**The "Sick immigrant" and "Healthy immigrant" phenomenon**

 **among Jews migrating from the USSR to Israel**

**Abstract**

The “healthy immigrant” phenomenon attributes health benefits to immigrants. We examined this phenomenon using the relationship between immigration and mortality, by income level, among Soviet immigrants to Israel in the 1990s, in comparison to veteran immigrants with similar genetic makeup.

A retrospective cohort study of mortality during 1996–2016 was conducted among 99,037 immigrants born during 1940–1955 in the USSR or Eastern Europe who immigrated during 1990–1995, compared to a control group of 119,150 Jews born during 1940–1955 who and/or whose parents were born in those same countries and immigrated by 1960.

After adjusting for gender, age, income and marital status, we found higher mortality rates among immigrants compared to non-immigrants for the total study population (adjusted hazard ratio (AHR) = 1.297, 99% confidence intervals (CI) = 1.248, 1.348) and among 27,563 men (AHR = 2.941, 99%CI = 2.704, 3.199) and 32,220 women (AHR = 1.756, 99%CI = 1.614, 1.909) with low incomes . The opposite relationship was found for 45,863 men (AHR = 0.714 ,99%CI = 0.635, 0.804) and for 24,852 women (AHR = 0.738 ,99%CI = 0.596, 0.913) with high incomes.

For the total study population, we found support for the “sick immigrant” phenomenon. However, both genders in the high-income subgroup, and women in the middle-income subgroup, demonstrated the “healthy immigrant” phenomenon. Decision makers in Israel should devote particular attention to immigrants from a low socioeconomic level. Our results emphasize the need for social stratification when examining the relationships between immigration and health outcomes.

**Keywords:** healthy immigrant**;** sick immigrant **;** mortality; gender; Israel

**Introduction**

In the 1990s, approximately one million immigrants from the USSR were brought to Israel [1] by authority of Israel’s Law of Return [2], which allows every member of a Jewish family to immigrate to the country. Previous studies conducted on these immigrants demonstrated poorer health outcomes compared to the local population [4-5]. In contrast, another study reported a certain advantage for life expectancy among female immigrants compared to non-immigrants; an opposite trend was found for males [3]. This result contradicts the results from studies conducted in the West, which reported a health advantage for immigrants compared to the local population [4, 6], in particular in countries that absorb immigrants with good health and welfare systems [6].

Besides the fact that immigrants usually come from countries with high health risks, the mental stress, low socioeconomic status and language barriers faced by immigrants when dealing with the healthcare system make it difficult to explain the “healthy immigrant” phenomenon [6]. Some explain the paradox by the advantage of correct health behavior, social support and genetic advantages [4, 6-7]. In contrast, some see this phenomenon as being biased in several ways, for example: immigration of healthy, strong people, intentional registration biases when entering the country of destination, filtering of health immigrants by the absorbing countries, a tendency of weak immigrants to return to their mother country named the “salmon effect” – in which immigrants with weakening health tend to return to their mother country prior to their death [4, 6-7].

In addition to these selection biases, we suggest that the groups compared in previous studies usually included the general population of the absorbing country without accounting for variance in genetic and cultural traits, which may provide an explanation for the differences in health outcomes and morbidity. The presence of a large population of veteran Jewish immigrants, who reached Israel from the same countries, and who have similar genetic and possibly cultural traits, allowed us to more accurately examine the relationship between immigration and mortality, in an immigration-absorbing country [2] in which the immigrant receives extensive health services provided within the framework of a national health insurance law [8].

Furthermore, in contrast to the global phenomenon of relatively young individual immigrants, mass immigration of Soviet Jews to Israel during the 1990s included groups and entire families covering a range of ages, who were ‘brought’ to Israel during a short period, without any selection, encouraged by Israel’s prevailing immigration policy, due to the situation in the USSR at that time. This immigration was characterized by a higher level of education, lower income level, and higher proportion of women, with a lower proportion of married women, in comparison to the general Jewish population in Israel [1]. The unique characteristics of this immigration group, which includes educated, but relatively low-income earners, prompted us to examine the role of income level in the relationship between immigration and mortality.

