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Old-age mortality in Israel: analysis of variation and change*

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Abstract

This study analyses differentials in life expectancy and cause-specific death rates among the elderly Jewish population in Israel in the early 1970s and early 1980s. We find substantial inequality in old-age mortality levels across subpopulations in geographic units and show that this inequality increased between the two periods. Much of the variation in old-age mortality is explained by differences in economic and social status, ethnicity and religiosity. The importance of religiosity is of particular interest in the context of Israeli society.

Inequalities in longevity across population subgroups characterize every society. This study analyses such differentials in life expectancy and cause-specific death rates among the elderly Jewish population in Israel. It covers a period of five years around the 1983 census, with comparisons to a similar period around the 1972 census. The analysis is restricted to the Jewish population because the socio-economic and cultural characteristics, as well as the quality of data, differ greatly between the Jewish and the Arab populations. Indeed, the quality of vital records as well as census data of the Arab population is problematic and raises difficulties both in analysis and in interpretation.

The units of analysis in this study are defined by geographic divisions based on census statistical areas. We show that old-age mortality levels are subject to very significant differences among subpopulations in geographic units, whether these are towns and cities, or smaller divisions. It is also shown that inequality across geographic units in life expectancy tended to increase between the early 1970s and the early 1980s. Our major aim is to analyse and explain old-age mortality differences among such population units, with respect to socio-economic and culture explanatory variables. Israel has extensive welfare programs including comprehensive and highly subsidized health schemes, covering almost the entire range of medical services. Nevertheless, there are differences in life expectancies across localities of up to eight years at age 65. Differences across the smaller divisions are even larger. How can such variations, under conditions of extensive welfare and health programs, be explained? A major hypothesis is that variations among population units in economic and social status, ethnicity, religiosity, and proximity to leading specialized medical centres, as well as some

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other characteristics, are associated among the elderly with cause-specific death rates and therefore with life expectancies.

Previous studies

The interrelationship between mortality levels and socio-economic variables is not a new research issue. Ecological interrelationships between socio-economic variables and mortality had already been studied in the nineteenth century, for example in London, as well as in some other regions and countries (Antonovsky 1967). Several ecological analyses of mortality differentials for more recent periods can be traced in the literature. Notable were a series of projects undertaken at the University of Chicago focusing on ecological relationships in the Chicago area between 1930 and 1960. More modern studies, using ecological relationships to analyse mortality patterns, have been conducted for the United States (Silver 1972), Japan (Sakai 1986) and some other countries. The most important common finding of these studies is the existence of socio-economic status differences in mortality. Indeed, some studies with historical perspectives indicate that socio-economic status tends to increase in importance over time as an explanation of life expectancy differentials (Preston and van de Walle 1978; Friedlander et al. 1985; Mosk and Johansson 1986). The analysis presented here is distinct in that it deals specifically with old-age mortality, and in that it employs a relatively large number of explanatory variables. Additionally, the analyses are based on a large number of units with relatively small populations, probably smaller than most studies of its kind.

Previous research on life expectancy levels and their socio-economic determinants in Israel is very limited. Several studies of differential mortality undertaken in the 1960s and 1970s dealt mainly with the effects of ethnicity and duration in Israel as potential explanations (Muhsam 1966; Peritz et al. 1973). Anson (1988) analysed standardized death rates for about 70 localities in Israel. He discovered significant differences and established interrelationships with welfare variables.

An important long-term project undertaken by the Unit for the Study of Health Services, at the Chaim Sheba Medical Center, Tel Aviv University, deals with different aspects of infant mortality among localities in Israel. Significant socio-economic and ethnic differences in infant mortality rates were discovered (Barell, Wax and Ruder 1988). Another study by this unit focused on adult mortality differences among the metropolitan areas of Tel Aviv (Lusky, Gurvitz and Barell 1992).

In a very detailed individual level study, Peritz and his associates measured the impact of birthplace (Europe, Middle Eastern countries in Asia, North Africa, and Israel), controlling for duration in the country. Their most interesting finding concerns the convergence patterns of mortality levels of recent migrants from these different origins with those who migrated earlier. In a follow up study (Peritz et al. 1983), comparisons among these different groups were made to document the changing patterns of differentials in cause-specific mortality levels. It was shown that during 1969-1973 differences in cause-specific mortality levels still prevailed. This finding is most relevant to the present study. We analyse cause-specific death rates by ethnicity among geographic units for 1972 and 1983. One of our objectives is to ascertain whether there are still significant ethnic effects after socio-economic status variables are controlled for.

Immigration, socio-economic differentiation and mortality trends

Life expectancy at age 65 increased by one-and-a-half years between the early 1970s and the early 1980s and by another year during the 1980s, while it was almost constant during the two decades before 1970. Hence, while there has been a strong and continuous decline in overall mortality since the massive immigration in the late 1940s and early 1950s, the decline in old-age mortality is a recent phenomenon. This raises an important analytic question. Under what conditions and circumstances are current life expectancies at age 65 high, and under what conditions are they likely to increase rapidly? It will be shown that socio-economic status, ethnicity and religiosity are key variables explaining both the variation and the change in life expectancy.

Israel is a country of immigration with ethnic and socio-economic diversity. Its Jewish population has grown and developed mainly as a result of extensive wave-like immigration during the present century. The ‘mass immigration’ wave following the foundation of the state in 1948 was most conspicuous in its enormous volume. It was not only variation in the volume of immigration but also the changing ethnic composition of immigrants over time which shaped Israel's socio-economic structure. Up to the foundation of the State in 1948, immigrants came predominantly from European countries. This group of veterans and their Israeli-born descendants now form a major part of Israel's higher-status population. Israel's ethnic structure changed radically with the wave of mass immigration when increasing proportions of immigrants came from African or Asian countries, a tendency which became even more pronounced during 1952-67. Another feature of the immigration waves was that the immigration from Asian and from African countries was not equally distributed over time either. While immigration from Asian countries was concentrated in the early years of statehood, immigration from North African countries was spread over a longer period — up to 1967. Subsequently, it was again European migration which dominated. While origin or ethnicity indicates the initial socio-economic and demographic characteristics at time of immigration, duration in Israel represents exposure to the new conditions in Israel. Hence, immigration patterns have created an extremely heterogeneous society. Indeed, Israel's Jewish population is differentiated not only by ethnicity, but also by socio-economic status levels. The historical patterns of immigration, particularly origins and time of arrival, have contributed towards a long-term association between ethnicity and socio-economic status. Considering immigrants from European, Asian and African origins as well as their respective descendants, their status levels from high to low can be ranked in that order (see Eisenstadt, Lissak and Nahon 1993). Many studies have demonstrated the existence of differentiation, in many social and demographic aspects, by both ethnicity and length of stay in Israel. The studies of differential mortality by Peritz and his associates (1973, 1983) have, indeed, shown that life expectancy at various adult ages was differentiated by these two factors. It has been demonstrated in these studies that Israeli-born (with no regard to their parents’ origin) had the highest life expectancies, followed by Asian and by European-born, while African-born had significantly lower life expectancies. Although these differences tended to diminish over time, even in very recent years immigrants of African origins show higher mortality at adult ages compared with other ethnic groups (e.g., State of Israel 1992:149). However, because ethnicity and socio-economic status levels are so tightly interrelated, a question of major importance is whether ethnic differences in mortality still persist after controlling for socio-economic status. The analysis in this paper attempts to answer this question.

