Looking beyond differences in life expectancy: Lifespan inequality between Jews and Arabs in Israel

Isaac Sasson[1,2] & Yan Zheng [1]

[1] Department of Sociology and Anthropology, Tel Aviv University
[2] Herczeg Institute on Aging, Tel Aviv University

* Corresponding author: isasson@tauex.tau.ac.il

Abstract

Israel's continued improvements in life expectancy at birth, currently exceeding 82 years for men and women combined, are coupled with persistent and increasing ethnic disparities in longevity. Substantial differences in life expectancy exist between Israel's Jewish majority population and its disadvantaged Arab minority. Although several studies documented Jewish-Arab differences in life expectancy over time, none has examined trends in lifespan variability. Analyzing vital statistics data from 1983 to 2018, we find that life expectancy increased more rapidly among Jews than among Arabs. By contrast, declines in lifespan variation were greater among Arabs, which nevertheless remains high relative to their Jewish counterparts. A contour decomposition of those trends reveals two disparate phenomena. First, Jewish-Arab disparities in infant and child mortality have narrowed over the study period. Second, the Arab old-age mortality advantage, which existed in 1983–1986, had reversed by 2015–2018, accounting for much of the widening gap in life expectancy. We discuss possible explanations for this reversal in age-specific mortality inequalities. The narrowing of infant and child mortality differentials between Jews and Arabs may be attributed to improvements in neonatal care and decreasing prevalence of consanguineous marriages among the latter. The disappearance of the Arab old-age mortality advantage may be related to cumulative exposure to social adversity and institutional discrimination over the life course, improvements in data quality over time, or changes in cohort-based mortality selection.

1 Introduction

Life expectancy at birth in Israel currently exceeds 82 years for men and women combined, placing it at the vanguard along with a handful of other countries (e.g., Japan, Switzerland, Italy, and Spain) (Central Bureau of Statistics 2023a). Yet, in spite of the sustained increase in longevity at the national level, Israel also exhibits substantial gaps in life expectancy at birth between its Jewish majority population and its Arab minority, with the latter at a considerable disadvantage (Chernichovsky and Anson 2005). The Jewish-Arab gap in life expectancy at birth had increased steadily since 1975, reaching 5.2 years among men and 3.9 years among women by 2015 (Central Bureau of Statistics 2023b).

Group differences in life expectancy, a central longevity indicator representing the life table mean age at death, reflect only one dimension of inequality in length of life. Over the past two decades, demographers have shown growing interest in lifespan variability, a complementary measure to life expectancy which indicates the spread of the age-at-death distribution about its mean (Kannisto 2000; van Raalte et al. 2018; van Raalte and Caswell 2013; Wilmoth and Horiuchi 1999). Higher lifespan variation indicates greater heterogeneity in underlying population health, and from an individual perspective potentially translates into greater uncertainty regarding the length of life (Brown et al. 2012; Edwards 2013; Sasson 2016). Past studies have documented higher lifespan variability among US blacks relative to non-Hispanic whites (Firebaugh et al. 2014), among non-Hispanic whites relative to Hispanics (Lariscy et al. 2016), and among less educated relative to college-educated individuals in the US and across Europe (Brown et al. 2012; Permanyer et al. 2018; Sasson 2016; van Raalte et al. 2011, 2012). Together, these studies have shown that the lifespans of minority and lower socioeconomic status

(SES) groups are not only shorter, on average, but also more heterogeneous. To date, no study has examined differences in lifespan variability among ethnic groups in Israel, nor how those differences have changed over time.

Although ethnicity remains a significant predictor of longevity in Israel, Jewish-Arab inequalities in mortality have thus far received little attention in demographic research. In order to fill this gap, the present study examines trends in life expectancy and lifespan variability among Israeli Arabs and Jews from 1983 to 2018. Using the contour decomposition method (Jdanov et al. 2017), we further decompose Jewish-Arab differences in life expectancy and disparity, as well as their evolution over time, into age-specific contributions. Our findings reveal that whereas the Jewish-Arab gap in life expectancy had increased for both men and women, the gap in lifespan variability narrowed for men; among women, it narrowed substantially until the early 2000s but started to widen again thereafter. In both cases, the trend was driven by rising ethnic disparities in old-age mortality, coupled with diminishing disparities in infant and child mortality. We discuss the potential mechanisms underlying those trends, as well as their policy implications and directions for future research. This study underscores the importance of measuring ethnic differences in lifespan variability — in addition to differences in life expectancy — which have rarely been studied outside the US context.

2 Background

2.1 Jewish-Arab Disparities in Life Expectancy at Birth

The population of Israel, numbering 9.7 million, is characterized by high ethnic and religious diversity. Its most salient ethnic divide is undoubtedly between the Jewish majority, constituting 74% of the total population, and the sizable Palestinian-Arab[1] minority (21%), most of which is Muslim (84%) and the remainder Christian (9%) and Druze (7%) (Central Bureau of Statistics 2021). The Arab population of Israel is politically, socially, and economically disadvantaged relative to the Jewish majority, a position dating back to 1948 and the establishment of the State of Israel against the backdrop of the (still ongoing) Israeli-Palestinian conflict. Arab citizens and residents of Israel have, on average, lower levels of formal education, income, and wealth (Okun and Friedlander 2005; Sa'di 1995; Sa'di and Lewin-Epstein 2001; Semyonov and Lewin-Epstein 2011) — all of which are known determinants of health and mortality (Hummer and Lariscy 2011; Marmot 2005).