This study aimed to examine the relationship between immigration and mortality from any cause of death, by income level, among people immigrating from the USSR during 1990–1995, in comparison to veteran immigrants who, or their parents, had immigrated from the USSR and Eastern Europe by 1960.

**Methods**

Using data gathered from several sources (Population Registry, Tax Authority, Education Registry, Ministry of Health), a retrospective cohort study was conducted on mortality by any cause of death during the 21 years from 1/1/1996 to 31/12/2016. The data were gathered and combined for this study by the Israel Central Bureau of Statistics (CBS). Data analysis was conducted in the CBS research room.

This study was approved by the Ethics Committee of the Population Registry, Tax Authority and CBS. All statistical analyses extracted from the CBS research room were approved as meeting ethical standards.

*Study population*

The study group (immigrants) included 99,037 people born during 1940–1955 who immigrated to Israel during 1990–1995 and were born in a former Soviet state or Eastern European country, not including 3,533 registered as natives of Ukraine and 677 registered as natives of Belarus We chose not to include immigrants that may have come from the region of the Chernobyl disaster, [9] which is considered to have potentially long-term health outcomes.

The control group included 119,150 Jews born during 1940–1955 who, and/or one of their parents, were born in an Eastern European country or former Soviet state (including Ukraine and Belarus) and reached Israel by 1960.

*Research variables*

The variables year of birth, gender, country of birth, year of immigration to and/or emigration from Israel were obtained from the Population Registry.

Marital status at the beginning of the monitoring period, as obtained from the Population Registry, was converted into a dichotomous variable in which ‘single’, ‘divorced’ and ‘widowed’ were defined as ‘unmarried’.

Socioeconomic status by residential area, in which the individual lived during 2017 or during his/her last year of life, was based on the 2013 socioeconomic index of the community of residence, as obtained from the CBS, and classified into socioeconomic levels for community of residence on a scale of 1-10. We classified this variable into low (1-5), middle (6-7) and high (8-10) socioeconomic status.

The highest relative income level per individual during the monitoring period was based on data obtained from the Tax Authority regarding individual income from wages or from annual business earnings (not including income from dividends, national insurance or any other income which is not wages or self-employed work). These data were obtained for the years 1996 and 2016 and for the years that the individual reached the age of 50 and/or 60 and/or 65 and/or 70 during the monitoring period. In the first stage towards building a unified variable, the income distribution of the entire study population in each of these years was divided into deciles. Based on this distribution, individual income level was determined according to the relative decile for each year separately. These variables were grouped into a unified variable that represents the highest relative income level reached by the individual during the monitoring period. This unified variable was classified into three categories: Low income level, in which the individual reached a relative income level of decile 3, at the most; Middle income level, in which the highest relative income level of the individual during this period stood at deciles 4–7; and High income level, in which the highest relative income level of the individual during this period stood at deciles 8–10.

Education level was constructed using data obtained from the Education Registry, managed by the CBS and based on education data from different sources such as academic institutions, Ministry of Education, sample surveys and censuses. We classified these data into three education levels: High – 15 years of education or more; Intermediate – 11-14 years of education; and Low – up to 10 years of education.

The effect variables for this study – mortality and year of death – were obtained from the Population Registry, based on data from the Ministry of Health and death certificates.

*Statistical analysis*

We first examined the distribution of the variables gender, age, marital status, education, socioeconomic status by residential area and immigration/emigration of immigrants and non-immigrants. Chi-square test was used to compare frequency distributions of categorical variables and t-test was used for age.

Second, mortality rates were examined with respect to the variables immigration, gender, marital status, education and socioeconomic status by residential area. Adjusted Hazard Ratio (AHR) for mortality, even after adjusting for age and/or gender, were used to compare mortality rates between groups.

