9
15	0.9010	−0.548	52.20	69.8	0.9154	−0.649	53.81	71.0
20	0.8514	−0.541	52.09	68.0	0.8603	−0.583	52.76	69.2
25	0.7584	−0.443	50.49	66.2	0.7782	−0.511	51.60	67.5
30	0.6238	−0.346	48.89	64.4	0.6634	−0.454	50.67	65.9
35	0.4812	−0.314	48.37	62.8	0.5154	−0.402	49.82	64.4
40	0.3240	−0.305	48.22	61.3	0.3406	−0.353	49.01	–
45	0.1831	−0.344	48.86	–	0.2251	−0.507	51.54	–
50	0.0909	−0.530	51.91	–	0.1019	−0.606	53.13	–
55	0.0469	−1.019	59.29	–	0.0253	−0.664	54.04	–
$\bar{M}_m$	32.26				32.61			

[a]Brass method.
[b]The approximate date of estimate, 1971.7, 1969.8 etc.

Table 28 Proportion of respondents with mother alive by place of residence (urban–rural) of respondent (1972, 1976, 1977, 1981)

Age group	1972 census		1976 survey (retro)		1977 survey (PFS)		1981 census	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
5–9	0.9800	0.9648	0.9760	0.9638	0.9863	0.9606	0.9838	0.9696
10–14	0.9558	0.9358	0.9601	0.9302	0.9636	0.9350	0.9648	0.9462
15–19	0.9207	0.8961	0.9391	0.9161	0.9430	0.9081	0.9373	0.9150
20–24	0.8715	0.8307	0.8977	0.8650	0.8972	0.8635	0.9019	0.8647
25–29	0.8104	0.7545	0.8470	0.7902	0.8263	0.7827	0.8566	0.7989
30–34	0.7346	0.6671	0.7699	0.6744	0.7605	0.7108	0.7887	0.7094
35–39	0.6406	0.5673	0.6978	0.5597	0.6809	0.5632	0.7027	0.6087
40–44	0.5451	0.4566	0.5647	0.4497	0.5486	0.4688	0.5947	0.4910
45–49	0.4363	0.3568	0.4676	0.3579	0.4790	0.3471	0.4808	0.3873
50–54	0.3230	0.2507	0.3478	0.1833	0.3291	0.2126	0.3678	0.2762
55–59	0.2190	0.1768	0.2185	0.1429	0.2048	0.1618	0.2574	0.2046
60–64	0.1404	0.1086	0.1233	0.0695	0.1124	0.0884	0.1634	0.1277

Table 29 Estimates of female survivorship from age 25 and mortality level (α) from orphanhood data,[a] by place of residence (urban–rural) of respondent (1972, 1976, 1977, 1981)

Age N	1972 census				1976 survey (retro)				1977 survey (PFS)				1981 census			
	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]
Urban																
10	0.9724	−0.757	55.48	68.3	0.9706	−0.720	54.92	72.5	0.9785	−0.895	57.54	73.5	0.9771	−0.862	57.05	77.3
15	0.9493	−0.675	54.22	66.4	0.9553	−0.749	55.36	70.5	0.9589	−0.796	56.08	71.6	0.9582	−0.785	55.92	75.4
20	0.9177	−0.604	53.10	64.6	0.9342	−0.741	55.24	68.7	0.9377	−0.773	55.73	69.8	0.9326	−0.725	55.00	73.6
25	0.8738	−0.542	52.10	63.0	0.8962	−0.668	54.11	67.1	0.8950	−0.661	54.00	68.2	0.8996	−0.688	54.42	72.0
30	0.8186	−0.509	51.57	61.5	0.8488	−0.635	53.59	65.7	0.8278	−0.547	52.18	66.7	0.8567	−0.670	54.14	70.6
35	0.7496	−0.497	51.38	60.3	0.7744	−0.577	52.67	64.5	0.7654	−0.547	52.18	65.5	0.7919	−0.635	53.59	69.5
40	0.6546	−0.490	51.26	59.3	0.7027	−0.618	53.32	63.8	0.6858	−0.572	52.59	64.7	0.7035	−0.619	53.35	68.6
45	0.5564	−0.544	52.13	–	0.5628	−0.559	52.38	–	0.5473	−0.523	51.80	–	0.5888	−0.620	53.35	68.0
50	0.4290	−0.610	53.19	–	0.4439	−0.644	53.73	–	0.4494	−0.657	53.93	–	0.4545	−0.669	54.13	–
55	0.2909	−0.726	55.01	–	0.2907	−0.725	54.99	–	0.2742	−0.680	54.30	–	0.3152	−0.790	55.99	–
$\bar{M}_f$	28.22				27.54				27.54				27.36			
Rural																
10	0.9567	−0.492	51.29	68.3	0.9536	−0.450	50.61	72.5	0.9528	−0.439	50.43	73.6	0.9622	−0.574	52.62	77.4
15	0.9306	−0.483	51.15	66.5	0.9278	−0.459	50.75	70.6	0.9305	−0.483	51.15	71.7	0.9404	−0.576	52.66	75.4
20	0.8969	−0.461	50.79	64.7	0.9142	−0.579	52.70	68.9	0.9065	−0.524	51.81	69.9	0.9118	−0.561	52.41	73.6
25	0.8405	−0.380	49.46	63.0	0.8701	−0.523	51.80	67.2	0.8689	−0.516	51.68	68.3	0.8670	−0.506	51.53	72.0
30	0.7734	−0.342	48.83	61.5	0.8066	−0.463	50.82	65.8	0.7929	−0.412	49.98	66.7	0.8082	−0.469	50.91	70.5
35	0.6956	−0.334	48.70	60.2	0.6972	−0.339	48.78	64.2	0.7401	−0.468	50.90	65.7	0.7250	−0.421	50.13	69.2
40	0.5997	−0.348	48.93	59.0	0.5809	−0.300	48.14	62.9	0.5813	−0.301	48.15	63.9	0.6254	−0.414	50.03	68.1
45	0.4837	−0.370	49.29	–	0.4641	−0.322	48.50	–	0.4878	−0.380	49.46	–	0.5012	−0.413	50.01	–
50	0.3694	−0.466	50.87	–	0.3566	−0.433	50.33	–	0.3461	−0.406	49.89	–	0.3794	−0.492	51.29	–
55	0.2419	−0.584	52.78	–	0.1732	−0.334	48.70	–	0.2000	−0.441	50.46	–	0.2536	−0.621	53.37	–
$\bar{M}_f$	29.11				28.50				28.50				28.19			

[a]Brass method.
[b]The approximate date of estimate, 1968.3, 1972.5 etc.

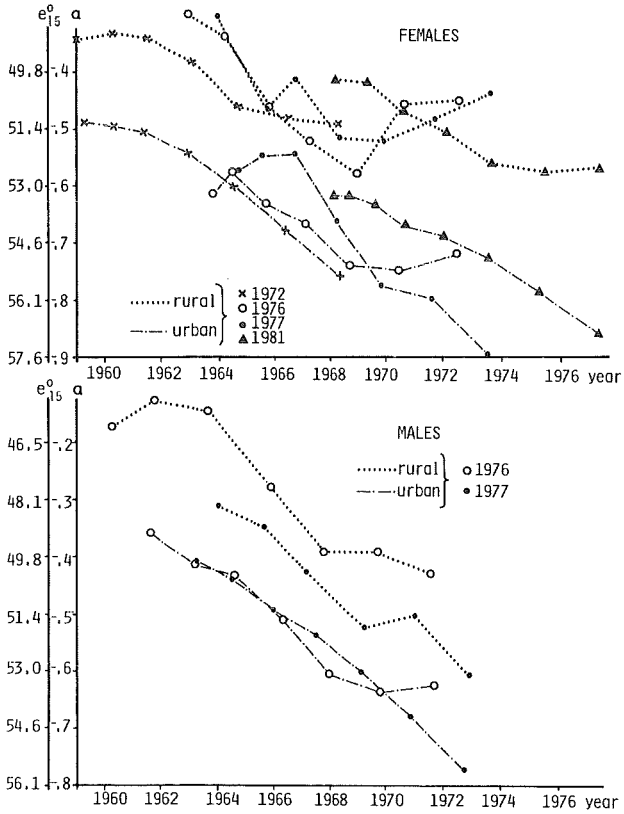

Figure 13 Trends in adult female and male mortality by place of residence of respondent, estimated from orphanhood data

30 and 31, and shown in figure 13. The urban estimates for 1976 and 1977 agree very well (except for the two youngest points), but the rural estimates for 1976 show higher mortality levels than the 1977 data.

