ABOUT MORTALITY DATA FOR ISRAEL

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GENERAL

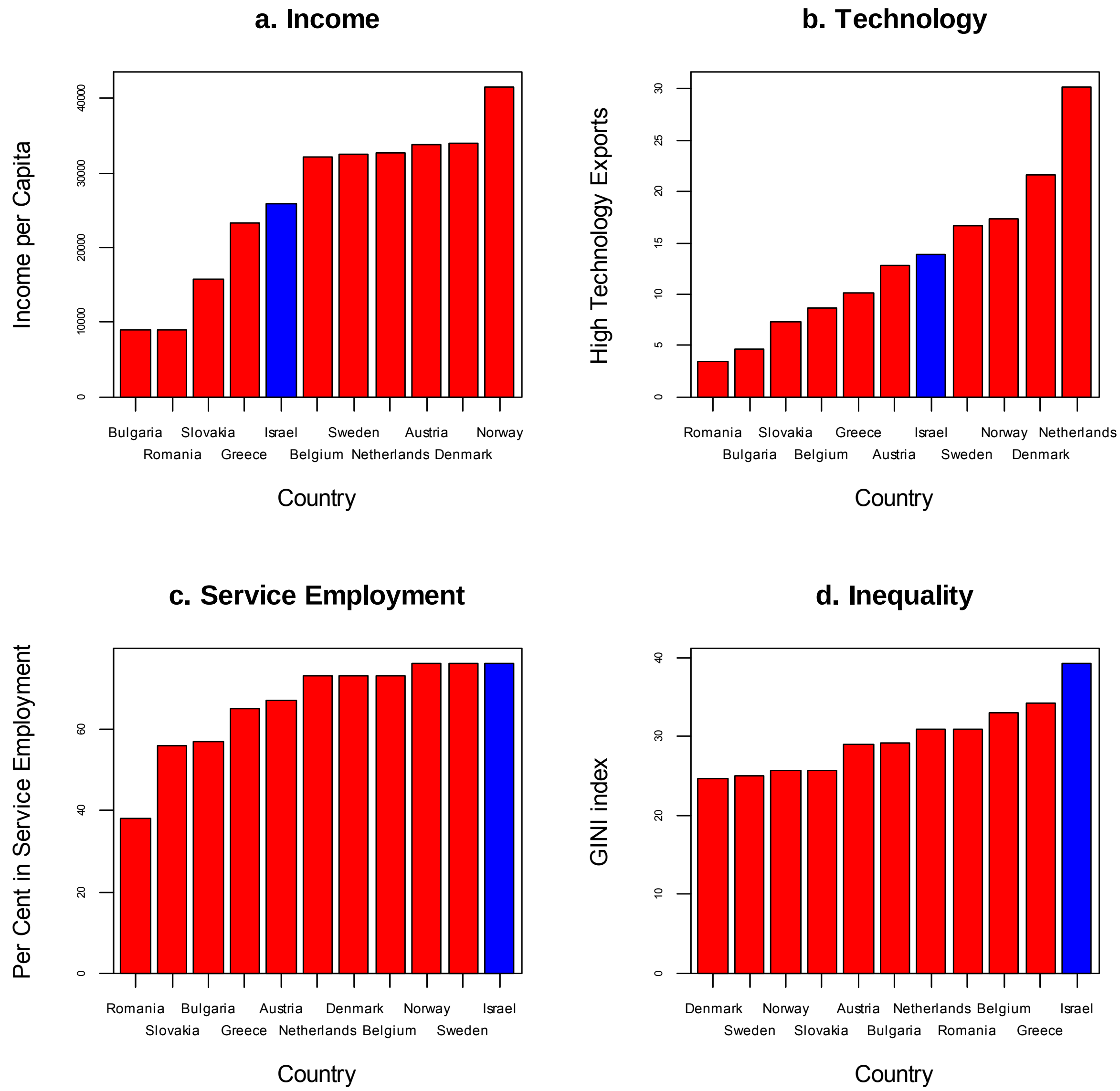
The state of Israel, in Asia Minor, covers a territory of about 20,000 square kilometers at the south-eastern corner of the Mediterranean basin. Since the founding of the state in 1948 the population has changed dramatically as a result of population movements during the War of Independence, mass immigration and border changes subsequent to the war of 1967. The data provided by the Central Bureau of Statistics (CBS) in Jerusalem refer to all populations subject to Israeli law, which includes residents of East Jerusalem, the Golan Heights and Jewish settlements in the Palestinian territories occupied since 1967. The Human Mortality Database (HMD) takes no position concerning the current or future legal or political status of these areas. Rather, the intention is merely to present the available data about the population in the HMD's standardized format, in the interest of scientific analysis of demographic processes in general and of patterns of mortality in particular.

The Economy

Economically, Israel can be placed at the lower end of the high-income countries, as can be seen in Figure 1, comparing Israel to ten other high-income countries with comparable population size (the countries were selected randomly from the 27 EU countries plus Norway and Switzerland). At an average income per capita of $26,000, Israel is on a par with Greece, above the three Eastern European countries but considerably below the six countries of Western Europe (Figure 1a). In terms of the percentage of High Technology exports (among all industrial exports), Israel ranks just above the median position, together with Austria, but considerably below the Nordic countries and the Netherlands (Figure 1b). The proportion employed in service occupations in general rises with the overall standard of living (among the 60 high Human Development Index (HDI) countries, the correlation is 0.65), but a precociously high proportion in service occupations can be indicative of structural abnormalities in the economy. As shown in Figure 1c, Israel (76 percent) leads the pack, together with Norway and Sweden, with a level considerably higher, for instance, than the ex-Socialist countries. Since much of the service employment in Israel is at minimal wage, the result is a high level of inequality, as can be seen in Figure 1d. At 39.2, Israel has clearly the highest level of inequality, slightly above Greece and considerably higher than the level of the other countries shown here.