Data and variables

Units of analysis

This study employs geographic aggregated data from the 1972 and the 1983 censuses and death registration data for five years centred on these Census years to explain variation in old-age mortality levels at each period. The basic geographic divisions consist of standard statistical areas defined by the Central Bureau of Statistics. These range mostly between population sizes of several hundred and a few thousand and are the smallest areas for which census returns as well as death statistics can be manipulated. However, our analysis is based on aggregates of these standard statistical areas — small local areas — whenever the population sizes of standard statistical areas are small. In all, some 580 small local areas are used in the analyses of life expectancies. These units range mostly between 2500 and 7000. The analysis of cause-specific mortality rates forced us to use larger aggregates, i.e. localities, because of data limitations. There are 65 units in these analyses, ranging mostly between 10,000 and 90,000. Some more details on the aggregation procedures are discussed in Appendix A.

Both vital registration records and census data, for the Jewish population, are considered to be of high quality. No burial can take place unless a death certificate has been signed by an authorized official. Both place of residence and place of death are registered, which is of particular importance in the analysis of old age mortality.

Age structures

Many of the population aged 65 and over are former immigrants who arrived in Israel with the mass immigration of 1948-1951. Their current reported ages as well as their age at death still depends, to a large extent, on the ages immigrants reported at arrival. There was a suspicion that among migrants from Asian and African countries, ages were overstated, which is a well known problem in age statistics (see Carrier and Farrag 1959). One implication would be that life tables as well as cause-specific death rates based on such age structures could produce biased estimates at the older ages. Appendix B discusses the ways in which age structures have been examined to detect such possible age overstatements. The conclusion is that serious age overstatement among these populations is unlikely.

Dependent variables

The major dependent variable in this study is life expectancy at age 65, e_{65}. Additional dependent variables are cause-specific (and for wider age groups age-standardized) death rates at age 65 and over, using five major cause-of-death categories:

$M_{in,x}$: The age-standardized or age-specific death rate of infectious diseases.
$M_{hc,x}$: The age-standardized or age-specific death rate of heart and circulatory diseases, excluding cerebrovascular diseases.
$M_{cva,x}$: The age-standardized or age-specific death rates of cerebrovascular diseases.
$M_{ca,x}$: The age-standardized or age-specific death rate of all cancer diseases.
$M_{ot,x}$: The age-standardized or age specific death rate of all other causes.

These dependent variables are analysed with respect to several explanatory variables.

Explanatory variables

The explanatory variables in the analyses are: economic status; social status measured in terms of educational attainment; ethnicity; religiosity; proximity to locations with specialized medical services; loneliness in terms of marital status; industry and employment status. Some of these variables can be defined in alternative ways. For example, social status is represented by the proportion of the population with at least nine years of formal education among the population aged 60 and over. This variable is preferred to the proportion with at least 13 years of education, which is used in many studies, because the general educational levels of these older population cohorts are relatively low. The explanatory variables are defined below.

EC_{90}: Proportion of all wage earners in the geographic unit whose earnings are within the upper decile range of the national income distribution. This is the economic status variable.

$ED_{9,60}$: Proportion with at least nine years of formal education among the population aged 60 years and over. This is considered as the social status variable.

ETAF: Proportion born in North African countries or their Israeli-born children, in the total population of the geographic unit. This is considered as the African ethnicity variable.

REL: Proportion of the total adult population who voted for religious political parties during the general elections of 1984. Three major religious parties participated in these elections. Two are ultra-religious parties, one dominated by people of European ethnicity, the ‘Agudah’, and the other dominated by people of Asian-African ethnicity, the ‘Shas’ party. The third, the ‘National Religious Party’, is a more modern religious party, has no clear ethnic identification, and is nationalistic. Altogether they formed over 15 per cent of the total electorate in 1983. The percentage of all three religious parties in a geographic unit is taken as the religiosity variable.

PROX: Proximity to locations with major specialized medical centres. This is the road distance from the geographic unit to the nearest of the three major cities in the country: Haifa, Tel-Aviv and Jerusalem.

LON_{65}: The ‘loneliness’ variable, calculated as the ratio of the number of never-married and divorced persons to the total number of persons in the 65-74 age-group. The widow category is not included in this variable, neither in the nominator nor in the denominator, to eliminate the representation of a mortality element on both sides of the regression equation. As the widow and widower subgroups are so important in the old-age population, their inevitable omission from the analysis is a shortcoming.

IND: Proportion of the male labour force engaged in industry. It is considered as a rough proxy for the exposure to pollution.

WLF_{55} and MLF_{55}: Proportion of women or men participating in the labour force in the 55-64 age group.

The inequality in old-age mortality

Variations in life expectancy at infancy or at age 65 among populations in geographic units are high, regardless of the kind of geographic divisions that are considered. Differentiation and inequality are present among small local areas or localities. Moreover, the inequality in life expectancy increased during the period 1972 to 1983. While in the present section we illustrate the inter-locality inequality in life expectancies, in a following section we attempt to provide explanation and interpretation.

We begin our examination of life expectancies with some comparisons. Whereas the 1972 life expectancy at age 65 was 13.4 for males and 14.5 for females in the country as a whole, localities range between 10.6 and 16.5 for males, and between 10.7 and 17 for females. In 1983 life expectancy at age 65 was 14.5 for males and 15.3 for females in the country as a whole, while localities range between 11.5 and 18 for males, and between 11.5 and 20.8 for females. While life expectancy at birth in 1972 was nearly 72 years for the entire Jewish population of Israel, individual localities range between 68 and 76 years. In 1983 life expectancy at birth was 75 years for the entire population, while individual localities range between 69 and 81 years.