The urban male mortality levels are comparable with the rural female levels, and indicate falls in mortality between the early and late 1960s from an $\mathring{e}_{15}$ of about 49 years to 53 years. The rural male mortality is considerably higher, particularly in the 1976 data. Both sets of information show fast declines in rural mortality.

Table 30 Proportion of respondents with father alive by place of residence (urban–rural) of respondent (1976, 1977)

Age group	1976 survey (retro)		1977 survey (PFS)	
	Urban	Rural	Urban	Rural
5–9	0.9652	0.9515	0.9706	0.9593
10–14	0.9265	0.9015	0.9435	0.9264
15–19	0.8989	0.8480	0.8895	0.8785
20–24	0.8251	0.7833	0.8312	0.8011
25–29	0.7323	0.6370	0.7349	0.6898
30–34	0.6170	0.5099	0.6420	0.5754
35–39	0.5070	0.4008	0.5076	0.4540
40–44	0.3681	0.3018	0.3807	0.3121
45–49	0.2586	0.1905	0.2947	0.2120
50–54	0.1772	0.0907	0.1940	0.1090
55–59	0.1025	0.0586	0.1050	0.0338
60–64	0.0430	0.0168	0.0342	0.0379

Differentials by education of respondent

Information on parental survival by education of respondent is difficult to interpret. Parents will not necessarily have the same level of education as their children; there have been marked changes in the recent availability of education in Peru. The examination of mortality levels of parents, located in time over the past 15 years or so, by the education of their daughters and sons is complicated, and the results must be interpreted with caution. The education level of the children becomes a proxy measure for socio-economic characteristics transmitted over generations.

The proportions of respondents with mother alive by education of respondent (1977 data) are shown in table 32 and conditional female survivorship values are given in table 33; the proportions with father alive by education of respondent are shown in table 34 and conditional male survivorship values are given in table 35; both sets of results are shown in figure 14. For both sexes, there are clear differentials by education, although some of the points are quite erratic. In each case the general impression is that male mortality is slightly higher than female. Very roughly, the α levels relating to respondents with no schooling are -0.1 to -0.2, for those with primary schooling -0.4 to -0.5, and those with secondary education and above -0.7 to -0.8; these correspond to $\mathring{e}_{15}$ values in the region of 45 or 46 for those with no schooling, 50 or 51 for those with primary education and 55 or 56 for those with secondary education and above.

7.2 WIDOWHOOD

A question on the survival of first spouse or cohabitant was asked of the ever-married population in the 1976 survey. Information is also available from the PFS individual survey on the status of the first union of all sampled ever-married women aged 15–49.

We are able to estimate female and male adult survivorship from the 1976 information and male adult survivorship from the 1977 data.

The Hill weighting method was used to convert the proportions not widowed into conditional survivorship values. The weights were selected using SMAM values and the population weighted mean ages at first marriage.[7] The probabilities of surviving were expressed in terms of α values using the General Standard model life table, and also $\mathring{e}_{15}$ values. They were located in time using the method proposed by Brass and Bamgboye (1981).

1976 data

An examination of the proportions of ever-married respondents with first spouse alive by age of respondent (table 36) shows great differences by sex. For both female and male respondents the proportions are close to one in the age groups 15–19 and 20–24 (as would be expected);

[7] These values were obtained for 1976 from the responses to the question on current marital status, and for 1977 from the PFS household survey information.

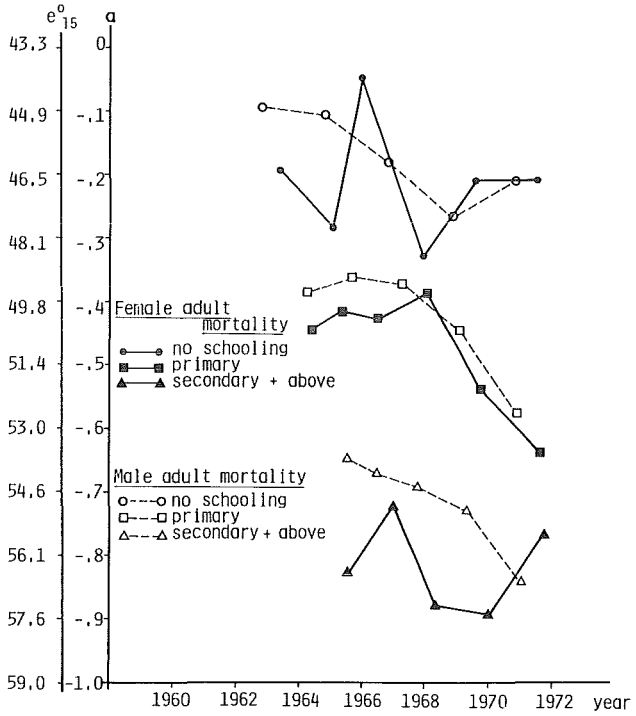

Figure 14 Trends in adult female and male mortality by education of respondent, estimated from 1977 orphanhood data

then, as the age of respondent increases, the proportions of female respondents with first husband alive decreases quite fast reaching about 0.52 for women aged 60–64. For male respondents the proportions decrease far more slowly to about 0.78 for men aged 60–64.

The survivorship values, and equivalent $\mathring{e}_{15}$ and α values, from age 27.5 for males and age 22.5 for females are shown in table 37. The female survivorship estimates are quite erratic (see figure 11) and although the level of mortality they indicate is broadly similar to the maternal orphanhood estimates, the widowhood information shows a slight *increase* in mortality over the period 1963–73. The estimates of male survivorship are less erratic, but show substantially higher mortality levels (and slower rates of decline) than those indicated by the paternal orphanhood estimates (see figure 12). This could be due to women reporting themselves as widowed rather than divorced or separated. The number of women reported as widowed in the 'widowhood question' is considerably higher than the number reported as widowed in the 'current marital status'; it seems improbable that all this discrepancy can be attributed to remarriage.

1977 data

The proportions of women with first husband alive obtained from the PFS individual survey (table 38) are slightly higher in each age group than those from the 1976 survey. Table 39 shows the derived male mortality estimates, which indicate lower mortality than is shown by the 1976 data (see figure 12). These 1977 estimates are quite erratic but broadly agree with the paternal orphanhood estimates.

7.3 CURRENT DEATHS

Direct information on deaths by age is available from the vital registration system although many deaths are never recorded. The observed death rates can be adjusted to give a better estimate of the true mortality levels in the population by using the population age distribution and the registered deaths by age. The method is based on the relationship whereby the birth rate for the population aged x and over ($b(x^+)$) is equal to the growth rate for the population aged x and over, plus the death rate for the same population. Substituting the observed death rate for the true death rate, we obtain:

$$b(x^+) = r + K.d(x^+)$$

where K is the correction factor. These relationships assume that the population is stable and closed, and that the *pattern* of deaths by age is correct, that is, the degree of under-reporting is the same at all ages.

For each data set, and for each sex separately, graphs were plotted of $b(x^+)$ against $d(x^+)$. Points which deviated greatly from a linear trend were omitted and a straight line fitted to the remaining points using the group average method (see Brass 1975, p 103). The gradient gives us the correction factor by which to adjust the reported deaths and the intercept on the y-axis an estimate of the growth rate of the population. The observed death rates by age were then corrected, and from these corrected rates, life tables were calculated for the same age range as that over which the line was fitted. Alpha values were then obtained (using the Brass–Bamgboye formula) corresponding to these survivorship ratios. The average of the α values relating to N = 45 up to N = 65 was calculated and plotted on the graph (see figures 18 and 19, below).

Three applications of the method were made. First, using the 1961 census age distribution and the average of the registered deaths for 1961, 1962 and 1963; secondly, the 1972 census age distribution and the deaths registered in 1971; and thirdly, the results of the 1974–6 multiround survey (EDEN), ie person–years (time of exposure) and deaths occurring during the period of the survey. In all three cases separate applications were made for females and males.