Thus, although in terms of average performance indicators Israel may be considered in the low to middle range of high income countries, Israel presents extremely high levels of inequality and service employment. Much of this is reflected in the important differences between the different origin groups in Israel, in particular between Arabs (Palestinians) and Jews, but also between Jews of different origins.

Figure 1: Israel, Comparative Economic Indicators, 1996-2005



Source: These data are taken from the United Nations Human Development Report (http://hdrstats.undp.org/buildtables/, downloaded June 10th 2008).

Notes:

1. Figure 1a presents information on Gross Domestic Income per capita in purchasing power parity (PPP) US$ for 2005.
2. Figure 1b shows High Technology exports as a percent of all industrial exports for each country in 2005.
3. Figure 1c represents the percentage employed in service occupations as a percent of total employment for each country in 2005.
4. Figure 1d presents the Gini index (higher values indicate greater within-country inequality) for the latest year available for each country in the period 1996-2005.

TERRITORIAL COVERAGE

There were no territorial changes during the period covered by the HMD (since 1983).

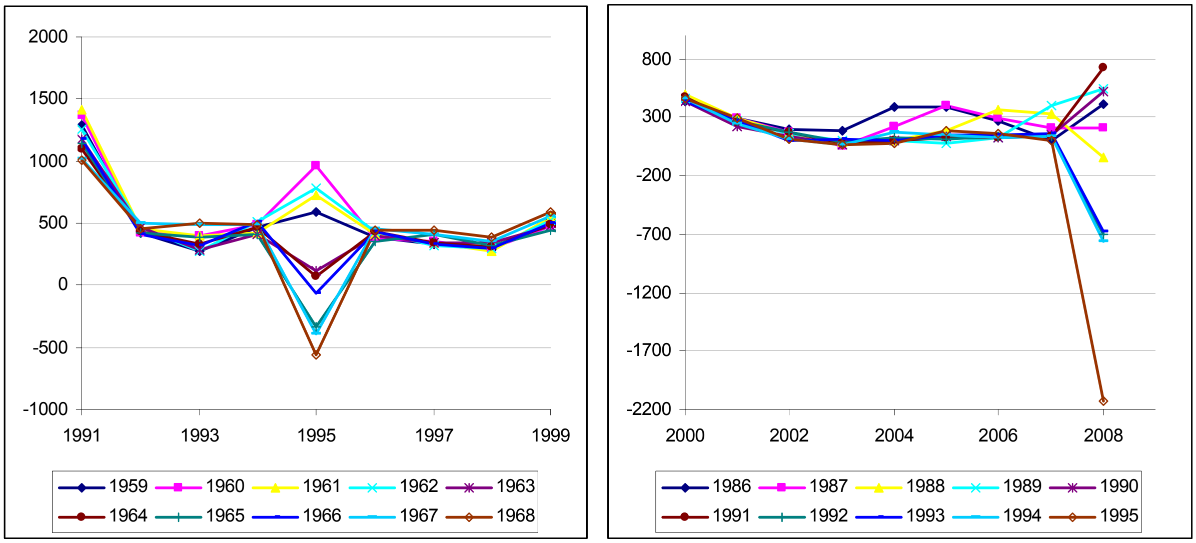
DEATH COUNT DATA

Israel has maintained a population registry since 1948, which records all births, deaths, changes in marital status and changes of address. In general, death registration covers the *de jure* population with the exception of deaths that occur abroad. The register has been operational since November 1948 and has been fully functional for the whole population (Jews and Arabs) since early 1949. Nonetheless, vital statistics (births and deaths) were not published for the Arab population until 1955. Prior to 2002, deaths of Israeli residents that occurred abroad were not registered. Since 2002, deaths of Israelis who died within one year of leaving the country have been registered. The data also do not include deaths of tourists and labour migrants. The death counts are available by single years of age with an open age interval for 95 years and older.

POPULATION COUNT DATA

The first Israeli census was held in November 1948, and was, in essence, a registration of the population within the territory held by Israel at that time. Since then, there have been five censuses, in 1961, 1972, 1983, 1995, and 2008. In the first four censuses, all *de jure* households (Israeli citizens and permanent residents) filled in a “short questionnaire” with summary details of household members by age, sex, marital status, relation to the nominated head of household, and place of birth. Twenty percent of households filled in a “long questionnaire” giving details of housing conditions and household wealth. For individuals aged 15 and older, details were also obtained on education, labour force characteristics, fertility (women) and internal migration. Current data on population are based on the census, updated through the population registry. A record is kept of all persons leaving and entering the country. Those who have been absent for more than a year are removed from the records until their return. The most recent census (in 2008), was a registry linked census and included only the 20 percent sample, on the basis of which current population data have been updated. Official annual population estimates are provided by single years of age, ending with an open age interval of 95 and over, and are post-censual population estimates, which have not been revised backwards according to subsequent censuses. For this reason there are significant jumps in net migration in years when the censuses were taken, which are 1995 and 2008 for the last two (Figure 2) (data for female cohorts are taken as an example)