Table 1 suggests that localities of low socio-economic status, particularly ‘new towns’ that were established to settle new immigrants after the early 1950s, have much lower life expectancies than average in 1983 (see the upper section in this Table). Table 1 also suggests that almost all localities with high life expectancies, such as Hod Hasharon or Raanana, were established before independence and are characterized by high economic status. An illustration of differences in life expectancies at age 65 (for males) between localities of low and of high socio-economic levels, may be taken as between Dimona, a low socio-economic status locality, and Raanana, a high socio-economic status locality. Life expectancy at age 65 in Dimona was 12.5 years in 1983, with lower and upper 95 per cent confidence limits of 10.7 and 14.2 respectively. In comparison, life expectancy at 65 for males in Raanana was 17.6 years, with lower and upper confidence limits of 15.6 and 19.5 years respectively. Similar patterns, though less extreme, can be found for 1972. Such differences in longevity are recorded among many units. These are explained and interpreted in a following section. Table 1 also presents standardized death rates at ages 65-79 from heart and circulatory diseases. Like life expectancies, these death rates are much lower for high-status localities than for those of low socio-economic status presented in the upper part of Table 1.

If life expectancies of smaller units, such as the small local areas, are compared, the range between extreme life expectancies either at age 65 or at birth is much larger, although significance declines. Comparison of these smaller areas shows large variations among different neighbourhoods in larger cities. For example, while a large number of neighbourhoods in Tel-Aviv are ranked at the top in their life expectancies, there are quite a few neighbourhoods ranked at the bottom.

Table 1
Life expectancies and standardized death rates from heart and circulatory diseases: selected localities, 1983

Locality	Life expectancy at age 65		Life expectancy at birth		Standardized death rate at age 65-79 from heart and circulatory diseases	
	Males	Females	Males	Females	Males	Females
			Localities of low socio-economic status			
Dimona	12.5	13.1	69.2	72.4	29.9	31.6
Tirat Karmel	12.8	12.7	69.8	72.9	29.1	30.5
Kiryat Malachi	13.0	13.4	72.2	72.7	23.2	28.8
Kiryat Shmona	13.6	14.4	69.4	73.0	21.2	22.1
Ramla	13.8	14.6	70.8	75.0	26.4	24.8
Or Yehuda	13.9	15.0	70.5	75.8	25.7	19.5
Bet Shemesh	14.1	14.2	70.6	73.2	32.7	27.4
			Localities of high socio-economic status			
Rehovot	15.8	17.3	74.8	77.5	19.3	14.5
Givatayim	16.1	18.1	75.4	78.6	18.1	12.7
Ramat Gan	16.1	17.7	74.7	78.3	19.1	13.8
Ramat Hasharon	16.2	15.9	74.7	76.5	23.3	20.6
Kiryat Ono	16.4	16.5	74.9	77.3	16.0	12.9
Hod Hasharon	16.8	22.9	73.9	81.4	20.9	13.6
Raanana	17.6	20.8	77.3	80.8	18.9	18.3

Table 2 presents several parameters describing the amount of differentiation among localities in life expectancies at age 65 for both 1972 and for 1983. The table shows that along with the overall increase in life expectancies between 1972 and 1983, there was an increase in inequality among localities. This is clearly seen from comparisons of the standard deviations, the quartile deviations and the various ranges shown for 1972 and 1983. Moreover, the table shows that in the lower range of life expectancies the increase in life expectancies between 1972 and 1983 was small. In the upper range of life expectancies, on the other hand, the increase between 1972 and 1983 was quite large. This pattern is particularly conspicuous for females relative to males. For example, while the lower quartile of life expectancy at age 65 increased from 12.68 in 1972 to 13.54 in 1983 for males, these values are 13.86 and 13.82 for females. On the other hand, the upper quartile for males is 14.20 in 1972 and 15.40 in 1983 and for females 15.38 and 16.54.

Table 2
Means, standard deviations and percentiles of life expectancy at age 65 (e_{65}) by sex, 1983 and 1972

	Both sexes		Males		Females	
Year	1983	1972	1983	1972	1983	1972
Mean ($\bar{x}$)	14.83	13.96	14.45	13.44	15.30	14.54
Standard deviation(s)	1.44	1.02	1.42	1.11	1.86	1.30
$\bar{x} - 2.5$ s	11.23	11.41	10.90	10.66	10.65	11.29
$\bar{x} + 2.5$ s	18.43	16.51	18.20	16.22	19.95	17.79
Minimum value	11.50	11.44	11.50	10.55	11.48	10.66
Maximum value	19.26	15.55	18.04	16.50	20.82	16.85
Range	7.76	4.11	6.54	5.95	9.34	6.19
Median	14.79	14.11	14.44	13.62	15.22	14.57
Lower quartile (Q_1)	13.95	13.20	13.54	12.68	13.82	13.86
Upper quartile (Q_3)	15.92	14.73	15.40	14.20	16.54	15.38
Interquartile range	1.97	1.53	1.86	1.57	2.72	1.52
Lower decile (P10)	12.90	12.56	12.56	11.90	13.18	12.57
Upper decile (P90)	16.62	15.28	16.29	14.67	17.70	16.35
(P90) - (P10)	3.72	2.72	3.73	2.77	4.52	3.78

Three observations are suggested by the tables. First, socio-economic differentiation in life expectancies appears to be substantial. Second, among localities of low socio-economic status (and therefore relatively low life expectancies), there was little increase in life expectancy between 1972 and 1983, while large increases were experienced in localities of relatively high socio-economic status levels, which were already characterized by relatively high life expectancies. This means that socio-economic inequality in life expectancies, which was already alarmingly large in the early 1970s, has further increased up to the early 1980s. Third, the pattern of increasing inequality in life expectancy among localities, was more conspicuous for women than for men. While the first and the second observations are subject to analysis in the present article, the third will be analysed in a forthcoming paper.

Can we be sure that our seemingly large socio-economic life-expectation differentials are not simply a consequence of different degrees of death under-registration, of misreporting of locality of residence or other such errors? Could misreporting account for errors that would increase mortality differentials among the localities? There can, of course, be no certainty about the precision of any vital registration system. However, Israel's census data are considered reasonably accurate by international standards, and the possibility of a significant effect of age misreporting by Asian or African migrants has been shown to be minimal (see the section on data and Appendix B). As for the death registration system, it should be noted that no burial can take place without registration, independent of the type of locality. Place of residence, not place of death, is recorded so that the effect of major hospitals being located mostly in large places is unlikely to be serious. We have also attempted to make comparisons of inter-locality differential mortality with other studies of geographic variations. However, no study dealing with such small divisions as those employed in this study could be found in the literature. One study for France uses 'small' divisions of two million on average, half of

Israel's total Jewish population, while another study, for Spain, used divisions of similar size. For these divisions, the differences in life expectancies were around four years (Higueras Arnal 1991; Chauvire 1991; Thumerelle 1991). When we aggregate Israel's population into ten divisions with mean populations of about 400,000, we also have smaller differences of about five years. Allowing for the smaller size of our divisions, the mortality inequalities we find might exist in many other countries.