Spatial segregation also has an important role in accounting for health and mortality inequalities between Arabs and Jews in Israel (Saabneh 2022). Over 70% of the Arab population of Israel resides in towns that are fully segregated from Jewish spaces, often located away from large urban centers (Schnell and Haj-Yahya 2014). As a result, Arabs have limited access to educational and employment opportunities, and receive lower occupational and economic returns on education (Khattab and Miaari 2013). Public healthcare provision, on the other hand, is widely accessible to both Jewish and Arab citizens of Israel. Arabs report *higher* rates of both visits to primary-care physicians (Israel Center for Disease Control 2017) and immunization (Shemesh et al. 2008) relative to the Jewish majority. Nevertheless, geographic maldistribution of resources remains a challenge for Israel's public healthcare system—particularly with

[1] Hereafter I use the general term Arab citizens and residents of Israel (Arab in short) because, on the one hand, not all Arab groups in Israel identify as Palestinian and, on the other hand, Palestinians who are not residents of Israel are excluded from Israeli vital statistics (Palestinians residing in Gaza and the West Bank are covered instead by the Palestinian Central Bureau of Statistics).

respect to specialized care—which disproportionately affects its Arab population (Clarfield et al. 2017).

Prior research on mortality inequalities in Israel pointed to persistent disparities between Jews and Arabs (Chernichovsky and Anson 2005). Arab men and women have had lower life expectancies at birth than their Jewish counterparts since at least the 1970s, when reliable vital statistics by ethnicity first became available. In 1975–1979, the Jewish-Arab gap in life expectancy at birth was 2.5 years among men and 3.3 years among women in favor of the Jewish population (Na'amnih et al. 2010). During the 1980s the same gap narrowed among both genders, but began increasing again in the 1990s, reaching 4.2 years among men and 3.1 years among women by 2008–2012 (Saabneh 2016). In the early years, infant and child mortality played a significant role in explaining the Arab disadvantage in life expectancy. The Jewish-Arab difference in under-5 mortality accounted for over *half* of the gap in life expectancy at birth during the late 1970s, compared with less than 15% three decades later (Saabneh 2016). In other words, while the Arab disadvantage in life expectancy persisted and even widened in recent decades, its origins had gradually shifted to older ages.

The shift in mortality disadvantage from younger to older ages coincides with the rapid epidemiological transition that the Arab minority has undergone in recent decades (Tarabeia et al. 2012). As preventable communicable diseases declined in the Arab population of Israel, chronic and degenerative diseases became more prominent. According to the Israel National Health Interview Survey, Arabs report substantially higher rates of smoking, obesity, and diabetes relative to Jews, as well as lower rates of physical activity (Israel Center for Disease Control 2017). Consequently, the main causes of death contributing to the gap in life expectancy between the two ethnic groups are heart disease, diabetes, and cancer (Chernichovsky et al. 2017; Saabneh 2016).

Prior research on mortality inequalities in Israel, however, has focused primarily on between-group ethnic differences in life expectancy. The present study examines in addition the dynamics of lifespan inequality within each ethnic group, and how patterns of Arab mortality advantage and disadvantage, by age, have changed over time.

2.2 Looking Beyond Differences in Life Expectancy: Lifespan Inequality, Mortality Differentials by Age, and Mortality Crossover

Recent research on social inequalities in mortality has highlighted the importance of looking beyond group differences in period life expectancy. While the life expectancy remains a key indicator of population health, it is now widely recognized that it can mask substantial inequality in length of life within national populations or social groups (van Raalte et al. 2018). Much like countries with similar GPD per capita can vary in their levels of income inequality, populations with similar levels of life expectancy can differ substantially with respect to lifespan inequality (Vaupel et al. 2011). In other words, whereas life expectancy is a measure of average performance, lifespan inequality is a measure of fairness. Greater inequality or variability in length of life indicates that lifespans are less equally distributed about the mean age at death. Demographers have thus called for supplementing central longevity indicators with measures of variability in length of life (Edwards and Tuljapurkar 2005; OECD 2007; Wilmoth and Horiuchi 1999).

Studies comparing lifespan inequality across racial/ethnic groups have thus far focused almost exclusively on the US population. A few studies reported, for example, that black Americans have higher lifespan variability than white Americas, in addition to lower life expectancy at birth (Edwards and Tuljapurkar 2005; Firebaugh et al. 2014; Sasson 2016). By contrast, Hispanic Americans have lower lifespan variability than white Americans (Lariscy et al. 2016). Outside of the US, however, studies on lifespan inequality across ethnic groups have been limited and often indirect. A recent study in Finland found that regions with a high proportion of Swedish speakers have consistently shown both higher life expectancy and lower lifespan variability than other parts of the country (Wilson et al. 2020). Yet, studies comparing lifespan inequality across ethnic groups remain scarce and none to date have focused on Israel, a country in which, much like the US, ethnicity remains a key predictor of health and longevity.

Drawing on the extant literature, there are two important caveats to studying trends in lifespan inequality. First, lifespan inequality can increase over time even under favourable conditions—for example, when mortality declines across all age groups but does so at a faster rate among the old relative to the young (Zhang and Vaupel 2009). It is therefore critical to consider the age pattern of mortality decline when evaluating temporal changes in lifespan inequality. Second, unobserved heterogeneity in mortality risk may disguise how mortality inequalities unfold with age, giving rise to mortality crossovers between social groups (Wrigley-Field 2014). Perhaps the most researched mortality crossover concerns the racial divide in the US, in which the mortality rate among blacks falls below that of whites at advanced ages (Johnson 2000; Manton et al. 1979). Several explanations for this phenomenon have been put forth, including age misreporting on death certificates among blacks (Coale and Kisker 1986; Preston and Elo 2006), differential mortality selection (Lynch et al. 2003), and variation in cohort mortality patterns underlying period mortality (Masters 2012). Other mortality crossovers between advantaged and disadvantaged social groups have been documented — for example, between Native Americans and white Americans (Thornton 2004) — but seldom outside the US and no such study has been conducted in Israel. The present study thus aims to address this lacuna and offer a detailed account of mortality and lifespan inequalities between Jews and Arabs in Israel.