Figure 2. Net migration estimates based on official annual female population estimates



Although Israel is not the only country which does not recalculate back population estimates after the next census there is no other country in the HMD with such large (in comparison with total population) and irregular migration. Thus, the standard HMD inter-censal method cannot be applied to correct this problem. We adjusted the official annual population estimates for 1985-1995 and 1996-2007 using the special method described in Appendix 2. Unfortunately, this non-standard approach required additional input data, namely two types of official population estimates ("new" and "old") for two census years (1995 and 2008): 1) estimates based on the new census data and 2) post-censal estimates based on the previous census. With help of the Central Bureau of Statistics of Israel we collected such data. The "old" post-censal population estimates for 1995 are based on the 1983 Census (the reference date is June 4th) whereas for 2008 they were derived on the basis of the 1995 Census (the reference date is November 4 th). Current population estimates from the end of 2008 onward are based on the 2008 census (the reference date is December 27th 2008) as well as birth and death data from vital statistics.

Population growth and structure

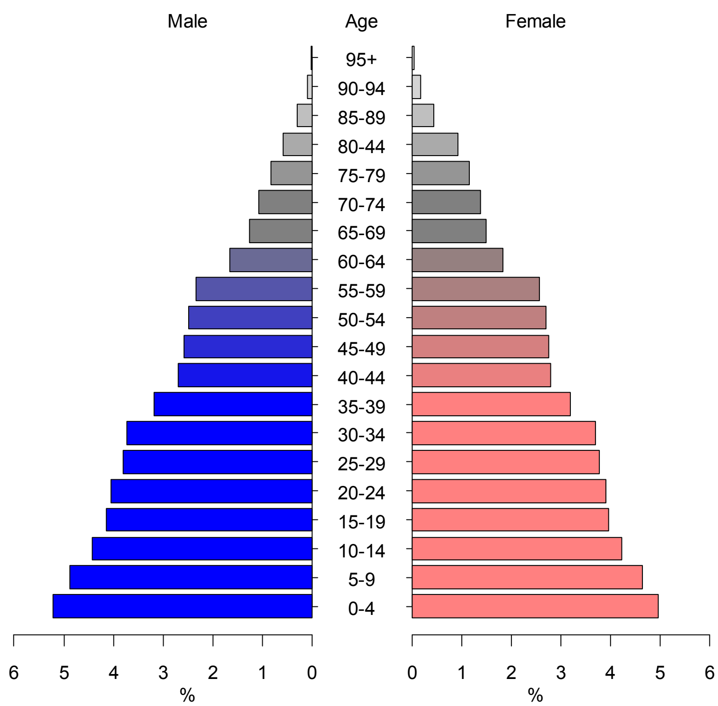
In 1948, on the eve of Israel's independence, there were an estimated 650,000 Jews and about 870,000 Arabs living in the territory that was to become the State of Israel. By mid-1949, at the time of the Rhodes armistice agreement, there were already about 900,000 Jews and only about 158,000 Arabs, of whom approximately 70 percent were Muslim, 21 percent Christian, and 9 percent Druze. Over the following 60 years, low mortality, high fertility and immigration have increased the total population to 7.7 million at the end of 2010 (http://www.cbs.gov.il/www/yarhon/b1_h.htm), of which about 80 percent are Jews and 20 percent Arab. Over one half of this tenfold increase in population is attributable to Jewish immigration, without which the Jewish population, by natural increase, would probably be less than two million.[1] In 2009, over 20 percent of the total

1 The current Jewish natural growth rate is around 13 per thousand, having risen from around 11 per thousand at the turn of the century. Historically, natural growth rates have been much higher, mainly as a

population, and 30 percent of the Jewish population, was born abroad, with about half of all immigrants having arrived since 1990.

Figure 3 presents the population pyramid for 2007 (CBS, 2008, Table 2.19). The population is composed of a number of identifiable bands, with break-points corresponding to critical years in Israel's history. The oldest band ends at about age 60, below which point the pyramid widens slightly. The second band of people born since the founding of the state ends around age 40 (i.e., with the cohorts born after the 1967 war). The third band would appear to end at around age 10, or, in terms of birth cohorts, almost a decade after the large immigration wave of the early 1990s. Thus, while the breaks in the population structure would appear to be associated with times of high immigration, this is not systematically the case, and a full analysis would have to consider economic, social and political developments within Israel.

Figure 3: Population Pyramid, Israel 2007



BIRTH COUNT DATA

Data on births cover all births in Israel for which at least one of the parents is an Israeli resident. Throughout the period covered by HMD data, the World Health Organization (WHO) definition of live births was used. The complete WHO definition of stillbirths was adopted in 2003. The data do not include births to Israelis abroad (children born abroad are registered as immigrants upon arrival in Israel).

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result of the high fertility of immigrants from Asia and Africa. Even at the historically high natural growth rates, the current Jewish population would only be about 2.7 million.