Table 3 illustrates old-age mortality differentials for several explanatory variables, for 1972 and for 1983. It presents selected characteristics for aggregated units characterized by lower and upper quartiles of life expectancy, both at birth and at age 65. Whereas among the low life-expectancy areas the mean percentages of high income (i.e., EC_{90}) were between 6.0 and 7.0, these percentages for high life-expectancy areas were over 12. Likewise, the table shows that areas of high life expectancies are characterized by large percentages of higher education, large percentages of the labour force in high-status occupations, and high levels of women's participation in the labour force. Religiosity is a complex variable: its effect on life expectancy cannot be seen clearly through these bivariate illustrations and it is excluded from this table. However, the multivariate analyses show that its effect on life expectancy is very significant.

Table 3
Mean values of selected socio-economic variables for aggregated populations belonging to quartile ranges in life expectancies, 1983 and 1972

Socio-economic variables	All areas	Areas within quartile range of e_0		Areas within quartile range of e_{65}	
		Lower quartile (1)	Upper quartile (2)	Lower quartile (3)	Upper quartile (4)
			1983		
Mean percentage income within Israel upper decile	10.4	5.7	14.1	6.3	13.4
Mean percentage with 13+ years of formal education at 25-34 age group	36.5	23.8	48.4	22.7	46.6
Mean percentage with 9+ years of formal education at 60-69 age group	42.4	28.8	54.3	28.3	52.8
Mean percentage males with high status occupations	26.2	17.8	33.3	17.6	32.5
Mean percentage women in labour force at age 55-64	31.7	25.5	38.6	24.8	37.2
Mean percentage born in Africa	9.3	14.9	5.4	15.7	6.0
			1972		
Mean percentage income within Israel upper decile	10.2	8.6	12.3	7.4	12.2
Mean percentage with 13+ years of formal education at 25-34 age group	19.8	12.3	27.0	11.0	27.0
Mean percentage with 9+ years of formal education at 60-69 age group	28.9	17.3	37.6	15.7	37.8
Mean percentage males with high status occupations	17.2	11.3	23.1	10.9	23.0
Mean percentage women in labour force at age 55-64	20.6	19.0	21.7	16.3	22.1

Mean percentage born in Africa	16.0	31.2	7.5	30.0	7.9

It can be concluded that socio-economic status, ethnicity, and old-age participation in the labour force, as well as some other variables, reveal associations with old-age mortality. However, these associations are not controlled by other explanatory variables and are re-examined through multivariate analyses.

The framework

The framework for the analyses is illustrated in Figure 1. Primarily, the focus of interest is on the relationship between life expectancy at age 65 — the dependent variable — and socio-cultural explanatory variables. The effects of these explanatory variables on old-age mortality may be assumed to operate through intermediate variables, mainly 'behavioural'. Food consumption and diets, the amount of smoking, exercise, the rational use of medical facilities, are just a few examples of such variables. Another category of intermediate variables is biological factors, which might intervene, for instance, between ethnicity and mortality. Hence, the socio-economic and culture variables affect, through behaviour characteristics, the cause-specific death rates which in turn determine old-age life expectancies.

While we do have data to express the more important socio-cultural variables, the cause-specific death rate variables and life expectancy at the older ages, we have no information on the intermediate behaviour or biological variables. Hence, the empirical analyses of the interrelationships cannot include explicitly the intermediate variables of the system proposed above. These have been included in Figure 1 just in order to present our analysis in a proper perspective.

Figure 1
Interrelationships among the major variables

Old-age mortality variations: hypotheses and explanation

We now attempt to evaluate hypotheses concerning the interrelationships between old-age mortality and the explanatory variables in the system described. Some of these hypotheses are based on previous studies mentioned above. Additionally, in formulating our hypotheses we make use of findings in various socio-demographic studies of Israel's population. Such studies have consistently shown significant interrelationships of demographic processes, not only with socio-economic status, but also with culture variables such as ethnicity and religiosity (e.g., Friedlander and Feldmann 1993).

Do variables such as socio-economic status, ethnicity, and religiosity affect cause-specific mortality and life expectancy at the older ages? The analyses in Tables 4 and 5 present t-statistics of multiple regression coefficients, and multiple correlation coefficients (R^2) for 1983 and 1972 respectively, for both males and females. Each line in these tables contains the coefficients of one equation relating to an age group within a cause-of-death category.

A brief glance at these tables provides a summary of their detailed content. There is a high concentration of significant effects on old-age mortality involving a small number of explanatory variables. These include economic and social status, ethnicity and religiosity, which are strongly related to death rates from heart and circulatory and from cerebrovascular diseases. All other explanatory variables are of much less importance in their explanatory power. The mortality patterns related to each explanatory variable are evaluated for 1983, with comparisons to 1972.

The effects of economic and social status levels

High educational levels in a population may increase consciousness regarding healthier consumption patterns and behaviour in general. Individuals in such populations may refrain from smoking, from consuming high-cholesterol food, or from heavy drinking; the result may be increased life expectancy. Similarly, the consciousness among high-status populations concerning lack of exercise and its effect on heart and circulatory diseases, may lead to change in behaviour and hence to reduced mortality from these causes. On the other hand, such high-status populations have the potential for more consumption in general, including unhealthy consumption.

Another behavioural aspect depending on the levels of socio-economic status, which may affect mortality rates, is the extent to which health services are consumed in a rational manner. It is well known that the use of private medical services has increased substantially in recent years, as the public services can no longer cope effectively with increasing demand. The costs of these private services, particularly of the more sophisticated procedures, which are often used at old ages, have increased exponentially. Such services can be used more extensively by high-status populations which could in turn lead to additional years of life expectancy. Such relationships with overall mortality have been explored in previous studies (McMichael 1985; Pagnanelli 1991; Powell-Griner and Rosenberg 1991).

To test the validity of the status hypothesis we attempt to find out whether and to what extent socio-economic status levels are negatively related to old-age mortality and positively related to life expectancy at age 65. One problem in this analysis arises from the interdependence between economic and social status which is in some instances quite strong. Indeed, in some analyses in the present study such interdependence prevents the simultaneous inclusion of these two explanatory variables in the same analysis.