3 Data and Methods

3.1 Data

The analysis is based on vital statistics data obtained from the Israel Central Bureau of Statistics. Raw death and midyear population counts were made available in single-year age intervals (0 to 95+), by gender and ethnicity, from 1983 to 2018. A total of 1,284,252 deaths were recorded among Jews and Arabs combined over the 36-year period. Since far fewer deaths occurred in the Arab minority—only 10.3% of the total—four-year periods were grouped together (1983–1986, 1987–1990, …, 2015–2018) to ensure that the number of deaths in each cell (period × ethnicity × gender) was sufficient (see Table 1 for breakdown by ethnicity, gender, and period). Age-specific mortality was smoothed over age and time without imposing a model structure (Camarda 2012) and extended to age 110 using the Kannisto model of old-age mortality (Thatcher et al. 1998). Following the Human Mortality Database methods protocol (Wilmoth et al. 2020), the Kannisto model was applied to mortality rates beyond the age in which death counts first fell below 100, or otherwise from age 90 and over.

Mortality data may conceal systematic biases as numerator-denominator mismatch and age misreporting, which, respectively, tend to overestimate social disparities and underestimate old-age mortality (Preston et al. 1999; Shkolnikov et al. 2007). Israeli mortality data, however, are on the whole impervious to such biases because death certificates are uniquely linked to the national population register using national identity numbers. For that reason, age misreporting at the time of death is unlikely, except in cases in which the date of birth had been erroneously recorded in the population register. Israel held its first national census in 1948, which also served the function of registering its citizenry (Leibler and Breslau 2005). Registration was completed in the years that followed and, since 1961, Israeli population estimates and vital statistics are based upon its *de jure* population, pertaining to citizens and permanent residents only (thus excluding Palestinians residing in Gaza and the West Bank). Given that birth registration in Israel is considered accurate and complete, data quality may be *potentially* compromised for two groups: individuals born prior to 1948 (Jewish or Arab) and immigrants arriving in Israel after 1948 (predominantly Jewish). Previous research, however, found no evidence of systematic age overstatement among the latter group—including Jewish immigrants arriving from Western Asia and Northern Africa, where such bias was initially suspected (Friedlander et al. 1995).

3.2 Analytical Strategy

Life expectancy at birth (e_0) and life disparity ($e^\dagger$), a measure of lifespan variability, were calculated in each 4-year period by gender and ethnicity. Life disparity can be interpreted as the average number of life years lost at death (Zhang and Vaupel 2009) and it is highly correlated with other indices of lifespan variation (van Raalte and Caswell 2013). In addition to documenting Jewish-Arab differences in life expectancy and life disparity over time, a key objective of this study was to decompose those differences by age.

The contour decomposition method decomposes differences in life table functions between two groups by age (Jdanov et al. 2017). Importantly, the method produces additive components of the life table function (e.g., life expectancy, life disparity), which correspond to the initial differences in age-specific mortality rates as well as to changes in those rates over time. In other words, the sum of age-specific contributions to both the initial difference (T1) and the trend (Δ) equal the age-specific contributions to the difference at the end of the study period (T2). A recent study by Saabneh (2022) applied the contour decomposition method to Jewish-Arab differences in life expectancy at birth, comparing the periods of 1990-1994 and 2010-2014. Here we extend the study period, starting a decade earlier and ending in 2018; we further extend the analysis to Jewish-Arab differences in life disparity, in addition to differences in life expectancy.

We apply the contour decomposition to the difference in life expectancy and life disparity between Israeli Arabs and Jews, from 1983 to 2018. The results will indicate which age groups had contributed most to the difference between the two groups in the early 1980s, and how changes in age-specific mortality since then have shaped near-present mortality inequalities. We end our analysis just prior to the COVD pandemic because COVID mortality was disproportionately higher among the Arab population of Israel and represents a break from the long-term trend (Haklai et al. 2022). We do not have sufficient post-pandemic data to determine the long-term impact of the pandemic on Jewish-Arab inequalities in life expectancy and disparity. We conducted additional analyses, described in the Appendix, to determine whether our results could be driven by data quality issues or age misreporting. The results indicate no evidence for such biases.

4 Results

4.1 Jewish-Arab Differences in Life Expectancy at Birth

Life expectancy at birth increased for both Arab and Jewish men and women over the past three decades. However, it increases more rapidly in the Jewish population compared to the Arab population of Israel. Consequently, the Jewish-Arab gap in life expectancy at birth had increased substantially since 1983 (Figure 1) for both men (Panel A) and women (Panel B). Among men, the gap was as low as 1.5 years in favor of the Jewish population in 1983 –1986, but increased to 4.0 years by 2015–2018. Over the same period, the gap similarly widened among women, increasing from 2.0 to 3.3 years. However, whereas the gap increased steadily among men, particularly since the early 2000s, among women it had increased in the 1990s but narrowed again during the last decade.

A contour decomposition of these trends sheds light on how changes in age-specific mortality rates, in each group, have contributed to the overall difference in life expectancy at birth (Figure 2). Among men (Panel A), it appears that in 1983–1986 the Jewish advantage was attributed to lower infant, child, and middle-age mortality. However, these were counterbalanced by an Arab old-age mortality (70 and older) advantage. Over time, Jewish-Arab differences in infant and child mortality had diminished, though still existed in 2015–2018, whereas the old-age Arab mortality advantage had reversed. Currently, most of the 4.0-year Jewish advantage in male life expectancy is attributed to old-age mortality.

The results are substantively similar among women (Panel B), with an initial Jewish advantage in infant and child mortality and an Arab advantage in old-age (80 and older) mortality. By 2013–2018, Arab women had become disadvantaged in nearly all age groups except for the oldest-old (90 and older), causing the gap in life expectancy to nearly double from 2.0 to 3.3 years.

4.2 Jewish-Arab Differences in Life Disparity at Birth

Trends in life disparity complement those in life expectancy and indicate how much heterogeneity in length of life exists in each gender-ethnicity group. Life disparity, the average number of life years lost at death, declined in all groups over the study period (Figure 3). Among men (Panel A), it declined from 12.0 to 10.4 years for Jews and from 14.1 to 11.6 years for Arabs. Among women (Panel B), it declined from 10.7 to 9.1 years for Jews and from 12.3 to 10.3 years for Arabs. One noteworthy exception is that whereas life disparity declined steadily for most groups, among Arab women the downward trend has plateaued in the early 2000s. Overall, however, the lifespans of Arab and Jewish men and women had become less heterogeneous between 1983–1986 and 2015–2018. Furthermore, in contrast to life expectancy, declines in life disparity were greater among Arabs than among Jews.