We note that due to a relatively high rate of missing information for the education variable among non-immigrants (20%), and a high correlation between this variable and the income variable, we decided not to include the education variable in the models in the remainder of the analysis.

Third, using Cox regression and adjusted Kaplan Meier curves we constructed models to evaluate the relationship between immigration and mortality, after controlling for gender, age, income level and marital status and their interactions. Likelihood ratio tests were used to compare between models, as described in detail in Online Resource 1. Effect estimates are presented as hazard ratios (HRs) and 99% confidence intervals (CIs) of a death associated with immigration group or with other covariates.

In Model 1 we included, in addition to immigration group, gender, age, income level and marital status. In Model 2, we added to the variables in the first model the following interactions: gender X immigration, gender X income and immigration X income. In Model 3 we added to the variables in Model 2 a three-way interaction between mortality, gender and income.

Last, to better understand the interaction between immigration gender and income, we divided the study population into six groups by income level (3) and gender (2). Cox regression and adjusted Kaplan Meier curves were used to analyze associations between mortality and immigration within each group, controlling for age and marital status.

People who emigrated from Israel during the study period and did not return by the end of the study period did not have information about death. They were considered censored and contributed to the number at risk in the survival analyses until the year they left Israel.

All statistical analyses were conducted using SPSS version 23.0

**Results**

*Demography*

The study population included 218,187, with 99,037 (45.4%) immigrants and 119,150 (54.6%) non-immigrants. The percentage of women in the immigrant population was higher (52.3%) than in the non-immigrant population (46.9%) (p<0.001). Immigrants were older, more educated, lived in areas with lower socioeconomic status, and received lower incomes than non-immigrants (p<0.001). Similarly, the proportion of married immigrants among males at the beginning of the study period was higher than that of non-immigrants (83.8% vs.77.0%) (p<0.001) and lower among females than non-immigrants (69.1% vs.75.1%) (p<0.001) (Table 1).

*Deaths*

The overall death rate during the study period among the 218,187 participants in the study was 9.4%. Examination of the distribution of mortality rate by study variable (Table 2) showed that the mortality rate was higher among immigrants than non-immigrants (10.7% vs. 8.3%) even after adjusting for age and gender (AHR = 1.337, 99% CI = 1.290, 1.386). Similarly, a higher mortality rate was found even after adjusting for gender and age among those who were not married at the beginning of the study period, compared to those who were married (AHR = 1.337; 99%CI = 1.285, 1.392).

When examining the role of the socioeconomic variables in predicting mortality after adjusting for gender and age, mortality rates were found to be higher for people with low (AHR = 2.277; 99%CI = 2.162, 2.397) and intermediate (AHR = 1.362; 99%CI = 1.303, 1.424) levels of education compared to those with a high level of education. Likewise, higher mortality rates were found among low-income (AHR = 2.758; 99%CI = 2.618, 2.904) and middle-income (AHR = 1.975; 99%CI = 1.878, 2.077) earners compared to high-income earners (Table 2).

*Multivariable models to evaluation the relationship between immigration and mortality*

The multivariable Cox model evaluating the relationship between immigration and mortality among all 218,187 participants in the study population included the base variables immigration, gender, age, income level and marital status (Model 1, Table 3). A higher mortality rate was found among immigrants compared to non-immigrants (HR = 1.297; 99%CI = 1.248, 1.348). Results for this model, and for all other models described below, indicated higher mortality rates for men compared to women, for married compared to unmarried people and for low- and middle-income earners compared to high-income earners.

Model 2 included the base variables as well as their interactions: gender X immigration, gender X income and immigration X income. These interactions were found to be statistically significant; when they were added to the model the relationship between immigration and mortality was reversed (HR = 0.529; 99%CI = 0.469, 0.597).

Model 3 included the interaction gender X immigration X income in addition to the base variables and the interactions in Model 2. This interaction was highly significant for low-income earners in comparison to high-income earners (p<0.001) and borderline significant for middle-income earners (p=0.118). When this interaction was added to the model, the estimate was somewhat attenuated in comparison to Model 2 (HR = 0.660; 99%CI = 0.535, 0.815), but the direction of the relationship was maintained (Table 3).