Table 4a

t- statistic of regressions of various explanatory variables on cause standardized death rates and life expectancy at age 65, males 1983[a]

Dependent variables: life expectancy and causes of death by age		Explanatory variables								
		Economic status	**Social status (education)**	**Ethnicity (Africa)**	**Religiosity**	**Labour participation**	**Proximity**	**Loneliness**	**Industry**	**R^2**
Life expectancy at age 65		3.993***		-4.022***	4.606***					0.588
Heart and circulatory	65-69			2.167***	-2.581***					0.133
	70-74	-1.631*			-3.915***					0.192
	75-79			2.521***	-2.302***					0.138
	80 + [b]	-2.942***	Not in model		-3.065***				1.730**	0.292
	65-79[b]	-2.203***			-4.165***					0.219
	65+[b]	-3.776***			-4.720***					0.301
Cerebro-vascular	65-69	-2.431***								0.083
	70-74		-1.914**			-3.209***		-1.550*		0.412
	75-79		-2.649***	1.959**						0.332
	80 + [b]		-1.656***	2.281***		Not in model		3.735***		0.376
	65-79[b]		-3.099***			-2.039***			2.064***	0.517
	65+[b]		-2.332***	3.210***					2.413***	0.565
Cancer	65-69			1.916**	-2.111***					0.100
	70-74	-1.541*			-2.736***					0.109
	75-79									c
	80 + [b]									c
	65-79[b]				-2.735***				2.171***	0.162
	65+[b]		Not in model		-2.727***				1.764**	0.143
Infectious	65-79[b]			1.609*	-1.477*	-1.965**	Not in model		Not in model	0.203
Others	65-79[b]		-2.436***	4.638***		-1.998***				0.674

[a] Significance: ***=5%; **=10%; * =15% [b] Standardized [c] No equation

Table 4b

t- statistic of regressions of various explanatory variables on cause standardized death rates and life expectancy at age 65, males 1972[a]

Dependent variables: life expectancy and causes of death by age		Explanatory variables								
		Economic status	**Social status (education)**	**Ethnicity (Africa)**	**Religiosity**	**Labour participation**	**Proximity**	**Loneliness**	**Industry**	R^2
Life expectancy at age 65			1.715**	-5.973***						0.658
Heart and circulatory	65-69				-2.367***				1.468*	0.113
	70-74	Not in model			-2.213***					0.078
	75-79		-1.801***							0.052
	80 + [b]									c
	65-79[b]			1.843**	-2.621***					0.130
	65+[b]	Not in model		2.363***	-2.647***					0.156
Cerebro-vascular	65-69			3.578***						0.179
	70-74	-2.246***	Not in model	3.373***	-1.672**					0.306
	75-79			1.688**						0.046
	80 + [b]		-2.319***			Not in model		1.914**		0.117
	65-79[b]			5.279***						0.322
	65+[b]			5.747***						0.364
Cancer	65-69									c
	70-74				-1.745**	Not in model				0.049
	75-79									c
	80 + [b]									c
	65-79[b]				-2.720***					0.113
	65+[b]				-2.150***					0.074
Infectious	65-79[b]	-2.138***								0.071
Others	65-79[b]		-3.664***		-1.931**	-3.131***				0.421

[a] Significance: ***=5%; **=10%; *=15% [b] Standardized [c] No equation

Ta**ble 5a**

t- statistic of regressions of various explanatory variables on cause standardized death rates and life expectancy at age 65, Females 1983[a]

Dependent variables: life expectancy and causes of death by age		Explanatory variables								
		Economic status	**Social status (education)**	**Ethnicity (Africa)**	**Religiosity**	**Labour participation**	**Proximity**	**Loneliness**	**Industry**	R^2
Life expectancy at age 65		2.511***	2.596***	-2.232***	4.078***					0.629
Heart and circulatory	65-69			4.390***	-1.525*					0.241
	70-74	-1.828**	-1.791**	1.528*	-2.110***					0.438
	75-79		-4.275***							0.220
	80 + [b]	-4.219***			-3.197***					0.248
	65-79[b]		-3.402***	1.932**	-1.643*					0.418
	65+[b]	-2.349***	-2.173***		-2.412***			-1.468*		0.424
Cerebro-vascular	65-69	Not in model	-2.065***			-1.493*	1.791**			0.334
	70-74			5.262***					2.078***	0.463
	75-79		-2.936***	2.075***	-2.278***					0.391
	80 + [b]		-2.373***	2.650***	-1.634*					0.385
	65-79[b]		-2.302***	3.531***	-1.693*	-1.762*		-1.544*		0.594
	65+[b]		-2.589***	3.284***	-2.329***	-1.516*				0.565
Cancer	65-69				-1.921**	3.585***				0.245
	70-74				-2.171***					0.067
	75-79			-2.114***	-2.029***					0.136
	80 + [b]									c
	65-79[b]									c
	65+[b]				-3.537***	1.885**	-1.724**			0.301
Infectious	65-79[b]		-1.561*			1.958*	2.138***			0.364
Others	65-79[b]	-3.324***		2.345***			2.605***	-1.512*		0.642

[a] Significance: ***=5%; **=10%; *=15% [b] Standardized [c] No equation

Ta**ble 5b**

t- statistic of regressions of various explanatory variables on cause standardized death rates and life expectancy at age 65, Females 1972[a]

Dependent variables: life expectancy and causes of death by age		Explanatory variables								
		Economic status	**Social status (education)**	**Ethnicity (Africa)**	**Religiosity**	**Labour participation**	**Proximity**	**Loneliness**	**Industry**	R^2
Life expectancy at age 65			2.424***	-4.295***						0.573
Heart and circulatory	65-69		Not in model	4.229***		Not in model		-2.258***		0.354
	70-74			2.649***		Not in model				0.111
	75-79		-1.679***							0.048
	80 + [b]									c
	65-79[b]			3.341***				-2.233***		0.282
	65+[b]			3.259***				-2.245***		0.276
Cerebro-vascular	65-69			5.098***		-1.485*				0.463
	70-74	-1.930***		4.982***						0.434
	75-79		-2.595***					-1.790***		0.219
	80 + [b]			2.216***						0.080
	65-79[b]		-2.701***	3.652***						0.535
	65+[b]		-2.824***	4.167***						0.581
Cancer	65-69									c
	70-74			-1.802***						0.054
	75-79									c
	80 + [b]									c
	65-79[b]									c
	65+[b]									c
Infectious	65-79[b]	-2.387***				Not in model				0.094
Others	65-79[b]	-2.204***		4.025***				-1.925**	Not in model	0.453

[a] Significance: ***=5%; **=10%; *=15% [b] Standardized [c] No equation

Considering first the 1983 patterns, we find that status variables have significant explanatory power in the analysis of death rates from heart and circulatory diseases, from cerebrovascular and all other causes, for both males and females (see Tables 4-5). More specifically, for both the 65-79 and the 80 and over age groups, the economic status and the social-status variables affect these death rates negatively. Moreover, there is a negative effect of economic or social status on male death rates from cancer at the 70-74 age group, which however is not highly significant; and there are significant effects of status on death rates from all 'other causes'. Finally, our analysis shows that the effect of economic status is significant and positive in the equation of life expectancy at age 65 for males, while for females, both the economic and the social-status variables are significant. Hence, there is strong evidence to support the hypothesis that economic and social-status levels are negatively associated with death rates at the older ages and positively associated with life expectancies at age 65. The interrelationship between status and death rates from heart and circulatory diseases is of particular importance since this category by itself accounts for about half of old age mortality: the status inequalities in society play an important role in its mortality patterns.