Nevertheless, Jewish men and women still exhibit lower levels of lifespan variability compared with their Arab counterparts. Among men, the Jewish-Arab gap in life disparity decreased from 2.2 to 1.2 years; among women, the same gap decreased from 1.7 to 1.2 years. The contour decomposition (Figure 4) reveals that life disparity among Arab men (Panel A) and women (Panel B) was higher in 1983–1986, because they had higher infant and child mortality but lower old-age mortality compared with the Jewish population. This caused Arab lifespans to be more varied than Jewish lifespans. Over time, the Jewish-Arab gap in life disparity has narrowed because Arabs had become less disadvantaged with respect to infant mortality, but also because they had lost their old-age mortality advantage.

4.3 The Evolution of the Jewish-Arab Mortality Crossover

Figure 5 shows the age in which the crossover in mortality rates between Jews and Arabs occurs. Between 1983 and 2018, Arab men and women had higher mortality rates than their Jewish counterparts from birth to middle age. However, Arab mortality rates gradually converged, and eventually fell below the mortality level of the Jewish population. This pattern indicates an advantage in old-age survival among Arabs relative to Jews of the same age.

More specifically, among men, the age of mortality crossover between Arabs and Jews increased consistently from 69 years in 1983-1986 to 99 years in 2015-2018. Among women, a somewhat different pattern is observed. In 1983-1986, the crossover age between Arab and Jewish women was 78 years, and it increased gradually over time and surpass 100 years by 2004-2009. However, this rise was followed by a substantial decline to 94 years in 2015-2018. Since mortality beyond age 95 is model-based, we do not interpret the changes occurring beyond that threshold. However, it is clear that for both genders there has been a steady rise in the mortality crossover age throughout most of the study period.

5 Discussion

Between 1983 and 2018, life expectancy at birth increased for Arab and Jewish men and women in Israel. However, consistent with recent studies (Chernichovsky et al. 2017; Saabneh 2016), increases in life expectancy were greater among the Jewish population compared with the Arab population, placing the latter at a greater disadvantage. In addition, this study documented trends and group differences in lifespan variability. Our findings suggest that life disparity decreased in all groups since 1983, but more so among Arab men and women. As a result, the Jewish-Arab gap in life disparity has narrowed over the study period.

In the early 1980s, Jewish-Arab differences in both life expectancy and life disparity reflected higher infant and child mortality among Arabs relative to Jews, coupled with an Arab old-age mortality advantage. By 2018, the Arab population had lost its old-age mortality advantage while narrowing the gap in infant and child mortality. The combined effect was an overall widening of the gap in life expectancy and a narrowing of the gap in lifespan variability. These findings underscore the importance of using multiple measures, of both central tendency and spread, in the study of inequalities in length of life.

Over the past three decades, Jewish-Arab mortality inequality in Israel has changed in two important ways. First, the long-standing Jewish-Arab gap in infant and child mortality has narrowed substantially. Infant mortality declined in Israel since the 1950s due to continued improvements in preventive and curative neonatal care, which contributed to a reduction in ethnic disparities (Amitai et al. 2005). In addition, consanguineous marriages, which are associated with greater risk of congenital malformations, have become less prevalent among Muslims in Israel (Sharkia et al. 2008). These factors have likely contributed to the rapid decline in infant mortality experienced by Israeli Arabs, although it remains higher than Jewish infant mortality. Second, the Arab old-age mortality advantage, which existed in 1983, had reversed by 2018. In contrast to infant and child mortality, old-age mortality is generally attributed to chronic diseases which develop over the life course, often as a result of exposure to social adversity (Dannefer 2003; Hatch 2005). Although public healthcare provision is widely accessible to both Arabs and Jews in Israel (Clarfield et al. 2017), Israeli Arabs have worse health outcomes associated with their lower socioeconomic status and greater exposure to traumatic events (Osman and Walsemann 2013). Furthermore, Israeli Arabs often report suffering from both interpersonal and institutional discrimination, which has been linked to adverse health outcomes in the US (Geronimus et al. 2006), although similar studies in Israel have thus far been inconclusive (Epel et al. 2010; Osman et al. 2018).

5.1 Limitations

The trends in life expectancy and life disparity documented in this study are based on period mortality, which combines multiple birth cohorts into a single synthetic cohort. Some caution should be exercised in drawing conclusions. An alternative explanation for the disappearance of the Arab old-age mortality advantage may be associated with data quality. In the US, age misreporting among blacks has been suggested as an explanation for their exceedingly low mortality at ages 85 and older in vital statistics (Preston and Elo 2006). Others have shown that the black-white mortality crossover persists even when the data are adjusted, and the age in which the crossover occurs tends to increase over time (Fenelon 2013; Lariscy 2017; Lynch et al. 2003). Aside from issues related to data quality, the mortality crossover could be explained by cohort-based mortality selection (Masters 2012). If a birth cohort is subjected to a higher mortality regime throughout its life course, survivors would tend to be especially robust, thus having lower old-age mortality rates than expected (Wrigley-Field 2014). This explanation has yet to be studied in the Israeli context. However, past Arab cohorts have been exposed to higher mortality and emigration rates during the mass expulsion of 1948 and its aftermath, likely rendering those who have remained in Israel select in various ways.

5.2 Conclusion

The Jewish-Arab gap in life expectancy has increased over the past three decades, rendering the Arab population of Israel increasingly disadvantaged. However, underlying this change are two disparate trends. First, the Arab disadvantage in infant and child mortality has decreased over time, contributing to a reduction in ethnic disparities in life expectancy. The rapid decline in Arab infant mortality is possibly related to improvements in neonatal care and declining consanguineous marriages among Muslims. Second, the Arab old-age mortality advantage has reversed and now accounts for most of the gap in life expectancy at birth. Although public healthcare is widely accessible to both Arabs and Jews in Israel, the persistence of ethnic disparities in health may be associated with life-long exposure to social adversity and institutional discrimination experienced by many Israeli Arabs.