A glance at the observed crude death rates for these three dates (see tables 40, 41 and 42) provides confirmation that deaths are severely under-reported in the registration system. Compared with the crude death rates (CDR) calculated from the EDEN survey (12.6 for females and 12.8 for males), the 1972 data indicate great under-reporting with CDRs of 6.2 and 6.8 for females and males respectively; the 1961 levels are more in line with those for 1976 but still slightly lower, 10.7 and 11.4. It is not really surprising that the EDEN survey shows the highest levels of mortality – this information is likely to be more thorough and reliable because of the way in which it was collected.

The partial birth and death rates are given in tables 40, 41 and 42 and plotted in figures 15, 16 and 17 for 1961, 1972 and 1974–6, for females and males separately.

Table 31 Estimates of male survivorship from age 32.5 and mortality level (α) from orphanhood data,[a] by place of residence (urban–rural) of respondent

Age N	1976 survey (retro)				1977 survey (PFS)			
	$\frac{1(35+N)}{1(32.5)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(35+N)}{1(32.5)}$	α	$\mathring{e}_{15}$	Date[b]
Urban								
10	0.9445	−0.625	53.43	71.7	0.9565	−0.772	55.71	72.8
15	0.9137	−0.637	53.62	69.8	0.9194	−0.679	54.28	70.9
20	0.8649	−0.605	53.12	68.0	0.8641	−0.601	53.05	69.1
25	0.7781	−0.511	51.60	66.3	0.7853	−0.536	52.01	67.5
30	0.6563	−0.435	50.36	64.6	0.6769	−0.492	51.29	65.9
35	0.5214	−0.416	50.05	63.2	0.5300	−0.438	50.41	64.5
40	0.3432	−0.360	49.13	61.7	0.3626	−0.414	50.02	63.2
45	0.2068	−0.440	50.44	–	0.2569	−0.610	53.19	–
50	0.1256	−0.740	55.22	–	0.1330	−0.778	55.80	–
55	0.0536	−1.096	60.33	–	0.0486	−1.039	59.56	–
$\bar{M}_m$	32.14				32.36			
Rural								
10	0.9247	−0.430	50.28	71.6	0.9429	−0.607	53.15	72.9
15	0.8765	−0.394	49.69	69.7	0.9066	−0.501	51.44	71.0
20	0.8180	−0.391	49.64	67.8	0.8479	−0.524	51.81	69.2
25	0.7088	−0.281	47.82	65.9	0.7535	−0.427	50.23	67.1
30	0.5528	−0.147	45.62	63.7	0.6247	−0.348	48.93	65.6
35	0.4148	−0.129	45.33	61.8	0.4812	−0.314	48.37	64.0
40	0.2837	−0.175	46.08	60.3	0.3005	−0.231	47.00	–
45	0.1374	−0.113	45.06	–	0.1736	−0.304	48.20	–
50	0.0273	+0.455	36.88	–	0.0514	−0.133	45.39	–
55	0.0375	−0.893	57.51	–	–	–	–	–
$\bar{M}_m$	32.12				32.72			

[a]Brass method.
[b]The approximate date of estimate, 1971.7, 1969.8 etc.

1961

By examining the plot of the points in figure 15, it was decided to exclude the first two points and the last point as these three deviated from the trend of the others. A line was fitted to the remaining 11 points (coinciding with 15+ up to 65+) giving an adjustment factor of 1.125 for females and 1.181 for males which implies a completeness of death registration of 88.9 and 84.5 per cent respectively. The estimated growth rates are 2.88 per cent per annum for females and 2.91 per cent for males. Survivorship values from age 15, $1_N/1_{15}$, were calculated and are shown in table 43 with the corresponding α values. These vary considerably depending on the range of ages over which they were calculated. The average of the α values for the range $1_{45}/1_{15}$ to $1_{65}/1_{15}$ was obtained and used to represent the level of mortality. For females this is −0.543 and for males −0.416. The levels of mortality indicated by these αs are considerably lower than those suggested for around 1961 by the orphanhood data, although the male–female differential in mortality is maintained.

Table 32 Proportion of respondents with mother alive by education of respondent, 1977

Age group	No schooling	Primary	Secondary and above
10–14	0.9057	0.9536	0.9574
15–19	0.8554	0.9145	0.9514
20–24	0.8261	0.8415	0.9256
25–29	0.6842	0.7909	0.8641
30–34	0.6621	0.7131	0.8255
35–39	0.5272	0.6282	0.7579
40–44	0.3991	0.5410	0.6034
45–49	0.3414	0.4249	0.5508
50–54	0.2111	0.2726	0.4254
55–59	0.1461	0.2113	0.2288
60–64	0.0809	0.1111	0.1466

1972

Lines were fitted to points representing from 15+ up to 70+ (see figure 16) giving correction factors of 1.470 for females and 1.582 for males, ie 68.0 and 63.2 per cent completeness of death registration respectively. The growth rates are 3.13 and 3.04 per cent per annum for females and males. The corrected death rates give sur-

Table 33 Estimates of female survivorship from age 25 and mortality level (α) from orphanhood data,[a] by education of respondent, 1977

Age N	No schooling				Primary				Secondary and above			
	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(25+N)}{1(25)}$	α	$\mathring{e}_{15}$	Date[b]
15	0.8956	−0.207	46.60	71.5	0.9458	−0.636	53.60	71.6	0.9562	−0.761	55.54	71.7
20	0.8531	−0.210	46.65	69.6	0.9087	−0.540	52.07	69.8	0.9494	−0.892	57.49	70.0
25	0.8284	−0.326	48.56	68.0	0.8423	−0.388	49.59	68.1	0.9266	−0.877	57.27	68.4
30	0.6860	−0.047	44.01	66.0	0.7972	−0.428	50.25	66.6	0.8672	−0.720	54.92	67.0
35	0.6794	−0.287	47.92	65.1	0.7239	−0.418	50.08	65.4	0.8342	−0.790	55.99	66.1
40	0.5415	−0.197	46.44	63.4	0.6378	−0.446	50.54	64.4	0.7751	−0.827	56.54	65.6
45	0.4027	−0.160	45.83	–	0.5483	−0.525	51.83	–	0.6067	−0.662	54.01	–
50	0.3270	−0.353	49.01	–	0.4082	−0.561	52.41	–	0.5370	−0.851	56.89	–
55	0.1881	−0.397	49.74	–	0.2508	−0.612	53.23	–	0.3556	−0.888	57.44	–

[a]Brass method.
[b]The approximate date of estimate, 1971.5, 1969.6 etc.
NOTE: $\bar{M}_f$ of 28.00 was used for all education categories.

vivorship values, l_N/l_{15}, that indicate slightly lower mortality than the 1961 values; the average α values (calculated over the range l_{45}/l_{15} to l_{65}/l_{15}) are -0.695 for females and -0.552 for males, both of which agree reasonably well with the other information on adult mortality around 1972.

1976

All points except those relating to the four youngest ages were used in fitting the lines (see figure 17). For both females and males the estimated line had a slope of very close to one, 1.019 and 1.025 respectively, indicating almost complete recording of deaths in the population. The growth rates are 2.61 per cent for females and 2.38 per cent for males. Survivorship values, l_N/l_{25}, were calculated from the corrected death rates, giving average α values of -0.640 for females and -0.500 for males.