*Analysis of the relationship between immigration and mortality when classifying by gender and income level*

The multivariable Cox models to evaluate the relationship between immigration and mortality within subgroups included the variables immigration, age and marital status. These models were run separately for each gender, and then for each combination of gender and income level (6 subgroups).

Among 110,520 males, a higher mortality rate was found for immigrants compared to non-immigrants (HR = 1.474; 99%CI = 1.407, 1.545). A weaker association with similar directionality was found among 107,667 women (HR = 1.167, 99%CI = 1.102, 1.236).

However, separate models for each income level within gender revealed differences in the strength and directionality of the estimates. Among 27,563 men with low incomes the mortality rate was higher among immigrants compared to non-immigrants (HR = 2.941; 99%CI = 2.704, 3.199) but the opposite directionality was found among 45,683 men with high incomes (HR = 0.714; 99%CI = 2.704, 3.199). No relationship between immigration and mortality was found for 37,094 men with middle-level incomes (HR = 0.1.039; 99%CI = 0.963, 1.121) (Table 4).

Similarly, for 32,220 women with low incomes the mortality rate was higher among immigrants compared to non-immigrants (HR = 1.756; 99%CI = 1.641, 1.909), but the opposite directionality for this relationship was found among 50,595 women with middle incomes and 24,852 women with high incomes (HR = 0.846; 99%CI = 0.772, 0.927 and HR = 0.738; 99%CI = 0.596, 0.913, respectively) (Table 4).

In summary, when examining the relationship between immigration and mortality in the total population it was found that immigration is a risk factor for mortality among both genders, but more so among men. When classifying the cohort by gender and income level it was found that among men and women with low incomes immigration was associated with increased mortality but among men with high incomes and among women with middle and high incomes mortality risk was lower among immigrants.

**Discussion**

Similarly, to previous analyses [1] we found that the immigrants from the USSR to Israel during 1990-1995 were more educated, earned less, and included a higher proportion of women and a lower proportion of married women than non-immigrant population of similar background. This can be related to the particularly large differences in life expectancy between genders in the USSR in the 1990s [3, 10].Alao, consistent with other studies, the current study found that having high income [11-15], being more educated [16-18] and being married [19] were related to better health outcomes.

When examining the relationship between immigration and mortality in a novel way, by comparing the immigrant group to a control group with similar genetic characteristics in a country that encourages immigration, we found support for the ‘sick immigrant’ phenomenon. Nevertheless, in the high-income subgroup we found the opposing ‘healthy immigrant’ phenomenon.

*The relationship between immigration and mortality in the total study population*

When examining the relationship between immigration and mortality in the total study population we found a trend opposite to that expected between immigration and mortality. Support for the ‘sick immigrant’ phenomenon in this immigrant group can be found in a study that examined the relationship between immigration and state of health in European countries and Israel, and demonstrated, as expected, a health advantage for immigrants in European countries in comparison to the local populations, while among those who immigrated from the USSR to Israel in the 1990s the opposite relationship was demonstrated [4].

Similar results were obtained from surveys conducted in Israel, which revealed that these immigrants evaluate their state of health as being worse and had a higher rate of hospitalization compared to the local Jewish population [5]. However, this finding is not in line with the results of a different study [3] that was conducted on this population and demonstrated a certain life expectancy advantage among female immigrants compared to non-immigrants. We note that the control group in that study included all Israeli citizens, including Arab Israeli citizens who have a higher mortality rate than the Jewish population [20], while in the current study we chose to include only Jews of Eastern European origin.

When comparing the mortality rate of these immigrants to the mortality rate of non-immigrants one should remember that they came from countries in which life expectancy is lower than in Western countries [3, 10, 21]; Israel has one of the highest life expectancies in the Western world.