FERTILITY: THE STALLED DEMOGRAPHIC TRANSITION

In comparison with most other developed countries, the demographic transition in Israel appears to have "stalled." The level of mortality is at, or below, that of other countries with a comparable mean standard of living, but fertility and family formation patterns remain considerably more traditional, with a higher level of fertility, earlier and more lasting marriages, and a larger proportion of the fecund life span spent in marriage (Peres and Katz 1981, Fogiel-Bijaoui 2002, Anson, 2010). This does not mean, however, that Israel is pre- or non-transitional. Table 1 presents comparative data for Europe and Israel, with a third column presenting data for the Occupied Palestinian Territories, as an example of a non-transitional society. Total fertility in Israel is higher than that for any European country, but considerably lower than for Palestine. Women's mean age at marriage (SMAM) in Israel is at the lower edge of the European distribution, whereas for Palestine it is considerably below the European values. Marital levels (I_m) (Coale, 1969) for Israel are at the upper end of the European distribution, but are considerably below that for Palestine. The level of divorce, as indicated by the divorced-to-married ratio, is relatively low, with Israel in the second quartile of the European range, but also considerably higher than for Palestine.

Table 1: Comparative Fertility and Nuptiality Indicators: Europe, Israel and Palestinian Authority circa 2001

Indicator	Europe[1] Lower Quartile Median Upper Quartile	Israel	Occupied Palestinian Territory
Total Fertility Rate (TFR)[2]	1.3 1.4 1.8	2.9	5.1
Singulate Mean Age of Marriage (SMAM)[3]	25 26 30	25	22
Coale's Marriage Index (I_m)[4]	0.391 0.485 0.518	0.565	0.686
Divorce/Married ratio among women[5]	0.0716 0.130 0.194	0.0911	0.0200

Notes:

1. Including 27 states of the European Union, plus Norway and Switzerland.
2. Source: United Nations Department of Economic and Social Affairs, Statistics and indicators on women and men, http://unstats.un.org/unsd/demographic/products/indwm/tab2c.htm, accessed November 18th 2007.
3. Source: United Nations Department of Economic and Social Affairs, Statistics and indicators on women and men, http://unstats.un.org/unsd/demographic/products/indwm/tab2b.htm, accessed November 18th 2007. European data do not include Germany.
4. Coale's marital index (approximate proportion of her fecund life the average woman spends married) (Coale, 1969). Source: United Nations Department of Economic and Social Affairs, Demographic Yearbook Special Census Topics, Table 3: Population by marital status, age, sex, urban/rural residence: each census, 1985-2004, (released: June 30th 2006). http://unstats.un.org/unsd/demographic/products/dyb/dybcens.htm, accessed November 18th 2007. European data do not include Belgium and Malta.
5. Ratio of the number of divorced women to the number of married women.

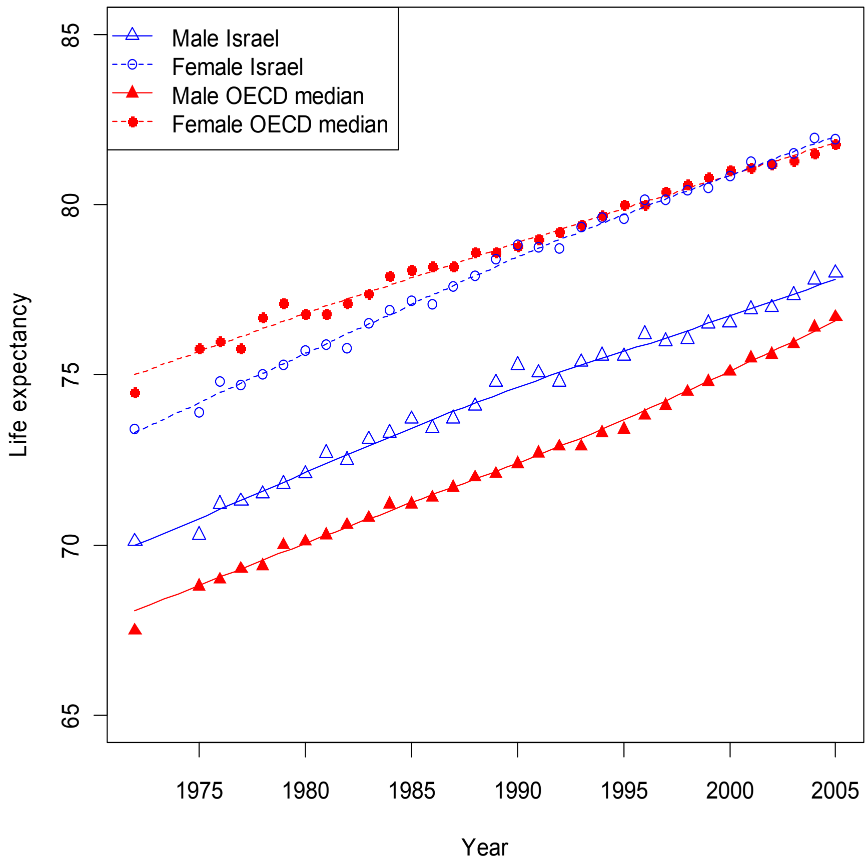
MORTALITY TRENDS

Israeli men's life expectancy is ranked 5th in the world, less than a year lower than in Switzerland, which is ranked first. Israeli women's life expectancy is ranked 12th, three years lower than in Japan, ranked first (2008) [CBS. 2010].

Figure 4 presents life expectancy trends for Israel compared with the median life expectancy for the OECD countries. Among males, Israeli life expectancy is consistently two to three years higher than the OECD median, although there appears to be a slight narrowing of the gap in recent years. In Israel, female life expectancy has been rising slightly faster than male life expectancy, with the result that the sex gap in life expectancy has widened from three to four years, and female life expectancy now matches the OECD median. The decline in infant mortality during 1970-2007 is presented in Figure 5, again with median OECD values for comparison.[2] In general, the infant mortality rate has declined at a constant rate over this period, following the OECD median, albeit at a level about 20 percent higher. The stillbirth ratio (stillbirths/live births) declined at about the same rate until the late 1980s; since then, it has leveled off to reach 3.8 per 1000 in 2006.