Table 34 Proportion of respondents with father alive by education of respondent, 1977

Age group	No schooling	Primary	Secondary and above
10–14	0.8868	0.9355	0.9590
15–19	0.8072	0.8634	0.9098
20–24	0.7585	0.7831	0.8558
25–29	0.5752	0.6803	0.7898
30–34	0.5120	0.5952	0.7034
35–39	0.3747	0.4869	0.5933
40–44	0.2494	0.3917	0.3855
45–49	0.2013	0.2717	0.3231
50–54	0.0835	0.1721	0.2565
55–59	0.0227	0.1234	0.0724
60–64	0.0313	0.0389	0.0345

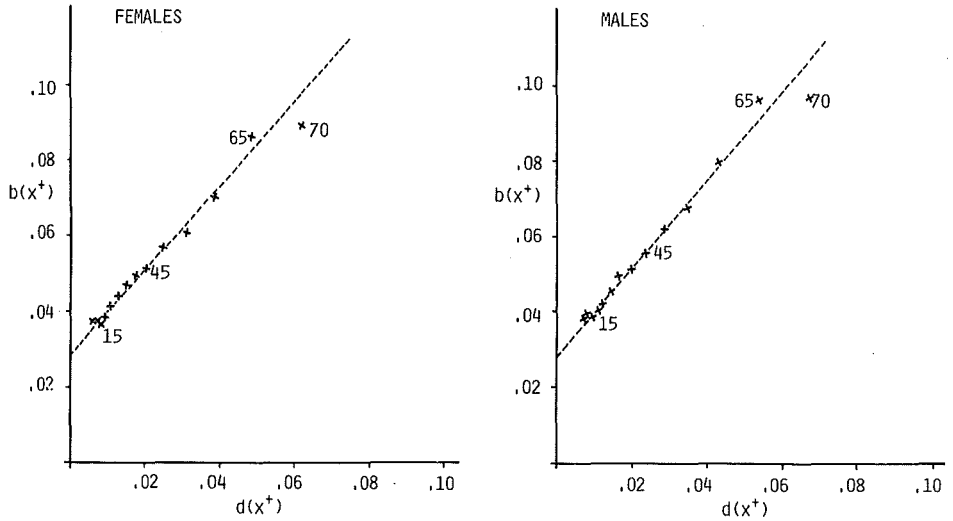

Figure 15 Partial birth and death rates over age x, 1961

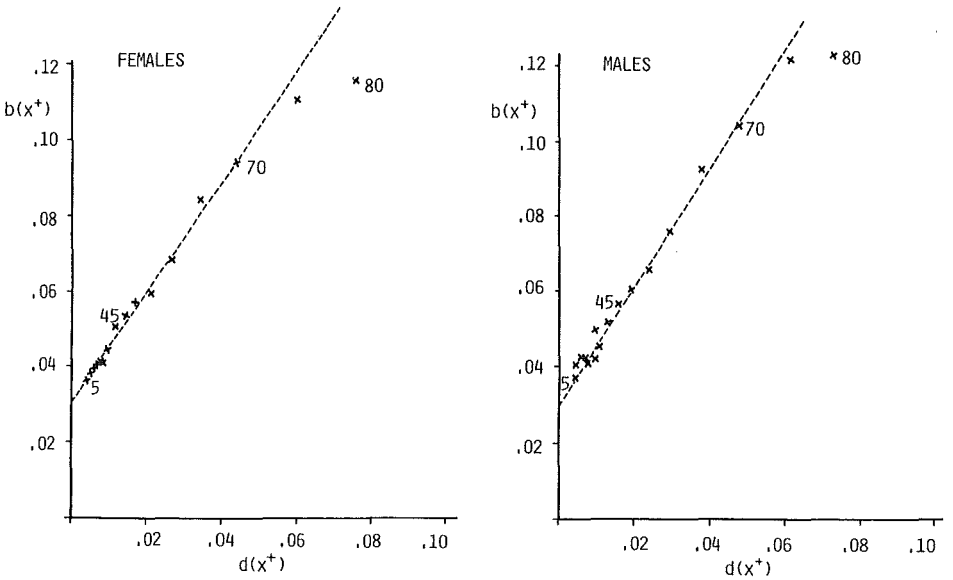

Figure 16 Partial birth and death rates over age x, 1972

Table 35 Estimates of male survivorship from age 32.5 and mortality level (α) from orphanhood data,[a] by education of respondent, 1977

Age N	No schooling				Primary				Secondary and above			
	$\frac{1(35+N)}{1(32.5)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(35+N)}{1(32.5)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{1(35+N)}{1(32.5)}$	α	$\mathring{e}_{15}$	Date[b]
15	0.8532	−0.210	46.65	70.8	0.9051	−0.575	52.63	70.9	0.9382	−0.841	56.74	71.0
20	0.7874	−0.266	47.57	68.9	0.8307	−0.446	50.54	69.1	0.8878	−0.728	55.04	69.3
25	0.6774	−0.180	46.16	66.9	0.7377	−0.374	49.36	67.3	0.8266	−0.691	54.47	67.8
30	0.5381	−0.105	44.93	64.8	0.6305	−0.364	49.19	65.7	0.7392	−0.670	54.14	66.5
35	0.4031	−0.095	44.77	62.8	0.5093	−0.386	49.56	64.3	0.6160	−0.648	53.79	65.5
40	0.2369	−0.196	46.42	–	0.3822	−0.466	50.87	–	0.3647	−0.420	50.11	–
45	0.1820	−0.340	48.80	–	0.2236	−0.502	51.46	–	0.2981	−0.728	55.04	–
50	0.0160	–	–	–	0.1150	−0.684	54.36	–	0.2183	−1.104	60.44	–
55	–	–	–	–	0.0937	−1.410	64.18	–	–	–	–	–

[a]Brass method.
[b]The approximate date of estimate, 1970.8, 1968.9 etc.
NOTE: $\bar{M}_m$ of 32.61 was used for all education categories.

7.4 INTERCENSAL SURVIVAL

1961–72

The age–sex distributions from the 1961 and 1972 censuses provide a way of estimating the mortality over this period; people aged (x + 11) in 1972 are the survivors of those aged x in 1961.[8] However, mortality in this intercensal period can be obscured by changes in the completeness of the census coverage, by migration (which, over certain age ranges, can have an effect far outweighing that of mortality), and by age misreporting.

Intercensal mortality was estimated by taking a series of 11-year projections[9] of the 1961 census age distribu-

[8] The censuses were held on 2 July 1961 and 4 June 1972.

[9] This was done using the FUTURE computer program written by Basia Zaba.

Table 36 Proportions of ever-married respondents with first spouse alive, by sex of respondent, 1976

Age	Female respondents	Male respondents
15–19	0.9908	1.0000
20–24	0.9879	0.9877
25–29	0.9726	0.9892
30–34	0.9555	0.9727
35–39	0.9133	0.9515
40–44	0.8710	0.9356
45–49	0.8286	0.8982
50–54	0.7511	0.8668
55–59	0.6549	0.8366
60–64	0.5183	0.7788
65–69	0.4609	0.7383

NOTE: Those ever-married respondents who did not state their widowhood status were omitted from both numerator and denominator.

Table 37 Estimates of male survivorship from age 27.5 and female survivorship from age 22.5 and mortality levels (α) from widowhood data,[a] 1976

Age N	Male survivorship				Female survivorship			
	$\frac{l(N+5)}{l(27.5)}$	α	$\mathring{e}_{15}$	Date[b]	$\frac{l(N-5)}{l(22.5)}$	α	$\mathring{e}_{15}$	Date[b]
25	0.9800	−0.077	44.48	–	–	–	–	–
30	0.9612	−0.391	49.64	73.2	0.9886	−0.408	49.92	–
35	0.9266	−0.343	48.85	70.9	0.9689	−0.485	51.18	73.3
40	0.8830	−0.301	48.15	68.6	0.9492	−0.515	51.67	71.1
45	0.8386	−0.319	48.45	66.6	0.9316	−0.570	52.55	69.0
50	0.7641	−0.269	47.62	64.7	0.8960	−0.511	51.60	67.0
55	0.6655	−0.215	46.73	63.0	0.8654	−0.539	52.05	65.4
60	0.5196	−0.112	45.05	61.1	0.8340	−0.600	53.04	64.1
65	0.4563	−0.286	47.90	60.6	0.7769	−0.605	53.12	63.1

[a] Hill method.

[b] The approximate date of estimate, 1973.2, 1970.9 etc.

NOTES: (1) $SMAM_f$ = 23.29; $SMAM_m$ = 25.95.

(2) Population weighted mean age at first marriage (females) = 22.88; Population weighted mean age at first marriage (males) = 25.00.