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Table 1. Number of deaths by ethnicity and gender, Israel 1983-2018.

	Jews			**Arabs**		
Period	**Men**	**Women**	**Total**	**Men**	**Women**	**Total**
1983 – 1986	53,930	47,617	101,547	6,007	4,976	10,983
1987 – 1990	54,695	49,157	103,852	6,225	5,220	11,445
1991 – 1994	61,123	57,020	118,143	6,619	5,617	12,236
1995 – 1998	65,044	63,617	128,661	7,171	5,706	12,877
1999 – 2002	66,450	66,755	133,205	8,021	6,079	14,100
2003 – 2006	66,039	68,537	134,576	8,563	6,689	15,252
2007 – 2010	66,580	70,158	136,738	9,359	6,982	16,341
2011 – 2014	69,703	73,461	143,164	10,185	8,056	18,241
2015 – 2018	75,302	76,793	152,095	11,768	9,028	20,796
Total	578,866	573,115	1,151,981	73,918	58,353	132,271

Figure 1. Trends in life expectancy at birth for Israeli Arabs and Jews, 1983–2018.

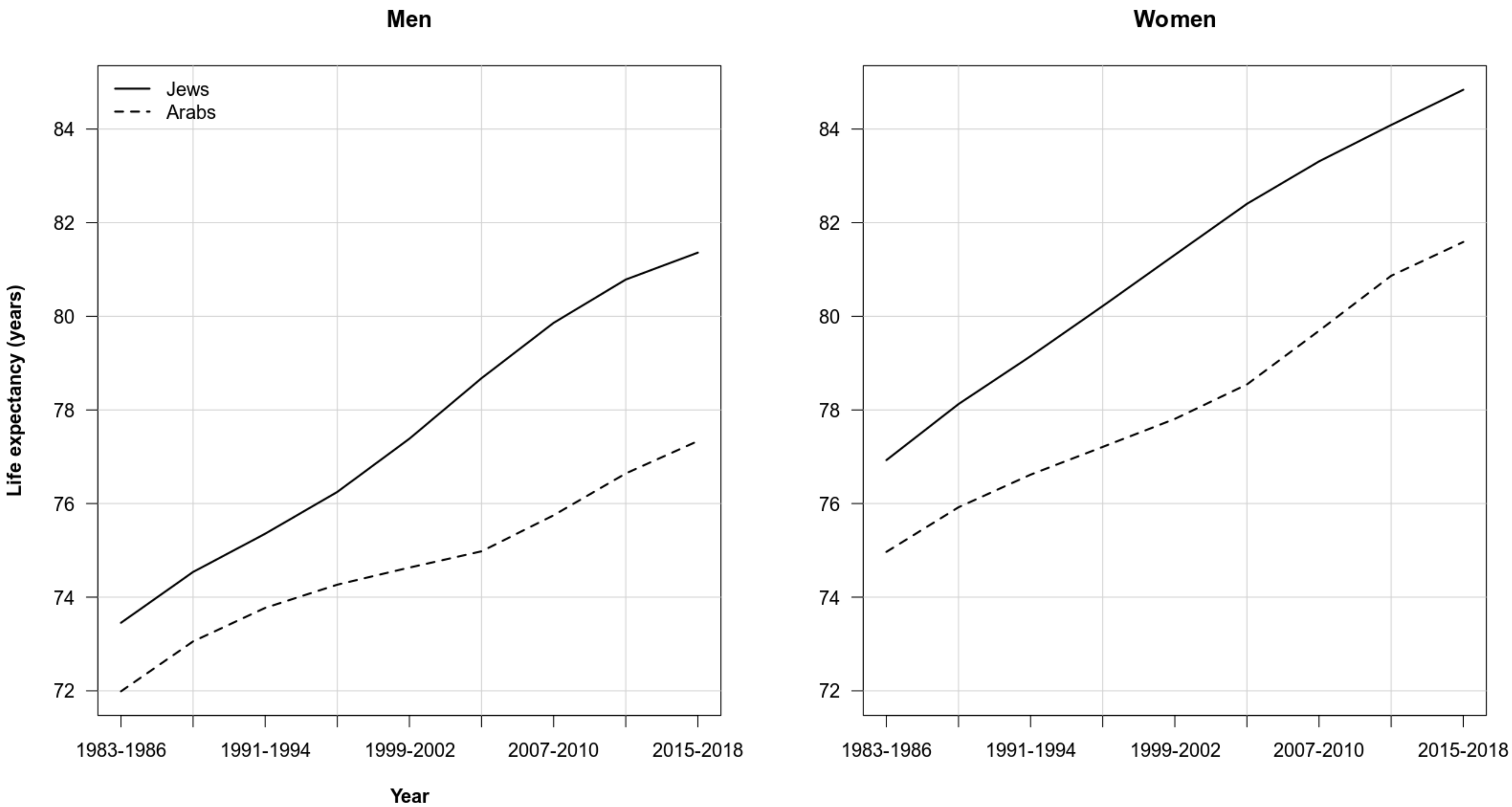


Figure 2. Contour decomposition of change in difference in life expectancy at birth between Israeli Arabs and Jews, 1983–2018.