Comparison to 1972 shows some similarity, particularly in the effects of status on death rates from heart and circulatory as well as from cerebrovascular diseases. It can be seen however that status was not as dominant in explaining death rates and life expectancy in 1972 as it was in 1983. Tables 4 and 5 suggest that during the period 1972-1983 there was a shift in the explanation of death rates and life expectancy from ethnicity to socio-economic status.

The effect of ethnicity on old-age mortality

The ethnic composition of a community may affect death rates and life expectancy even when other major variables, particularly socio-economic status, are controlled; ethnicity may have an impact on survivorship through various intermediate biological and behavioural variables. For example, genetic factors associated with the susceptibility to some diseases may be associated with ethnicity. Ethnicity may imply cultural characteristics connected with diets, and other activities or modes of behaviour, which may be related directly or indirectly to the risk of mortality from specific causes. Some evidence to the effect of ethnicity on mortality can be found in the literature (e.g. Keith and Smith 1988; Powles 1989).

It was stated in a previous section that micro-level analyses of ethnic differences in mortality have been undertaken in the past, although socio-economic variables could not be controlled (Peritz et al. 1973, 1983). The analyses have shown that North African ethnicity is negatively related with survivorship at most ages; on the other hand, Asian ethnicity has no such effect. Our analytic question is whether, and to what extent, these ethnicity variables affect old-age mortality, when socio-economic variables are controlled. The regressions for 1983 in Tables 4 and 5 show that African ethnicity affects life expectancy negatively through significantly higher death rates from heart and circulatory diseases, and in particular from cerebrovascular and 'other' causes at the oldest age groups, for both males and females. As mentioned earlier, the association of African ethnicity with mortality from cerebrovascular diseases was hypothesized to have a genetic explanation, but the present study cannot contribute towards its validation.

Tables 4 and 5 present similar regression coefficients for 1972. It has been argued that ethnicity, as defined by Asian, African or European origin, has been a major determinant of mortality, as well as of other demographic processes, since the early 1950s. However, with the increased exposure of Asian and African immigrants to Israeli society the importance of ethnicity as a determinant of mortality has declined. In particular, evidence from several sources has shown that the negative impact of Asian origin on life expectancy has decreased significantly since the early 1950s, and our analysis shows that it was virtually eliminated by the early 1970s. In contrast, the negative association between African origin and life expectancy has remained, although a decline is noticeable during the 1970s, while status and religiosity variables became increasingly influential. Hence, as was found by Peritz and colleagues (1973; 1983) ethnicity still has a significant independent effect on old-age mortality. Our data are insufficient for further interpretation of these results.

The effect of religiosity on old-age mortality

Is religiosity likely to affect survivorship at the older ages, when social and economic status variables are controlled? The existence of such an effect has been established among Jews in the United States (Idler and Kasl 1992). A negative relationship between religiosity and the incidence of myocardial infarction has been observed in Israel (Snyder et al. 1978). The interrelationship between religiosity and survivorship operates through intermediate behavioural variables. Religiosity involves behaviour and life style, which include a variety of familial as well as community activities, particularly at the older ages. Frequent visits to the synagogue for various religious activities, work with communal mutual aid organizations, and other voluntary activities may be assumed to provide purpose and moral strength at old age, which may contribute to higher life expectancies. While such extrafamilial activities are more frequent for males, females' activity is more concentrated around the wider family and the household. It would indeed be interesting to find out whether the positive effect of community activities, such as can be found among religious groups, on life expectancy, is valid in general, when other variables are controlled. Unfortunately, this cannot be done in the present study.

The relationship between religiosity and life expectancy at the older ages is somewhat complex. On the one hand, it is inversely related with both economic and educational levels, which in turn are positively related with life expectancy. On the other hand, religiosity levels are positively related with life expectancy, through life-style characteristics, which we are unable to measure (see also the section on recursive models).

It can be seen in Tables 4 and 5 that, for males, the religiosity variable is consistently negative, particularly for heart and circulatory diseases, but also for cancer and infectious diseases. Among females, religiosity also affects negatively the death rates from heart and circulatory diseases and from cancer; however, unlike the regression for males, religiosity also affects negatively the death rates from cerebrovascular diseases. Moreover, religiosity has the highest T value in the life expectancy equation (at age 65) for both males and females.

Can we find similar religiosity effects on old-age mortality in 1972? These tables provide comparisons to 1983, and suggest that such effect was not as systematic for males, and was not significant at all for females. However, we cannot offer an interpretation to the change in this effect during the period 1972-1983. Nevertheless, by the evidence of the data presented, we accept the religiosity hypothesis and consider its interrelationship as one of the more interesting observations in this study.

Old-age mortality and other variables

We are left with the remaining three variables, loneliness (defined in terms of marital status), industry and participation in the labour force. We deal with all these three variables in this section because their interrelationships with old-age mortality are less consistent than the variables in the previous hypotheses.

The loneliness hypothesis has been considered in previous studies. It has been repeatedly observed that non-married persons, that is, those of single, divorced, or widowed status, have higher probabilities of dying compared with the married. Part of the explanation is 'selectivity' while part is 'protective' (Spiegelman 1968: 91-92; Hu and Goldman 1990; Powell-Griner and Rosenberg 1991).

Our aggregate level analyses in Tables 4 and 5 suggest that the hypothesis that life expectancy at age 65 is negatively related with this variable, is not supported for males at either period; however, the loneliness variable for females shows some consistent relationships with mortality. But a more appropriate individual-level analysis published recently, which is partly consistent with our findings, shows that unmarried persons are disadvantaged in life expectancy in Israel in general: particularly widowers (Eisenbach 1994).

Another hypothesis is concerned with the relationship of old-age mortality, particularly from cancer, with the industry variable. A positive relationship should be expected. Table 4 suggests that such expected relationships are significant for males and only in some cause-of-death and age categories. For example, the industry variable has a significant positive effect on the male death rate from cancer at the 65-79 age group, which is consistent with expectation. The industry variable also affects the death rate from heart and circulatory diseases at the 80-and-over age group, and the death rate from cerebrovascular diseases. This interrelationship seems to be a new phenomenon, as we do not find it for 1972; it may reflect an increase over time in environment problems.