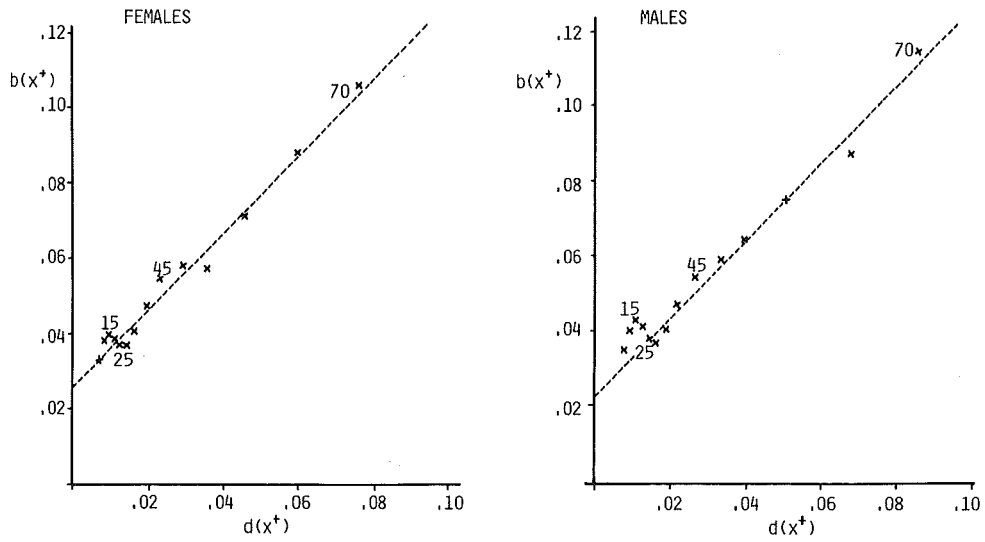

Figure 17 Partial birth and death rates over age x, 1974–6

Table 38 Proportions of ever-married women with first spouse alive, 1977

Age	Proportion with first spouse alive
15–19	0.9936
20–24	0.9922
25–29	0.9858
30–34	0.9591
35–39	0.9315
40–44	0.9255
45–49	0.8601

Table 39 Estimates of male survivorship from age 27.5 and mortality level (α) from widowhood data,[a] 1977

Age N	Male survivorship			
	$\frac{1(N+5)}{1(27.5)}$	α	$\mathring{e}_{15}$	Date[b]
25	0.9889	−0.464	50.84	–
30	0.9678	−0.507	51.54	74.3
35	0.9399	−0.474	51.00	71.9
40	0.9271	−0.615	53.27	69.8
45	0.8742	−0.496	51.36	67.8

[a]Hill method.
[b]The appropriate date of estimate 1974.3, 1971.9 etc.
NOTES: (1) $SMAM_f$ = 23.30.
(2) Population weighted mean age at first marriage (males) = 24.82.

tions by sex, using different mortality assumptions. The level of mortality was described by the alpha value of the logit model life-table system. Nine projections were made for each sex using α values ranging from −0.2 to −1.0. The age pattern of mortality was kept as in the General Standard (B = 1.0). The level of fertility and the shape of the fertility distribution are largely irrelevant in this exercise as they only affect the projected population up to age 11.

For each level of mortality the projected population was cumulated to give the population aged 15 and over, 20 and over, etc. These cumulants were then compared with the equivalent cumulants in the enumerated 1972 population. Tables 44 and 45 show, for females and males respectively, these projected cumulants (for four of the nine α values used), and also the cumulants derived from the reported population. The implied α shown in the table is that value needed to obtain the 1972 reported figure by projecting the 1961 population. The series of α values vary considerably with age. If the values all fluctuated around a central figure it would be reasonable to estimate an average level of mortality. However, since they decline so clearly with age (even when the oldest and youngest ages are excluded) it is inappropriate to suggest averaging the values to obtain the intercensal level of mortality.

It is apparent that factors other than mortality are affecting the 1961 and 1972 age distributions and preventing this method from working well. The method is vulnerable to age-reporting errors, although the effects of this should be reduced by cumulating the populations. The two censuses may have different completeness of

Table 40 Registered deaths, population and partial birth and death rates, 1961

Age group x, x + 4	Females				Males			
	Population	Deaths[a]	Partial birth rate $b(x^+)$	Partial death rate $d(x^+)$	Population	Deaths[a]	Partial birth rate $b(x^+)$	Partial death rate $d(x^+)$
0–4	831 323	26 603	–	–	840 206	28 830	–	–
5–9	727 533	1 745	0.03759	0.00643	738 830	1 882	0.03867	0.00664
10–14	557 497	911	0.03758	0.00729	594 698	997	0.03988	0.00754
15–19	479 739	1 117	0.03624	0.00839	493 977	1 190	0.03960	0.00881
20–24	427 630	1 491	0.03808	0.00961	420 560	1 406	0.04055	0.01021
25–29	381 419	1 455	0.04138	0.01095	359 851	1 333	0.04253	0.01179
30–34	308 469	1 401	0.04384	0.01267	311 544	1 386	0.04552	0.01376
35–39	279 394	1 413	0.04647	0.01466	260 561	1 375	0.04918	0.01625
40–44	211 283	1 203	0.04978	0.01738	209 046	1 452	0.05202	0.01942
45–49	187 315	1 262	0.05147	0.02057	177 315	1 534	0.05569	0.02317
50–54	148 883	1 203	0.05726	0.02498	142 983	1 624	0.06202	0.02816
55–59	115 351	1.149	0.06030	0.03072	110 092	1 652	0.06776	0.03459
60–64	112 220	2 072	0.07048	0.03813	98 761	2 435	0.07929	0.04278
65–69	70 198	1 651	0.08660	0.04861	59 518	1 838	0.09614	0.05365
70–74	54 941	1 615	0.08910	0.06115	42 164	1 743	0.09674	0.06655
75+	85 510	6 974	–	–	62 949	5 252	–	–
NS	–	–			2 463	315		
Total	4 978 705	53 265			4 925 518	56 244		

[a]Deaths used are the average of those registered in 1961, 1962 and 1963.

Table 41 Registered deaths, population and partial birth and death rates, 1972

Age group x, x + 4	Females				Males			
	Population	Deaths[a]	Partial birth rate $b(x^+)$	Partial death rate $d(x^+)$	Population	Deaths[a]	Partial birth rate $b(x^+)$	Partial death rate $d(x^+)$
0–4	1 093 263	17 882	–	–	1 107 751	20 323	–	–
5–9	1 000 175	1 098	0.03708	0.00391	1 022 565	1 314	0.03761	0.00418
10–14	829 093	643	0.03938	0.00452	884 417	707	0.04109	0.00482
15–19	698 185	901	0.04002	0.00533	715 127	939	0.04258	0.00577
20–24	578 620	998	0.04095	0.00624	571 969	1 175	0.04232	0.00682
25–29	471 501	1 010	0.04135	0.00726	458 049	1 054	0.04171	0.00792
30–34	381 363	962	0.04124	0.00843	390 364	979	0.04218	0.00920
35–39	373 277	1 179	0.04474	0.009 77	355 814	1 177	0.04603	0.01081
40–44	297 789	1 035	0.05110	0.01165	307 210	1 181	0.05240	0.01292
45–49	246 223	1 061	0.05357	0.01404	241 742	1 366	0.05729	0.01583
50–54	193 251	1 009	0.05713	0.01716	195 367	1 380	0.06102	0.01926
55–59	150 654	1 074	0.05971	0.02116	149 321	1 440	0.06616	0.02384
60–64	141 240	1 433	0.06862	0.02614	133 330	1 957	0.07604	0.02954
65–69	98 019	1 576	0.08421	0.03409	88 790	1 934	0.09318	0.03785
70–74	77 233	1 644	0.09418	0.04357	66 383	2 005	0.10374	0.04738
75–79	42 896	1 517	0.11035	0.05938	34 949	1 593	0.12179	0.06109
80–84	33 606	1 630	0.11598	0.07500	24 432	1 346	0.12306	0.07233
85+	32 356	3 317	–	–	23 821	2 144	–	–
NS	14 934	1 568			13 129	1 784		
Total	6 753 678	41 537			6 784 530	45 798		

[a]Deaths used are those registered in 1971.
NOTE: Those who did not state their age were omitted from the calculations.