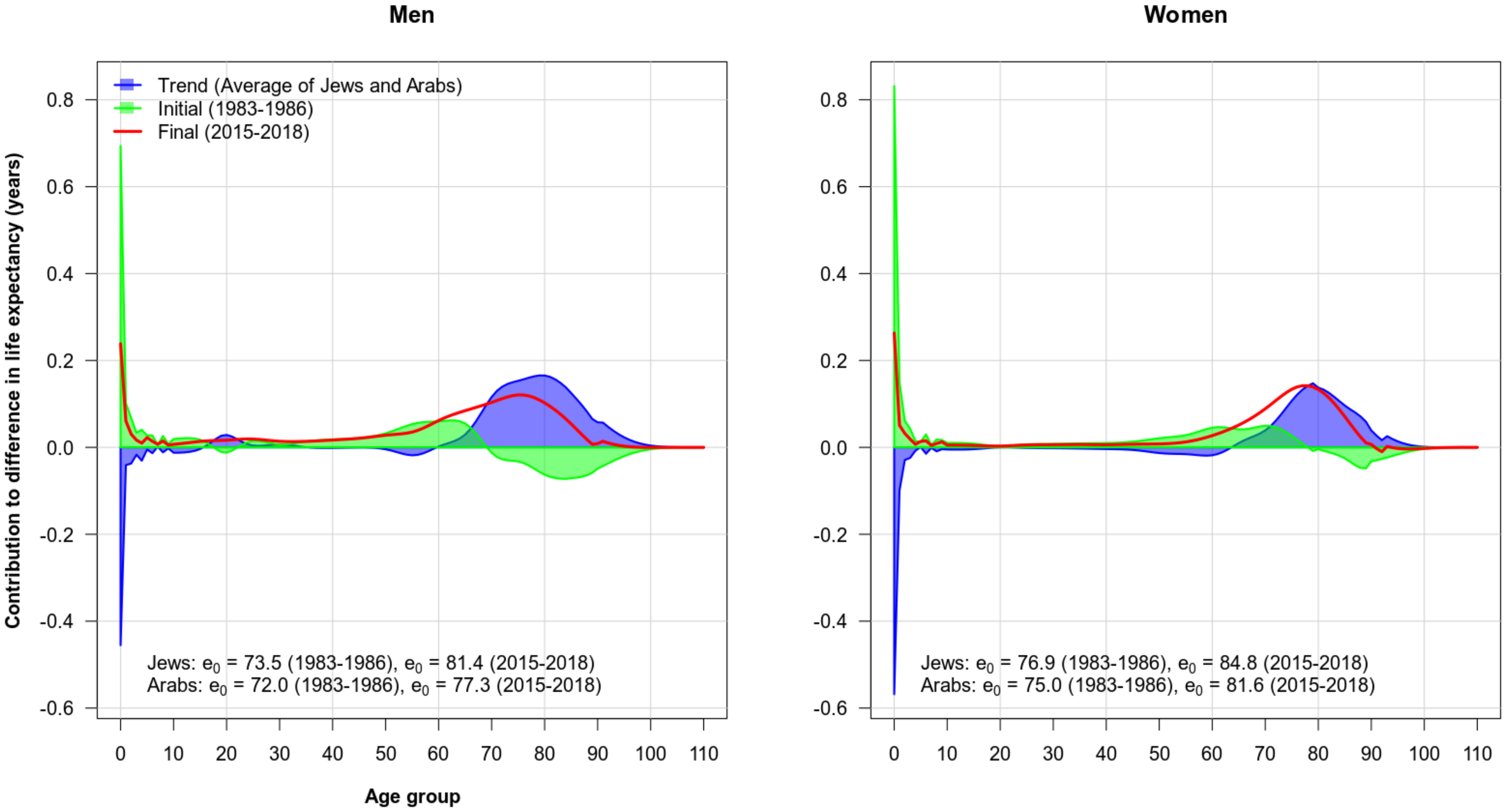


Figure 3. Trends in life disparity at birth for Israeli Arabs and Jews, 1983–2018.