Our last hypothesis is concerned with the rate of old-age participation in the labour force. This variable was considered to represent a proxy for extrafamilial activity at the older ages, but has also an income effect. It is hypothesized to have a positive effect on life expectancy and negative effects on cause-specific death rates. It has in addition a qualification that healthier people tend to be more active economically. Table 4 suggests that this variable is negatively related with the death rate from cerebrovascular diseases among both sexes, and from infectious and 'other' diseases at the 65-79 age group for males, while its other coefficients are positive and contrary to the hypothesis. We must conclude, therefore, that this hypothesis has little support in this study.

Another hypothesis which was considered at the early stages of this project is concerned with the geographic proximity of place of residence to major units of specialized medical services. The three major cities in the country offer such specialized medical services: the distance from each locality to the closest of these cities was considered as a proxy variable for the accessibility of the population to such medical services. Controlling for status and ethnicity variables is of critical importance in testing this hypothesis because these explanatory variables tend to be associated with distance from the three major cities.

We expected strong positive relationships between proximity and the cause-specific death rates, particularly heart diseases for which distance and time are critical. However, our analysis shows that the effect of proximity was insignificant whenever status and ethnicity were controlled.

The increase in life expectancy 1972-1983: different patterns

In the discussion concerning the inequality in old-age mortality (see Table 2), it was suggested that an increase in inter-locality differentiation in life expectancy at age 65 occurred in the period 1972-1983. In particular, localities with relatively low life expectancies in 1972 seemed to have experienced only slight increases in life expectancies, if any, particularly among women. Table 6 provides the interpretation for that pattern. It shows unequivocally that when other variables are controlled, the increase in life expectancy 1972-1983 is inversely related with its initial level and with African ethnicity, while it is positively related with status and religiosity. Hence, localities with small proportions of high income earners or with high proportions of population of African ethnicity, experienced small increases in life expectancy during 1972-1983, despite being located at the lower part of the 1972 life expectancy distribution. Almost all these localities are new towns, as shown in the lower part of Table 2. This pattern explains the increase in the inequality in life expectancy during that period.

Table 6
t statistics of regression coefficients of various explanatory variables on differences in life expectancies 1972-1983, at age 65

Explanatory variables	Males		Females	
	t	Significance	t	Significance
Initial life expectancy e_{65}, 1972	-4.261	.0001	-2.958	.0047
Religiosity	+2.665	.0103	+3.343	.0016
African ethnicity	-1.919	.0605	-2.190	.0330
Social status (education levels)	+2.508	.0153	+1.776	.0819
R^2	0.325		0.316	

The analysis of life expectancy at age 65 through a recursive model

We now propose to explore more complex interrelationships, through a system of structural equations using recursive models. Such models may provide a clearer interpretation of the interrelationship structure among the dependent and the explanatory variables. They enable the distinction between direct and indirect effects of the explanatory variables on the dependent variable, life expectancy, under the assumptions specified below. For example, the observation that the population of African ethnicity has experienced higher mortality levels for many years, was interpreted in terms of a possible ethnic-genetic factor (see Tables 3-5; Peritz et al. 1973, 1983). On the other hand, it has also been shown that socio-economic status has a dominant negative effect on life-expectancy levels. The analytic question we pose is whether, and to what extent, the higher 'African mortality' is related to the direct ethnic effect, or to the lower level of socio-economic status among this ethnic group: the indirect effect.

These models are estimated under the assumption that the variables in the system can be arranged hierarchically in terms of their causal priorities. This assumption implies that ethnicity and religiosity may affect all other variables in the system, but these cannot affect ethnicity and religiosity. Education may affect life expectancy, but this cannot affect education, or other variables in the system. In addition, it is assumed that the error terms of the equations are uncorrelated. These assumptions allow the estimation of the regression coefficients of the proposed model through ordinary least square methods (e.g., Wonnacott and Wonnacott 1970; Blalock 1971; Johnston 1987). Since the present analysis does not use information on cause of death it is possible to use the 600 smaller units.

The following structural equations are estimated under these assumptions, and describe the hypothesized interrelationship system between life expectancy at age 65 and the explanatory variables among men and women:

$$ED_{9.60} = A_{ed} + B_{ed.et} ETAF + B_{ed.re} REL + e_{ed}$$

$$E_{65} = A_e + B_{e.et}\ ETAF + B_{e.re}\ REL + B_{e.ed} ED_{9.60} + B_{e.lo} LON_{70} + e_e$$

where A_{ed}, $B_{ed.et}$, $B_{ed.re}$, and e_{ed}, denote the constant term, the regression coefficients of ethnicity and of religiosity, and the residual error term, respectively, of the education dependent variable $ED_{9.60}$. A_e, $B_{e.et}$, $B_{e.re}$, $B_{e.ed}$, $B_{e.lo}$, and e_e denote the constant term, the regression coefficients of ethnicity religiosity and of loneliness, and the residual error term, respectively, of the life-expectancy dependent variable at age 65, E_{65}. ETAF, REL,

$ED_{9.60}$, and LON_{70} are the explanatory variables of these equations as defined above. The structural equations for women are similar.

Figures 2 and 3 show the main results of these analyses for men and women respectively. The numerical values above each arrow in these figures represent the t statistics of the appropriate regression coefficient.

Beginning with the analysis for men, it can be seen that African ethnicity affects life expectancy both directly, and indirectly. The indirect effect of African ethnicity on life expectancy operates through the educational level: social status. African ethnicity affects the social status variable negatively, and social status affects life expectancy positively. African ethnicity has, therefore, a negative indirect effect on life expectancy through the status variable. Furthermore, the direct effect of African ethnicity on life expectancy is also negative. This is the ethnicity effect discussed in an earlier section, which might be genetic, as hypothesized in a previous study (Peritz et al. 1973, 1983), or behavioural, or both. The structural equations enable the calculation of the relative strength of the direct and the indirect effects of African ethnicity. For example, a difference of ten per cent in African ethnicity between localities implies a difference of about ten months in life expectancy at age 65. About eight and a half months of these are due to the direct effect.

As for the religiosity variable for men, its indirect effect on life expectancy is negative, but quite small. This may be referred to as the socio-economic effect of religiosity on life expectancy at age 65. However, the direct effect of religiosity on life expectancy is positive. This may be interpreted as the religious 'life-style' effect that has been discussed above. Again, the relative strength of the direct and the indirect effects of religiosity can be calculated. For example, a difference of ten per cent in religiosity between localities implies a difference of about two and a half months in life expectancy at age 65. While the direct effect is positive and amounts to almost three months, the indirect effect is negative and small.