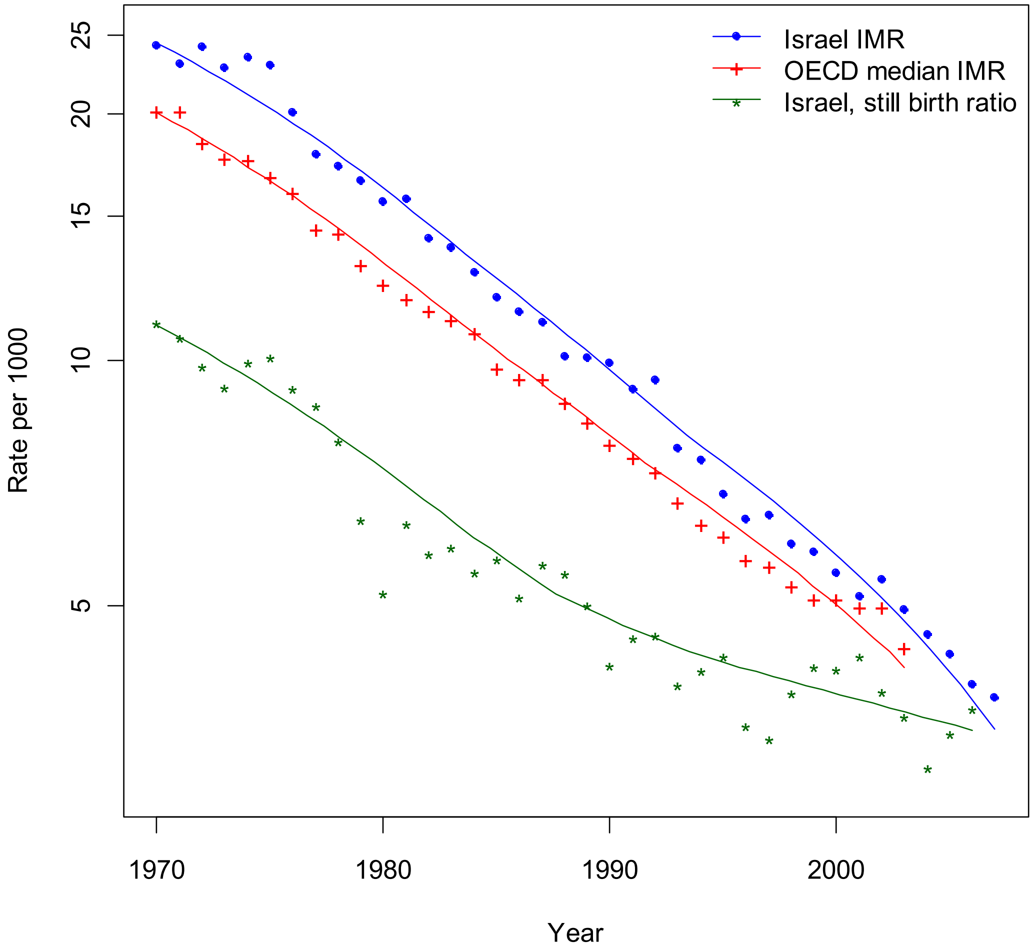
2 The median is presented rather than the mean as it is less sensitive to the extremely high infant mortality rate in Turkey and Mexico, particularly in the earlier years.

Figure 4: Life Expectancy Trends, Israeli Population and OECD Median



Israeli data through 1982 from publications by the CBS; estimates since 1983 come from the HMD. OECD data come from http://www.oecd.org/document/16/0,3343,en_2825_495642_2085200_1_1_1_1,00.html, downloaded June 10th 2008.

Figure 5: Infant Mortality Ratio (IMR) and Stillbirth Trends, 1970-2007



Source: Israeli data come from CBS 2008, Table 3.1. OECD data come from (http://ocde.p4.siteinternet.com/publications/doifiles/812005171G007.xls, downloaded May 13th 2009).
Note: The IMR is expressed as the number of infant deaths per 1,000 live births in the same year. The stillbirth ratio is the number of stillbirths per 1,000 live births.

DATA QUALITY ISSUES

HMD estimates of the population at advanced ages are calculated using the extinct cohort and survivor ratio methods.[3] As a result, population sizes at ages 80 and older differ from those published by the CBS. There are two reasons for these differences between the official and HMD population estimates for ages 80+.

The data for Israel do not show a typical age heaping pattern. Nonetheless, the official population estimates suggest that the 1900 birth cohort is substantially larger than the cohorts born in 1899 and 1901 (Figure 6, left panel, presents data for females; the picture for males is similar). Some cohort heaping is also observed for the 1910 cohort (not shown). It is very likely that many immigrants who arrived without a birth certificate, or from countries with problematic registration at the time of their birth, rounded off their birth year to the nearest decade. This hypothesis is supported by similar heaping in the death counts (Figure 5, central panel). If such cohort misreporting were the same among deaths and population counts, the errors should cancel out when calculating death rates. An implausible concavity in mortality curves by cohort (Figure 5, right panel) suggests that the misreporting bias may have been more severe for population counts than for death counts. This peculiarity is observed up until 1995 when the 1900 cohort was included in the age group 95+. The 1995 census data for one-year age groups is available only for ages below 95; thus, it is not possible to check what happened to the size of this cohort in the 1995 census. However, after 1995 the size of the 95+ age group grew 4.3-fold for men and 8.4-fold for women, when compared with the pre-census year.