Table 42 Deaths in the survey population, person-years at risk and partial birth and death rates (1974–6)

Age group x, x + 4	Females				Males			
	Person-years	Deaths	Partial birth rate $b(x^+)$	Partial death rate $d(x^+)$	Person-years	Deaths	Partial birth rate $b(x^+)$	Partial death rate $d(x^+)$
0–4	4 841.22	218	–	–	5 009.13	212	–	–
5–9	5 029.24	17	0.0334	0.0073	5 031.11	9	0.0357	0.0075
10–14	4 432.91	3	0.0386	0.0082	4 441.06	7	0.0410	0.0088
15–19	3 541.52	9	0.0397	0.0098	3 702.08	9	0.0436	0.0105
20–24	2 813.12	16	0.0384	0.0114	2 603.61	10	0.0421	0.0125
25–29	2 315.72	11	0.0373	0.0125	2 081.67	13	0.0379	0.0143
30–34	1 902.05	8	0.0369	0.0141	1 798.53	7	0.0378	0.0160
35–39	1 935.22	7	0.0403	0.0161	1 672.37	8	0.0409	0.0185
40–44	1 696.29	11	0.0478	0.0192	1 553.75	9	0.0474	0.0219
45–49	1 523.62	6	0.0546	0.0229	1 322.78	9	0.0548	0.0267
50–54	1 012.05	9	0.0580	0.0295	1 012.49	16	0.0594	0.0333
55–59	928.30	10	0.0577	0.0357	875.61	12	0.0647	0.0394
60–64	815.98	13	0.0716	0.0452	661.13	10	0.0753	0.0505
65–69	608.41	20	0.0880	0.0599	547.36	22	0.0876	0.0674
70–74	463.79	20	0.1061	0.0762	411.07	19	0.1152	0.0853
75+	546.37	57	–	–	420.93	52	–	–
Total	34 405.81	435			33 144.68	424		

coverage. The US Bureau of the Census, in deriving its annual population estimates, assumed a 4.9 per cent net under numeration of both censuses (US Bureau of the Census 1980). However, if the underenumeration occurred among different age groups in the two censuses this could greatly distort the mortality estimates.

Migration is another factor which affects the age distribution and thus the estimates of intercensal mortality.

Table 43 Estimates of survivorship values and corresponding mortality levels (α) from data on current deaths (1961, 1972, 1974–6)

Age N	1961		1972		1974–6	
	$1_N/1_{15}$	α	$1_N/1_{15}$	α	$1_N/1_{25}$	α
Females						
15	1.0000	–	1.0000	–	–	–
20	0.9870	−0.549	0.9906	−0.730	–	–
25	0.9679	−0.525	0.9781	−0.742	1.0000	–
30	0.9472	−0.509	0.9629	−0.713	0.9761	−0.415
35	0.9233	−0.484	0.9451	−0.683	0.9554	−0.473
40	0.8973	−0.475	0.9234	−0.655	0.9379	−0.552
45	0.8690	−0.481	0.9001	−0.652	0.9074	−0.529
50	0.8366	−0.499	0.8721	−0.659	0.8894	−0.627
55	0.7993	−0.535	0.8392	−0.685	0.8499	−0.639
60	0.7557	−0.588	0.7963	−0.716	0.8044	−0.678
65	0.6808	−0.610	0.7389	−0.765	0.7415	−0.726
70	0.5960	–	0.6561	−0.811	0.6264	−0.708
Males						
15	1.0000	–	1.0000	–	–	–
20	0.9859	−0.503	0.9897	−0.679	–	–
25	0.9666	−0.502	0.9738	−0.641	1.0000	–
30	0.9457	−0.492	0.9562	−0.619	0.9685	−0.239
35	0.9212	−0.468	0.9374	−0.607	0.9493	−0.393
40	0.8929	−0.449	0.9132	−0.580	0.9264	−0.445
45	0.8570	−0.423	0.8858	−0.569	0.8992	−0.474
50	0.8143	−0.411	0.8470	−0.543	0.8684	−0.513
55	0.7613	−0.409	0.8009	−0.541	0.8006	−0.440
60	0.6965	−0.419	0.7418	−0.547	0.7462	−0.486
65	0.6017	−0.416	0.6602	−0.558	0.6904	−0.584
70	0.5007	–	0.5551	−0.580	0.5609	−0.554

Table 44 Estimates of female adult mortality by intercensal projection (1961–72)

Age range	Projected from 1961 population				Reported 1972 population	Implied α[a]
	$\alpha = -0.2$ $e_{15} = 46.48$	$\alpha = -0.4$ $e_{15} = 49.79$	$\alpha = -0.6$ $e_{15} = 53.04$	$\alpha = -0.8$ $e_{15} = 56.14$		
15+	3 740 232	3 830 990	3 911 353	3 980 450	3 816 213	−0.367
20+	3 013 619	3 096 774	3 171 402	3 236 322	3 118 028	−0.455
25+	2 452 885	2 528 192	2 596 810	2 657 306	2 539 408	−0.432
30+	1 993 542	2 060 296	2 122 262	2 177 800	2 067 907	−0.424
35+	1 587 875	1 646 415	1 701 889	1 752 526	1 686 544	−0.544
40+	1 226 175	1 277 044	1 326 346	1 372 258	1 313 267	−0.546
45+	932 206	976 205	1 019 866	1 061 388	1 015 478	−0.580
50+	676 114	713 121	750 895	787 740	769 255	−0.699
55+	481 178	511 687	543 814	576 056	576 004	−0.800

[a]Alpha values were obtained by linear interpolation between projected populations corresponding to α values 0.1 apart, rather than 0.2 as shown in the table.

Peru has net immigration, which occurs mainly among young adults. In this age range the probability of dying is very low and so the effect of migration can easily swamp that of mortality. The fact that the male α values are more erratic and variable than the female ones may support the suggestion that migration is distorting the estimates of mortality. In 1961, of the foreign population in Peru (66 733, or 0.7 per cent of the total population) 55.5 per cent were men. Although emigration statistics are difficult to obtain, it is likely that young adult males constitute a large proportion of the total.

1972–81

The 1972 and 1981[10] census age–sex distributions provide an opportunity to estimate mortality over a second inter-

[10] Held on 12 July 1981.

Table 45 Estimates of male adult mortality by intercensal projection (1961–72)

Age range	Projected from 1961 population				Reported 1972 population	Implied α[a]
	$\alpha = -0.2$ $e_{15} = 46.48$	$\alpha = -0.4$ $e_{15} = 49.79$	$\alpha = -0.6$ $e_{15} = 53.04$	$\alpha = -0.8$ $e_{15} = 56.14$		
15+	3 726 442	3 814 678	3 892 129	3 958 007	3 756 668	−0.267
20+	2 991 219	3 071 759	3 143 406	3 205 057	3 041 541	−0.323
25+	2 398 544	2 470 773	2 536 060	2 593 025	2 469 572	−0.397
30+	1 920 170	1 983 499	2 041 865	2 093 672	2 011 523	−0.494
35+	1 517 456	1 572 633	1 624 554	1 671 498	1 621 159	−0.587
40+	1 174 921	1 222 836	1 268 915	1 311 384	1 265 345	−0.584
45+	881 772	922 832	963 280	1 001 368	958 135	−0.574
50+	638 913	673 354	708 225	741 886	716 393	−0.648
55+	448 912	477 010	506 368	535 534	521 026	−0.700

[a]Alpha values were obtained by linear interpolation between projected populations corresponding to α values 0.1 apart, rather than 0.2 as shown in the table.

Table 46 Estimates of adult mortality by intercensal projection (1972–81)

Age range	Projected from 1972 population				Reported 1981 population	Implied α[a]
	$\alpha = -0.4$ $e_{15} = 49.79$	$\alpha = -0.6$ $e_{15} = 53.04$	$\alpha = -0.8$ $e_{15} = 56.14$	$\alpha = -1.0$ $e_{15} = 59.03$		
Females						
10+	5 964 697	6 060 145	6 140 477	6 206 626	6 146 434	−0.817
15+	4 915 823	5 001 696	5 075 105	5 136 364	5 071 795	−0.791
20+	3 967 272	4 047 266	4 116 391	4 174 608	4 135 750	−0.864
25+	3 191 696	3 264 390	3 328 139	3 382 504	3 317 224	−0.764
30+	2 545 823	2 610 647	2 668 531	2 718 659	2 658 786	−0.765
35+	2 014 128	2 072 095	2 124 802	2 171 158	2 145 676	−0.887
40+	1 585 569	1 637 614	1 685 789	1 728 806	1 688 844	−0.814
45+	1 228 517	1 274 938	1 318 738	1 358 489	1 323 345	−0.823
50+	892 244	932 312	971 067	1 006 994	997 229	−0.944
Males						
10+	5 920 794	6 030 599	6 125 222	6 204 340	5 991 761	−0.327
15+	4 871 267	4 968 076	5 052 999	5 125 103	4 877 957	−0.213
20+	3 901 341	3 990 107	4 068 963	4 136 645	3 973 049	−0.361
25+	3 086 857	3 165 494	3 236 595	3 298 567	3 202 204	−0.500
30+	2 440 727	2 509 081	2 572 188	2 628 199	2 588 326	−0.656
35+	1 926 879	1 986 708	2 043 080	2 094 005	2 083 827	−0.759
40+	1 513 929	1 566 539	1 617 105	1 663 582	1 653 879	−0.757
45+	1 159 663	1 205 355	1 250 239	1 292 293	1 282 539	−0.753
50+	843 134	881 553	920 311	947 501	963 911	−0.837

[a]Alpha values were obtained by linear interpolation between projected populations corresponding to α values 0.1 apart, rather than 0.2 as shown in the table.

censal period; people aged (x+9) in 1981 are the survivors of those aged x in 1972.