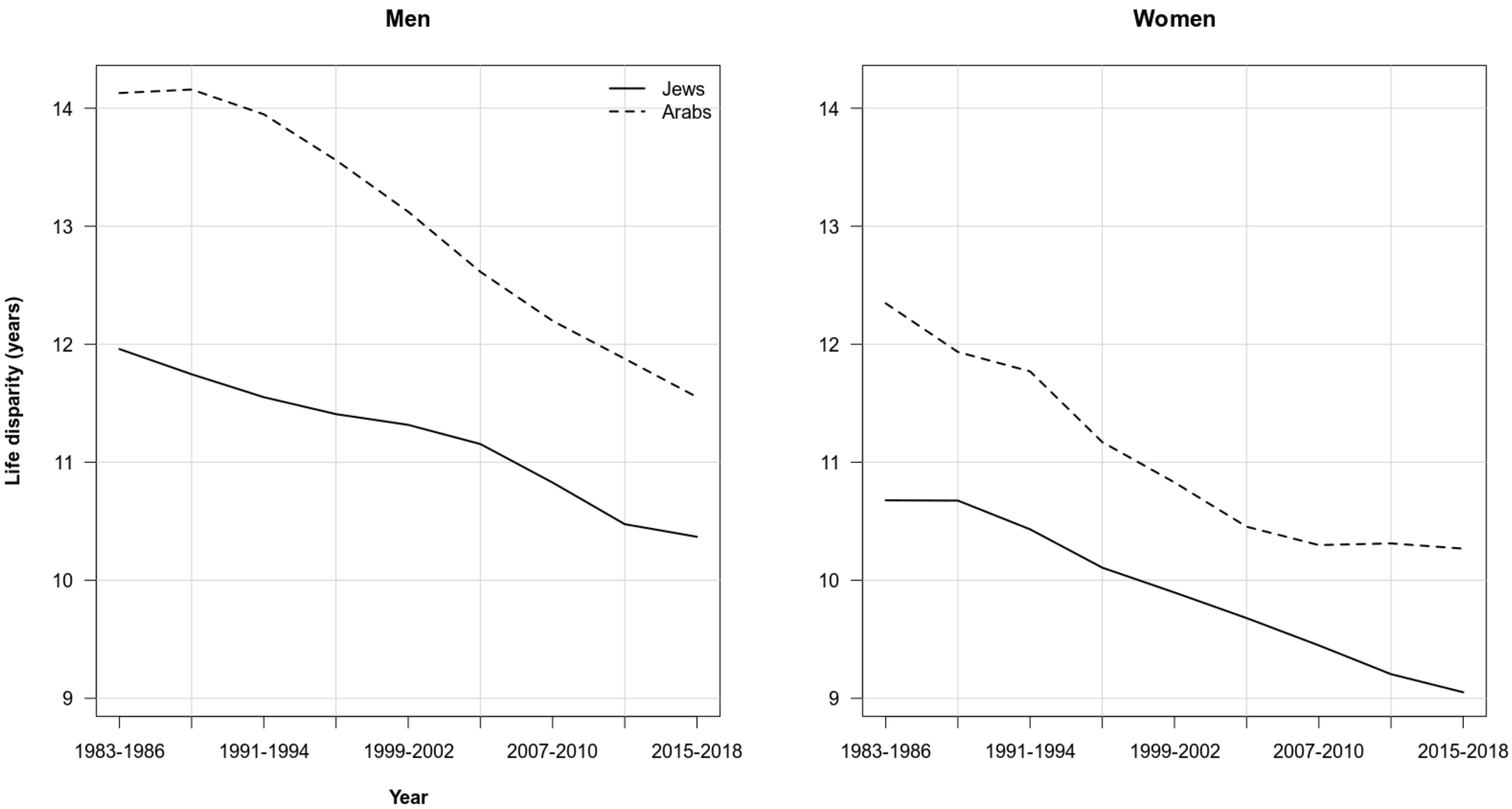


Figure 4. Contour decomposition of change in difference in life disparity at birth between Israeli Arabs and Jews, 1983–2018.

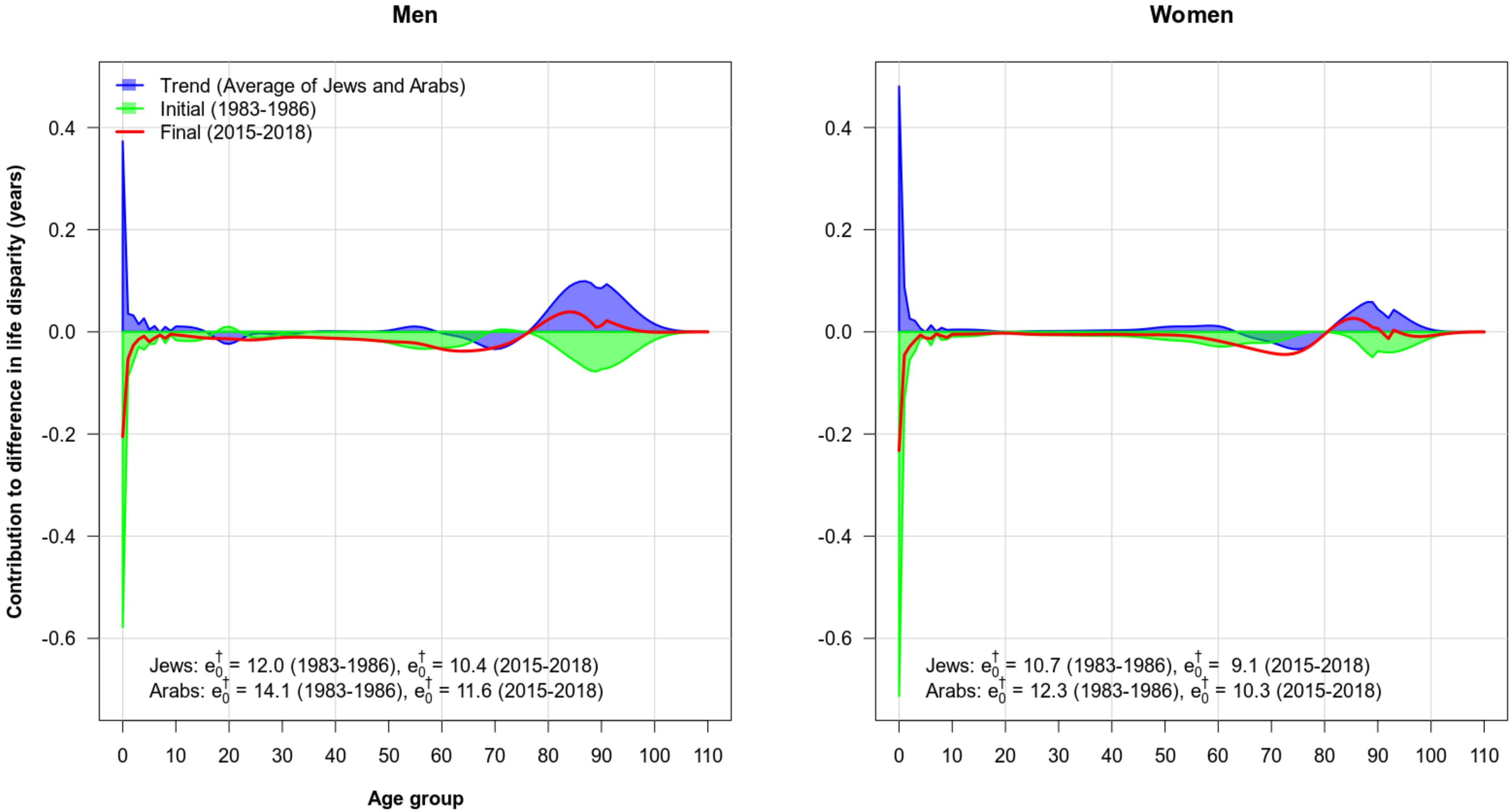


Figure 5. Mortality crossover age between Israeli Arabs and Jews, 1983–2018.

Appendix

We applied Myers (1954) blended index to determine whether there is digit preference in the age distribution of reported number of deaths. This index was often used to measure the preference for ages ending in any of the 10 digits (0-9), with the value ranging from 0 (no age heaping) to 90 (all reported ages end in the same terminal digit). The calculation of this index includes following main steps (2004):

1. Sum of populations ending in each digit over the whole range starting with the lower limit of the range (e.g., 10, 20, 30,…, 80; 11, 21, 31,…, 81);