The HMD methods eliminate some of the irregularities in the size of age-specific population groups (Figure 7) at old ages. These procedures increase the size of the age group 80-94 in 1984-2002 by an average of 9% for females and 6% for males. This increase may be partly explained by using the extinct/almost extinct cohort method which is based on an assumption of zero migration. However, this assumption may not work for Israel, where the number of migrants at age 75+ in 2009 was 681, corresponding to 0.2% of the population aged 75 and older registered at the beginning of the year. In the years with higher levels of migration, this number may have been significantly higher, so that the cumulative error may be significant. Detailed data on migration by age groups (at least up to 80+ for the zone of interest) and sex are not available. Thus, the effect of migration cannot be estimated, but the recalculated data look more plausible. At ages 95+, the HMD estimates smooth out the huge increase around 1995 in the official population estimates. Nonetheless, the HMD methods do not correct for any cohort heaping in the death counts, and as the HMD methods for estimating the population at ages 80+ rely on the death counts, some biases could therefore remain.

This heaping of birth cohorts on decennial years also raises the possibility of another important, but not so easily discernible, distortion in the data, namely that of immigrants adjusting their declared age in order to avoid conscription or to increase their probability of obtaining access to education, employment, or a pension. This is particularly likely with migration waves in the 1950s and 1960s, when refugees and immigrants from less developed countries predominated. Later waves originated mainly from Europe, North and South America and the countries of the former Soviet Union (CBS, 2008, Tables 4.2, 4.4).

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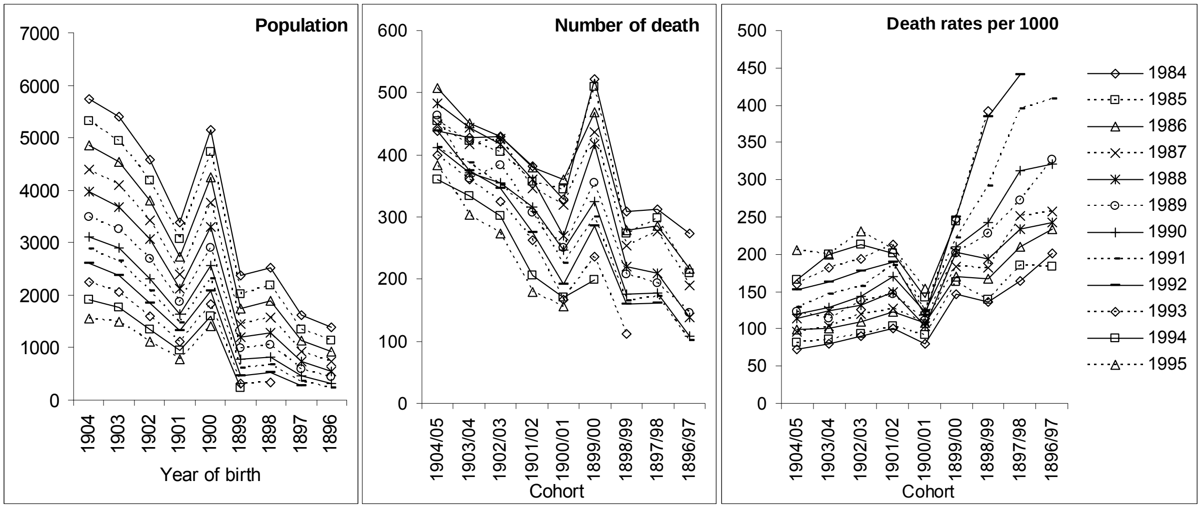
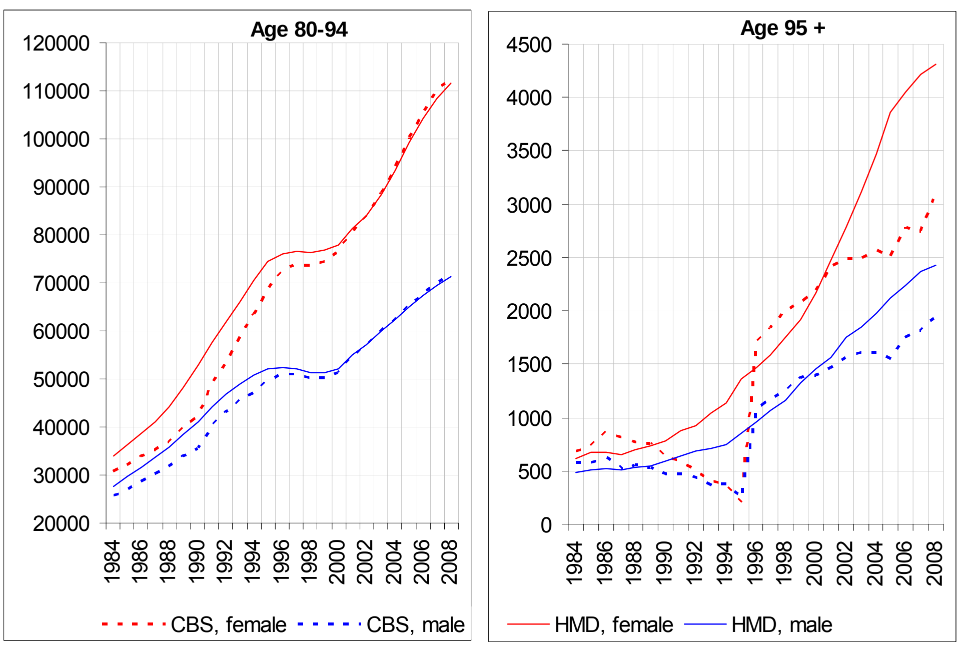
3 For details, see pp. 27-32 of the Methods Protocol (May 31st, 2007, Version 5).