The same method was used as outlined above, and the results, for females and males, are given in table 46.

For females, the α values are all grouped fairly close together (with the exception of that corresponding to age 50+) and show no sign of decreasing with age. Since they all fall between −0.76 and −0.89 it seems reasonable to take the average of these values to obtain an estimate of mortality corresponding to the middle of the intercensal period. This gives an α value of −0.816 for about 1977.0, which corresponds fairly well with the trend indicated by the earlier estimates of female adult mortality (see figure 11), although shows lower mortality than the orphanhood estimates from the 1981 census.

As for 1961–72, the series of α values for males varies a great deal with age, although shows a general decline. In this case it is not appropriate to average the values, so no estimate of male intercensal mortality can be made by this method. A plausible explanation for the poor working of this method for males is that migration is distorting the male age distribution.

8 Conclusion

The previous sections outline the derivations of child and adult mortality estimates from information obtained in the national censuses of 1940, 1972 and 1981, and in two demographic sample surveys, the National Demographic Survey (1974–6) and the Peru Fertility Survey (1977). The results are shown in figures 18 and 19.

The technique of estimating levels of child mortality from the proportion of children dead by age of mother seems to work well in Peru, giving reasonably consistent results for the different data sets. However, the information obtained from the younger women shows higher mortality than that from the older women; this is probably due to the higher child mortality experienced by these younger women because of selection of those who have births at early ages and the high proportion of first births.

The results indicate declines in the level of child mortality (ie deaths up to age five), from around 300 per 1000 in 1940 to 150 per 1000 in the early 1970s; this is equivalent to a fall in the infant mortality rate from 200 per 1000 to under 100 per 1000. The scant evidence on sex differentials in child mortality suggests a small advantage to female children in the region of 10 to 20 per 1000 in deaths up to age five.

The information on levels of adult survival comes from four sources: orphanhood data, widowhood data, 'current' deaths, and intercensal survival.

There are four overlapping sets of estimates of female adult survivorship obtained from orphanhood data, spanning the period 1960–77. The estimates show remarkable agreement, and indicate a steady decline over this period from an $\mathring{e}_{15}$ of about 50 years in 1960 to 55 years in the late 1970s. There are only two sets of information on male adult survival from orphanhood data; these are consistent except for the most recent points which diverge. They show a fast rate of improvement in mortality levels, from an $\mathring{e}_{15}$ of 48 years in the early 1960s to somewhere in the region of 53 years in the early 1970s. These results indicate higher male than female adult mortality although the sex differential appears to be decreasing; in the early 1960s males had a lower $\mathring{e}_{15}$ by about two years, while a decade later it was nearer to one year.

Unlike the orphanhood method which appears to work well and give plausible and consistent results, estimates derived from widowhood data are much less reasonable. Female survivorship estimated from widowhood does show broadly similar levels of mortality to those obtained from orphanhood; however the points are erratic and the impression is of increasing mortality over

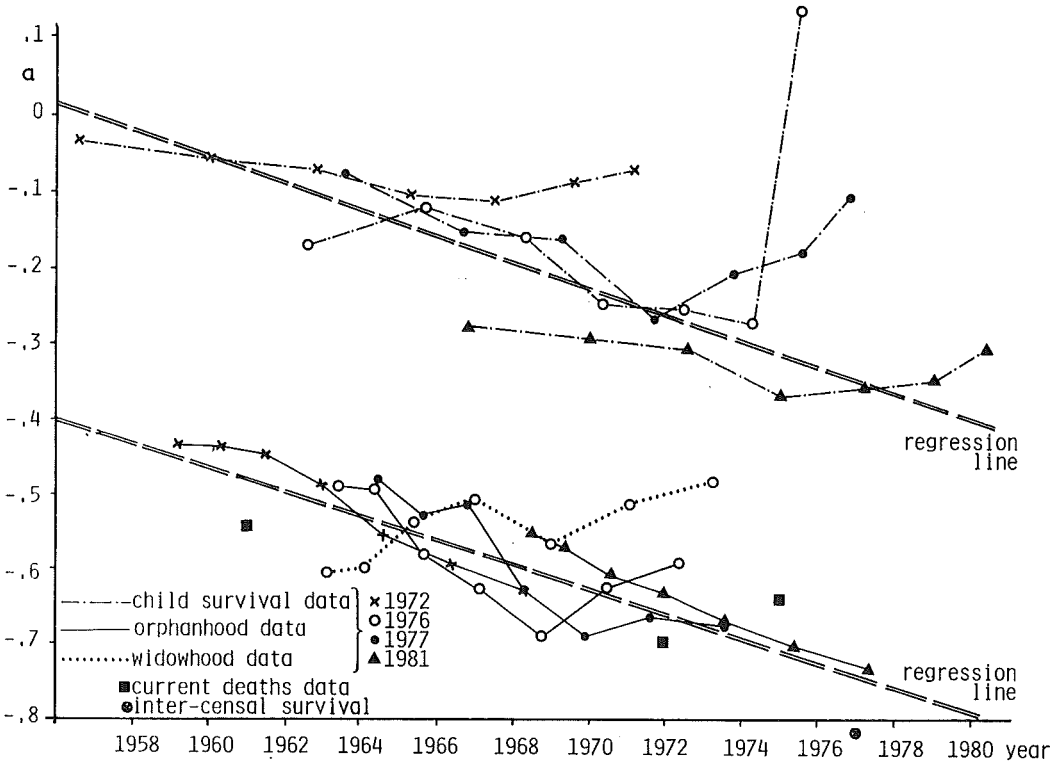

Figure 18 Levels and trends in female childhood and adult mortality

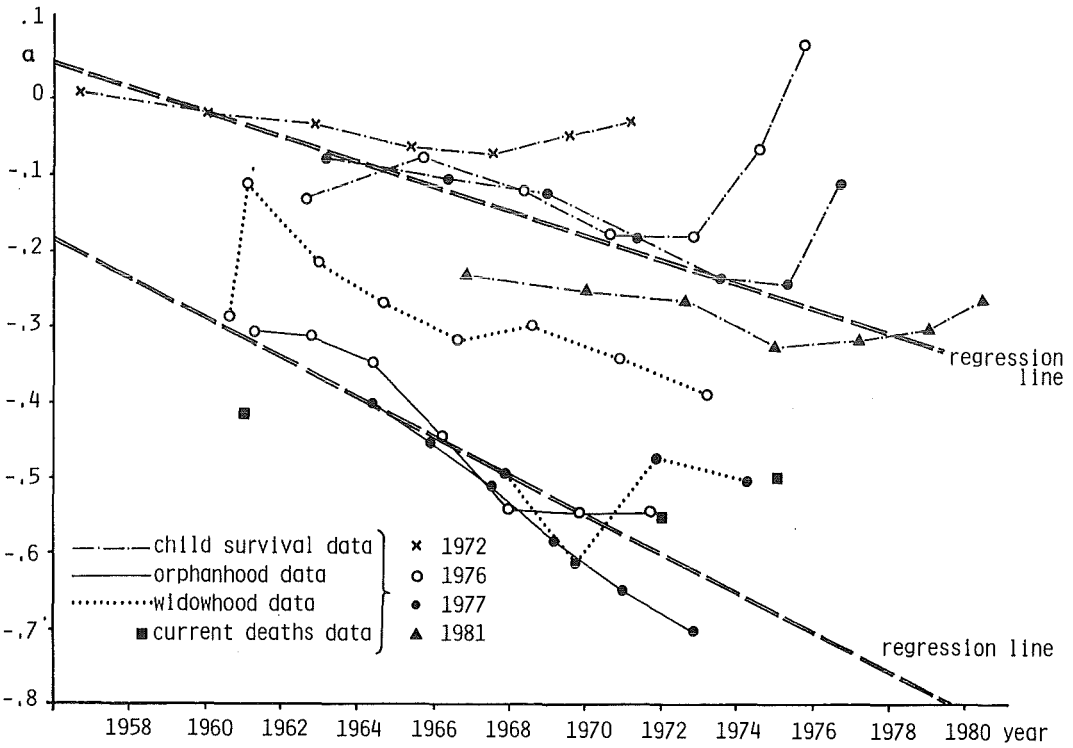

Figure 19 Levels and trends in male childhood and adult mortality

time. For males the two sets of widowhood estimates give very different results from each other. The 1976 survey results indicate substantially higher mortality than that shown by the orphanhood data and the 1977 widowhood data.