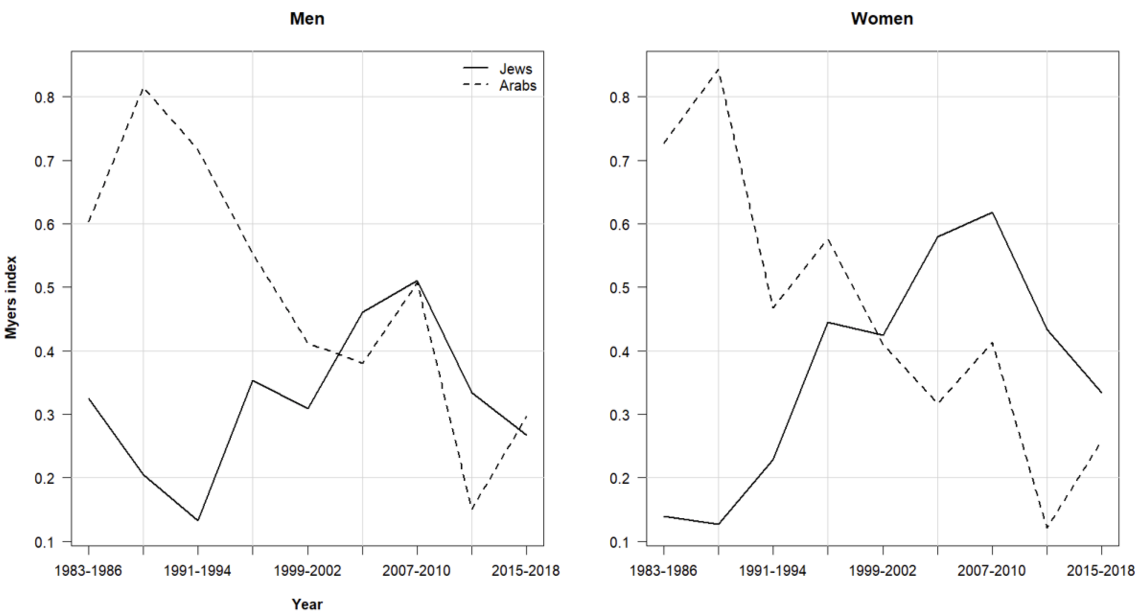
2. Ascertain sum excluding the first population combined in step 1 (e.g., 20, 30, 40,.., 80; 21, 31, 41,…, 81);

3. Weight the sums in steps 1 and 2 and add the results to obtain a blended population (e.g., weights 1 and 9 for 0 digit; weights 2 and 8 for 1);

4. Convert distribution in step 3 into percentages;

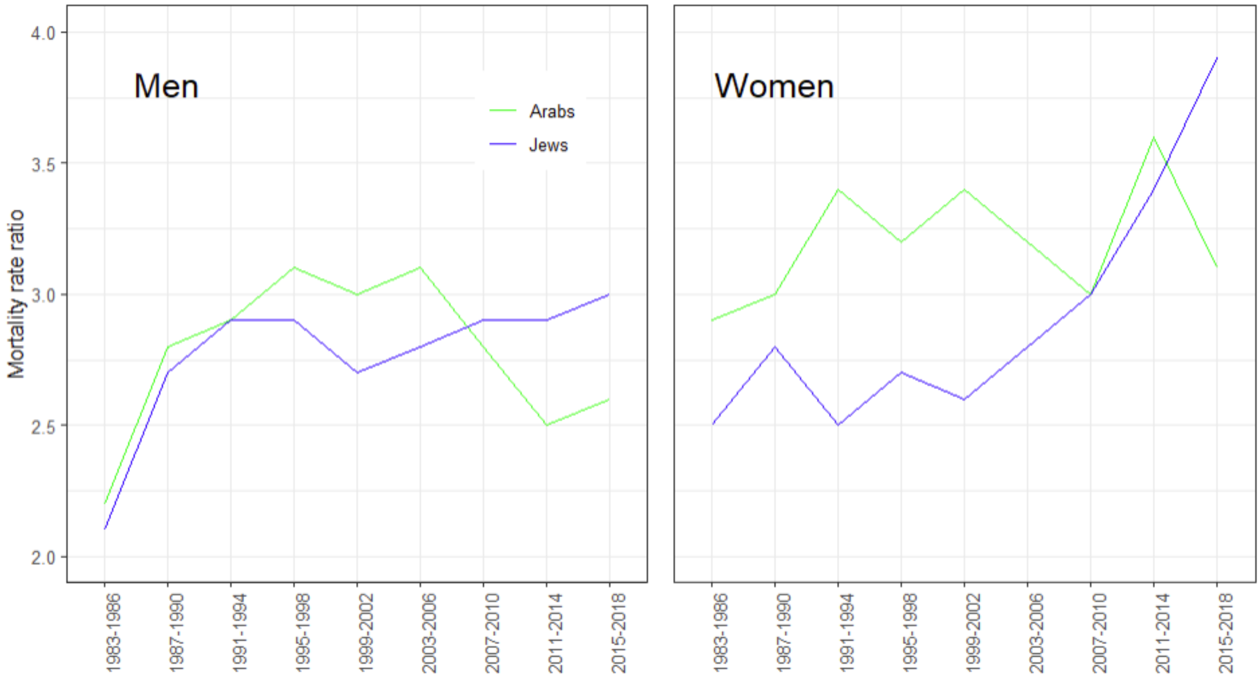
5. Take half the sum of the absolute deviations of each percentage in step 4.

Figure A1. Myers index for age heaping in the number of deaths



The estimated results were presented in Figure A1. Both Jewish and Arabic population scored less than 1 on the Myers blended index throughout the study period, suggesting no age heaping was detected regarding the reported number of deaths across single ages. This also shows that current evaluation using reported age-specific death data are reliable.

Figure A2. Mortality rate ratios comparisons between Arabs and Jews



We compared the mortality rate ratios in different periods for both Arabs and Jews, so as to find out if there are anomalies for observed subgroups of population. Specifically, we computed the mortality rate ratio ${}_5m_{40}/{}_5m_{30}$ in 1983-1986, ${}_5m_{45}/{}_5m_{35}$ in 1987-1990, and then ${}_5m_{50}/{}_5m_{40}$ in 2015-2018, etc., for Arabs and Jews, separately. The results were presented in Figure A2. The pattern appears pretty similar across Jews and Arabs (especially for men) though there are some expected fluctuations due to small cell sizes. Therefore, the life expectancy and disparity results based on the data we use are valid.