Figure 6. Population Size, Number of Deaths and Death Rates for the 1896-1905 Birth Cohorts During the Period 1984-1995, Females



Source: Population and death counts come from the Input (raw) data. Death rates are calculated based on those data.

Figure 7. Population at Ages 80-94 and 95+, Official vs. HMD estimates, 1984-2007



SUMMARY

Israel is characterized by low mortality, a very heterogeneous population, and a high level of economic inequality. There are certain limitations to the Israeli data, as discussed above, most of which derive from the large proportion of first generation immigrants from countries with poor vital statistics systems. Israel is also a country with a very high level of immigration. The most notable peak, in 1990, is related to the collapse of the USSR. Although migration statistics are very well documented, there remain some problems with the age structure of the migration flow, and some undercount of migrants. Unfortunately, the CBS does not recalculate back annual population estimates using data from the most recent census and for this reason the annual official population estimates are slightly biased. Nonetheless, taking these limitations into account, Israel's rapid economic growth, its stalled fertility transition, as well as its special situation as a society in conflict offer an important case for comparison with other low mortality societies.

REVISION HISTORY

Changes with the December 2017 revision:

Life tables: All life tables have been recalculated using a modified methods protocol. The revised protocol (Version 6) includes two changes: 1) a more precise way to calculate a0, the mean age at death for children dying during the first year of life and 2) the use of birth-by-month data (where and when available) to more accurately estimate population exposures. These changes have been implemented simultaneously for ALL HMD series/countries. For more details about these changes, see the revised Methods Protocol (at http://www.mortality.org/Public/Docs/MethodsProtocol.pdf), particularly section 7.1 on Period life tables and section 6 and Appendix E, on death rates. The life tables calculated under the prior methods (Version 5) remain available at v5.mortality.org but will not be further updated in the future.

Changes with the October 2018 revision:

The provisional data on deaths for 2014 have been replaced by final data.

ACKNOWLEDGEMENTS

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APPENDIX 1:

DESCRIPTION OF THE ORIGINAL DATA USED FOR HMD CALCULATIONS

POPULATION

Period	Type of Data	Age Grouping	Comments	RefCode†
1983-2016	Annual population estimates (as of Dec 31st) for the *de jure* population by sex and age	0,1,2,3,4,…,94,95+	Unpublished data	01, 04, 05, 08, 09, 12, 13, 14, 17

DEATHS

Period	Type of Data	Age Grouping	Comments	RefCode†
1983-2016	Annual death counts for the de jure population by sex and age	0,1,2,3,4,…,94,95+	Unpublished data.	03, 07, 11, 16, 19

BIRTHS BY SEX

Period	Type of Data	Age Grouping	Comments	RefCode†
1983-2016	Annual live birth counts by sex	0,1,2,3,4,…,94,95+	Published data	02, 06, 10, 15, 18

BIRTHS BY MONTH

Type of data: Annual live birth counts by month

Period covered: 1980-2009

RefCodes: 20

APPENDIX 2: Adjustment of population estimation during the period 1996-2007 to 2008 census data

The 1995 census helped verify population estimates during the inter-censal period 1985-1995 and the 2008 census helped verify population estimates during the inter-censal period 1996-2007. For some young cohorts the difference between post- and pre- census population estimates is fairly significant. For this reason, back estimation of net migration in 2008 for some cohorts is very different from migration in the period 1996-2007, and the dynamics of back-estimated cohort migration look unlikely (Figure 2.1, left panel).

Figure 2.1. Net migration estimates based on official annual population estimates and adjusted HMD estimates in female cohorts 1991-1995