The adjustment of observed deaths by age from the vital registration system (and deaths occurring during the period of the 1974–6 multiround survey) using the appropriate age distributions works reasonably well. The resulting estimates of levels of female and male adult mortality are similar to the orphanhood estimates, although the 1961 estimates are rather low and those of 1974–6 slightly too high in comparison.

The estimation of intercensal mortality by comparing two successive census age distributions can be seriously distorted by changes in census coverage, age misreporting and migration. The method does not work well for either sex for the 1961–72 period, or for males during 1972–81. A comparison of the 1972 and 1981 age distributions for females yields an estimate of intercensal mortality that is more or less in line with estimates from other sources of information. The fact that the method works better for females than males suggests that migration could be having an adverse effect on the results.

An attempt was made to obtain life tables for each sex separately from the information on child and adult levels of mortality. The method adopted was, for both females and males, to fit a regression line to the 'reliable' child mortality estimates and a second line to the 'reliable' adult mortality estimates.

The decision on which points to accept as 'reliable' is largely subjective and somewhat arbitrary. In the case of child mortality, information from women aged 15–19 and 20–24 was excluded for all data sets. The 1940 census information was not used. For adult mortality, the widowhood information was omitted from the calculations, as was the information from intercensal survival, with the exception of the female estimate for the 1972–81 period. All the other estimates were used.

The regression lines (which gave α in terms of the date of estimate) were fitted using the group average method (see figures 18 and 19). It was decided to obtain life tables for two points in time, namely 1965 and 1972. The resulting child and adult α values for females and males are:

Females	*1965*	*1972*
child	−0.137	−0.259
adult	−0.542	−0.658
Males		
child	−0.098	−0.213
adult	−0.417	−0.596

Using these α values and the General Standard of the logit model life table, two life tables were constructed for each sex. Because of the differing levels of child and adult mortality, it was necessary to bring the two halves of the life table into line with each other; 15 was chosen as the age at which to do this. The resultant abridged life tables, for females and males, are as shown in tables 47 and 48 for 1965 and 1972 respectively.

The general picture shown by the life tables is of improving mortality levels (summarized by the expectation of life at birth, $\mathring{e}_0$), and higher male than female mortality at both dates, though the sex differential seems to be decreasing. The female $\mathring{e}_0$ improves from 53.2 years in 1965 to 57.2 in 1972, and the male $\mathring{e}_0$ value increases from 50.8 to 55.5 years. These figures indicate a very fast rate of improvement in mortality levels, an increase in the $\mathring{e}_0$ value of 4 years for females and 4.7 years for males

Table 47 Abridged life table for 1965

Age x	Females		Males	
	l_x	$\mathring{e}_x$	l_x	$\mathring{e}_x$
0	10000	53.20	10000	50.75
1	8817	59.29	8732	57.07
2	8462	60.76	8356	58.62
3	8299	60.95	8185	58.84
4	8203	60.65	8084	58.57
5	8142	60.11	8020	58.03
10	7980	56.27	7851	54.22
15	7859	52.10	7724	50.08
20	7756	47.76	7598	45.86
25	7614	43.61	7427	41.86
30	7466	39.42	7250	37.82
35	7310	35.21	7064	33.75
40	7134	31.01	6856	29.70
45	6922	26.89	6611	25.71
50	6654	22.87	6303	21.84
55	6296	19.03	5901	18.16
60	5816	15.39	5375	14.69
65	5135	12.10	4654	11.58
70	4229	9.16	3736	8.82
75	3044	6.75	2603	6.56
80	1739	4.94	1436	4.87
85	682	3.73	548	3.70
90	152	3.03	120	3.00
95	16	2.50	12	2.50

Table 48 Abridged life table for 1972

Age x	Females		Males	
	l_x	$\mathring{e}_x$	l_x	$\mathring{e}_x$
0	10000	57.21	10000	55.51
1	9048	62.20	8967	60.87
2	8753	63.28	8650	62.08
3	8616	63.28	8503	62.15
4	8534	62.89	8417	61.78
5	8483	62.26	8361	61.19
10	8345	58.25	8215	57.23
15	8241	53.95	8105	52.97
20	8153	49.51	8008	48.58
25	8031	45.22	7875	44.36
30	7904	40.91	7735	40.12
35	7768	36.58	7588	35.85
40	7613	32.27	7420	31.60
45	7426	28.02	7218	27.42
50	7185	23.88	6961	23.34
55	6860	19.89	6614	19.43
60	6414	16.10	6146	15.72
65	5763	12.64	5472	12.35
70	4859	9.53	4557	9.32
75	3611	6.95	3329	6.84
80	2138	5.02	1932	4.98
85	864	3.74	768	3.74
90	195	3.01	172	3.02
95	20	2.50	18	2.50

over this seven-year period. The difference between the female and male $\mathring{e}_0$ values in 1965 is 2.25 years; by 1972 this has decreased to 1.7 years.

The life table for 1965 shows infant mortality levels (IMR) of 118 per 1000 for females and 127 per 1000 for males; by 1972 these levels have fallen to 95 and 103 per 1000. The child mortality levels (deaths before aged five) are 186 per 1000 for females and 198 per 1000 for males in 1965, and 152 and 164 per 1000 respectively in 1972. These figures should be seen as indications of the level of mortality, rather than as exact estimates.

These infant and child mortality levels are high by Latin American standards. Estimates suggest that most of the Caribbean countries (except Haiti and Dominican Republic) have IMRs of less than 50 per 1000, while the majority of the other countries have levels between 50 and 100 per 1000. Bolivia and Haiti have IMRs probably exceeding 150 per 1000, while several of the Central American countries have levels similar to those in Peru. The same ranking appears in the overall mortality levels as summarized by life expectancy at birth. Peru appears to have higher mortality than most other Latin American countries with the exception of Bolivia, Haiti and some countries of Central America (US Bureau of the Census 1980 and UN 1982).

Life tables have not been produced for different sectors of the population, but the child and adult mortality estimates suggest that there are strong differentials by urban–rural residence, by region of residence and by educational level. Since, in retrospective surveys, the characteristics refer to the respondent some caution must be taken in interpreting the results.

The child mortality levels for the whole population obscure the vast range between different groups of the population, from moderately low levels among the most educated (IMR of about 40 per 1000) to extremely high levels among the rural and Sierra populations and those with no schooling (IMR of 160 per 1000). The infant mortality experienced by those who have not attended school is four times that of those with secondary schooling. Rural levels are almost twice urban levels. There is no evidence that these differentials are decreasing over time. The trends by urban–rural residence show, if anything, an increasing urban–rural differential, since the urban levels of mortality appear to be falling at a faster rate than the rural levels.

Similar differentials are observed for adult mortality; $\mathring{e}_{15}$ values for urban residents are two or three years higher than for rural residents. Because of the sex difference in mortality, this means that mortality levels of rural women are similar to those of urban men. Education is a very powerful discriminator of adult mortality levels – there is a ten-year difference in $\mathring{e}_{15}$ levels between those with no schooling (45 or 46 years) and those with secondary schooling (55 or 56 years).

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