Figure 2
Recursive model: male life expectancy at age 65 ('t' statistic for variables in structural equations shown above arrows)

Figure 3 presents the regression coefficients of the recursive model for women. Again, both the indirect (socio-economic) and the direct ethnicity effects are negative. Religiosity, on the other hand, has an indirect negative effect on life expectancy through education, and a positive direct effect. In contrast with the analysis for men, the indirect effects of both ethnicity and religiosity are stronger than the direct effects. For example, a difference of ten per cent in African ethnicity between localities implies a difference of about 14 months in life expectancy at age 65. About nine months of these are due to the indirect (socio-economic) effect. A difference of ten per cent in religiosity between localities implies a difference of one month in life expectancy at age 65. This difference is the result of a negative indirect effect of two months and a positive direct effect of one month. One interpretation for the strong negative socio-economic effect of ethnicity on women's life expectancy may be a low level of consciousness regarding their health condition. The finding of a strong indirect socio-economic effect of religiosity on women's life expectancy is consistent with the hypothesis that women benefit less than men from the advantages of a religious lifestyle.

Figure 3
Recursive model: female life expectancy at age 65 ('t' statistic for variables in structural equations shown above arrows)

Summary and conclusion

The decline in old-age mortality is a new demographic process. Indeed, up to the 1970s there was hardly any increase in life expectancy at age 65 in the country as a whole. Old-age mortality data for other developed countries show a similar pattern.

Our analysis has documented very large differences among geographic areas in both overall and old-age mortality levels. These mortality inequalities, across subpopulations in a country with highly subsidized health services, with relatively small numbers of homeless or hungry, led us to attempt to explain inter-locality variations in cause-specific death rates and life expectancies at age 65.

A comparison of old-age mortality from the early 1970s to the early 1980s shows an overall increase in life expectancy. However, while life expectancy increases in localities characterized by high status levels, mostly with high initial life expectancies, were relatively large, increases for localities with low socio-economic status, mostly with relatively low initial life expectancies, were small. Hence, the socio-economic inequality in longevity increased during that period in general, even more strongly among women.

Death rates from heart and circulatory diseases account for about half of old-age mortality. Our analysis suggests that large proportions of people with high socio-economic status, high proportions of religious people and low proportions of population of African ethnicity are associated with low death rates from these diseases. Contrary to expectations, close proximity to major medical centres was not found to be a significant determinant of low mortality levels from heart and circulatory diseases, when socio-economic status and ethnicity are controlled.

Cancer makes a much smaller contribution to old-age mortality, less than 20 per cent, and its explanation, in general, is not as good as for heart and circulatory diseases. Indeed, the analysis for women, in particular, provided poor explanation. However, for men, high levels of socio-economic status and large proportions of religious people are associated with low rates of cancer mortality, while high proportions of the labour force in industries are associated with high cancer mortality in localities.

Hence, viewing the overall patterns of our results, we can confirm that socio-economic status, African ethnicity and religiosity are the major variables explaining inter-locality differences in old-age mortality. Among these, the socio-economic status levels are the most important, especially at the more advanced ages.

Localities with high proportions of population of African ethnicity have relatively low life expectancies both due to lower socio-economic levels, and because this ethnic group has a specific negative effect on life expectancy, genetic or behavioural. In contrast, it is interesting to note that Asian ethnicity has no direct or indirect negative effect on life expectancy at the older ages.

Our analyses suggest that localities with relatively high proportions of religious people are subject to two forces operating in opposite directions on life expectancy levels. The negative force is due to the relatively lower socio-economic status among the religious section of the population. The positive force is connected with the life style of the religious population.

Is there a lesson that can be drawn from these findings? Can these be a basis for a policy to increase the life expectancy of the society at large? It is obviously impossible to equalize socio-economic status levels among ethnic groups or among other kinds of population subgroups. Equally, the population at large cannot be expected to adopt a religious life style which could, according to our analysis, lead to increased life expectancy. These rather naive statements are made to draw attention to the structure of the initial framework discussed earlier in this paper. What is needed is research that can shed light on the intermediate variables between socio-economic and cultural variables on the one hand, and old-age mortality from the different causes of death, on the other. Indeed, a contribution might be made by a better understanding of the mechanisms under which variables such as ethnicity, the level of social or economic status and the life style of religious people affect the death rates from major causes. This could make it possible to design policies that will lead to increases in overall life expectancies without inconceivable revolutionary changes in the structure of society.

Appendix A: constructing life tables in small local areas

Estimates of life table functions may be inaccurate for small populations, such as those in statistical areas. Hence, the smaller statistical areas were aggregated. These aggregates are referred to as small local areas.

The full enumeration of both the 1983 and the 1972 Population Censuses provided the mid-year populations by age and sex. The distribution of deaths by age and sex was extracted from vital registration data for five years.

Statistical areas were aggregated into small local areas under the constraint that sub-quarter borders were not crossed, and with a preference for joining areas with similar socio-economic characteristics. Small settlements such as *kibbutzim* and *moshavim* were aggregated within subdistricts (*nafoth*) by type of settlement.

Using the population data from the full enumeration of the Census and the number of deaths from registration data we computed age-specific mortality rates. We used the Reed-Merrell method of life table construction (Shryock and Siegel 1973:443-444).

Appendix B: the accuracy of the reported age structure

Birth registration in the State of Israel is considered to be accurate and complete. However, a possible source for deviations from the true age structure of death rates may be the incorrect registration of the age of new immigrants upon their arrival.

Many Israelis were born in countries in Asia and Africa. It is common in less developed countries for the elderly to overstate their ages: consequently, mortality levels may be underestimated among the elderly. The purpose of this appendix is to detect the presence of age-overstatement.

If the real age of a cohort is less than its reported age, we would expect the cohort's mortality level to be relatively low over time. Thus, we should be able to observe a cohort effect on mortality due to the initial age-overstatement; for real cohort effects see for instance Preston and van de Walle (1978); Anderson and Silver (1989); Caselli and Capocaccia (1989).

We assume that the people born in Europe or America tend to report correct ages compared with those born in Africa or Asia. Hence, we used ratios of the age-specific mortality rates for African and Asian Jews relative to those for European and American Jews for each age group above age 40 to detect age-overstatement. Our comparison reveals that mortality patterns among Asian men are closest to those of Europeans and Americans, followed by Asian women, African men and African women, in that order.

If age-overstatement were common, we would expect these ratios to decline with age. Ratios for older men and women born in Africa, however, show no such decline. Hence, we found no evidence of age-overstatement among Asian or African Jews. Thus, old-age mortality is unlikely to have been underestimated. The rising ratios of African mortality rates relative to those of Europeans and Americans are consistent with the findings in this paper regarding the effect of ethnicity.

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