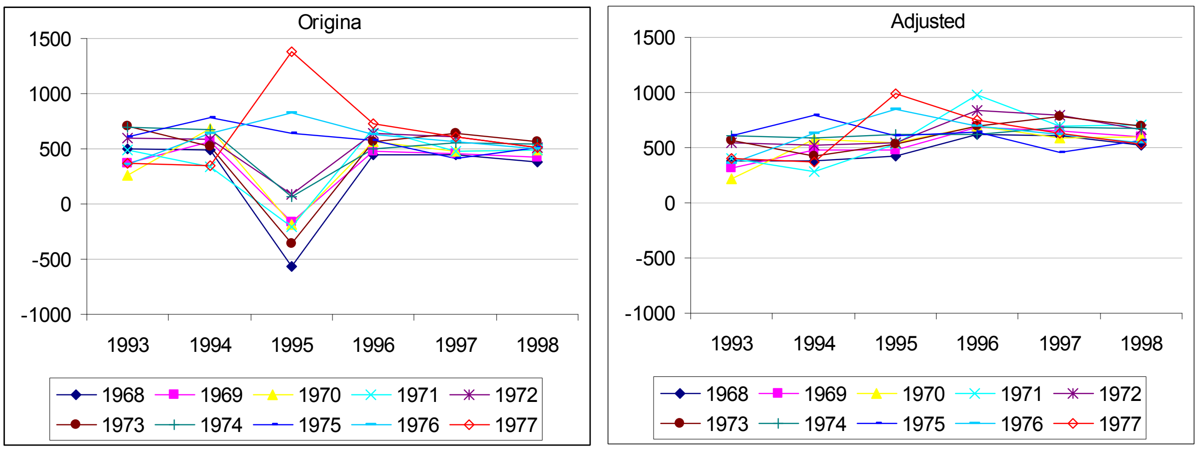
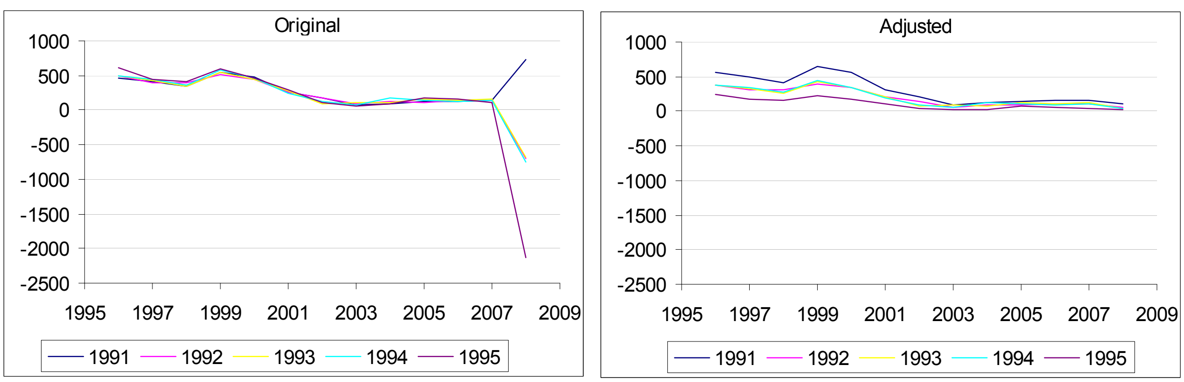


Figure 2.2. Net migration estimates based on official annual population estimates and adjusted HMD estimates in female cohorts 1991-1995



The standard HMD pre- and post-censal survival method ignores all information concerning migration, which is clearly inappropriate in this case. . We therefore made the following adjustment. For each 1905-1994 (correspondingly 1919-2008) birth cohort, net migration during 1984-1995 (1996-2008) (Figure 2.1, right panel) was adjusted proportionately, so that the cohort size calculated from the 1983 (correspondingly 1995) census became equal to the estimates based on the 1995 (or 2008 census correspondingly) (Figure 2.2, right panel). The corresponding correction factor for the population size is less than 0.7% of the total population, and the relative correction factor for the cohort size at ages 0-79 is within the interval (−6.8%, 5.4%) for males and (−3.7%, 4.1%) for females. The algorithm for these population adjustments is detailed below.

To obtain a corrected population estimate, the net number of migrants is first adjusted. The initial value of net migration for a cohort born in year Y, at year t, is calculated using the official annual post-censal population estimates and death counts (split by triangles, if necessary) as follows:

$$W^{Y}(t) = P(t+1, t-Y+1) - P(t, t-Y) + D_{U}(t, t-Y) + D_{L}(t, t-Y+1),$$

where $P(t, x)$ stands for the population at age x at the beginning of year t and $D_{L}(t, x)$ and $D_{U}(t, x)$ represent the number of lower-triangle and upper-triangle deaths recorded among those aged $[x, x+1)$ in year t. For the cohort born in year t, net migration is equal to

$$W^{t}(t) = P(t+1, 0) - B(t) + D_{L}(t, 0).$$

where $B(t)$ is the number of births occurring in year t.

Let Δ_1 be the difference between the estimated cohort sizes at the end of 1995 based on the 1983 census and the post-censal estimates based on the 1995 census and Δ_2 the difference between the estimated cohort sizes at the end of 2008 based on the 1995 census and the post-censal estimates based on the 2008 census. The correction coefficient k_j for this cohort is

$$k_1 = \Delta_1 / \sum_{t=1985}^{1995} \left| W^{Y}(t) \right| \text{ and } k_2 = \Delta_2 / \sum_{t=1996}^{2008} \left| W^{Y}(t) \right|,$$

where $\left| W^{Y} \right|$ means absolute value of W^{Y}.

Adjusted net migration $\tilde{W}^{Y}$ in year t is equal to

$$\tilde{W}^{Y}(t) = \begin{cases} W^{Y}(t) \cdot (1 + k_j^{Y}) \text{ for } W^{Y}(t) \geq 0 \\ W^{Y}(t) \cdot (1 - k_j^{Y}) \text{ for } W^{Y}(t) < 0 \end{cases},$$

$j = 1,\ j = 1, 1985 \leq t \leq 1995;\ j = 2, 1996 \leq t \leq 2007$, and adjusted cohort size is calculated by the formulae

$$\tilde{P}(t+1, t-Y+1) = \tilde{P}(t, t-Y) - \left(D_{U}(t, t-Y) + D_{L}(t, t-Y+1)\right) + \tilde{W}^{Y}(t),$$

$$1985 < t < 1995 \text{ and } 1996 < t < 2007.$$

For the cohort born in year t

$$\tilde{P}(t+1, 0) = B(t) - D_{U}(t, t-Y) - \tilde{W}^{t}(t).$$