Nevertheless, the ‘healthy immigrant’ phenomenon has been demonstrated in the Western world also among immigrants from developing countries in which life expectancy is relatively low [4, 6]. Furthermore, in line with previous studies [6], we could have expected that in Israel, as a multicultural country that absorbs immigration with good health and welfare systems, immigrants would have a particularly high advantage.

It is noteworthy that during the 1990s the immigration options for Soviet Jews were mainly the USA and Israel. Immigration to the USA during that period was conditional on obtaining a visa and having family connections. Those who were unable to pass the American selection applied to Israel. A study on Jews who immigrated to the USA from the USSR in the 1990s reported a higher level of disability within this population than within the white population in the USA [22]. This finding was explained by early life conditions including poor nutrition during childhood and infectious diseases that may have long-term consequences, alongside social and psychological pressures related to the Soviet economic crisis.

Besides the explanations with respect to early living conditions and pressures related to the Soviet economic crisis there are other possible explanations for the unique ‘sick immigrant’ phenomenon among Soviet immigrants to Israel during 1990–1995. First, these people immigrated under the authority of the Law of Return [2] that enables any Jewish family member to immigrate to Israel without the customary filtering and health examinations practiced in other Western countries that were suggested as a potential explanation for the ‘healthy immigrant’ phenomenon in these countries [4]. Second, the high level of health in Israel and the broad health services provided within the framework of the National Health Insurance Law [8] to every immigrant may serve as a catalyst for immigration among sick people who need these health services and are more inclined to die. Third, biases in the registration of entries to and exits from the country, which have been raised in the literature as a potential explanation for the ‘healthy immigrant’ phenomenon in Western countries [6-7] seem less reasonable in Israel and its boundaries because each immigrant was assigned a personal identification number and therefore was included in the population register. Fourth, correct health behavior among immigrants, which is considered to be one of the explanations for the ‘healthy immigrant’ phenomenon [4, 6-7], is not relevant with respect to this immigration population that consumes more alcohol than the general Israeli population [23-24] and has poorer health behavior than that prevailing in Israel [21]. Finally, the genetic advantage attributed to immigrants, which serves as one of the explanations for the ‘healthy immigrant’ phenomenon [4, 6-7], is not relevant for this study as we chose to focus on a control group that is supposed to have a similar genetic base.

*Classifying the cohort by income level*

When examining the relationship between immigration and mortality, while classifying the cohort by income level, we found that immigration protects against mortality for high-income earners and is a risk factor for mortality for low-income earners. The ‘sick immigrant’ phenomenon among low-income earners in contrast to the ‘healthy immigrant’ phenomenon among high-income earners can be explained in several ways. First, we suggest that immigrants with high income potential made an educated decision to immigrate while examining other potential options and it could be expected that the strong and healthy people who estimated that they could manage the transition better are the ones who immigrated [6-7]. In contrast, among immigrants with low income potential, immigration to Israel could have been considered an opportunity, and it could be hypothesized that the decision to immigrate was more sweeping, leading to a situation where the weak also immigrated; this is evident in the mortality differences within the immigrant group.

Furthermore, we suggest that the bias of returning immigration or the ‘salmon effect’ – which describes a situation in which immigrants tend to return to their mother countries when their health deteriorates before their death [4, 6-7] – is expected to be more prevalent among high-income owners who can afford to immigrate back and leave Israel despite the health services they receive through the National Health Insurance Law [8]. Also, although these immigrants have poorer health habits [21, 23-24] than those prevailing in Israel, we suggest that those who achieved a high income are more in contact with the Israeli society, which could have exposed them to other, better health habits. Lastly, we propose that those who achieved a high income have less language barriers, more health literacy skills and are less inclined to the mental stress that characterizes immigrants.

Effect modification by income level was indicated in a study conducted in Finland in which lower mortality rates were found among immigrants at all income levels. However, differences between immigrants and non-immigrants were greater among immigrants with low socioeconomic status. In other words, a more widespread ‘healthy immigrant’ phenomenon was found among those with *low* socioeconomic status. These findings, which contradict our results, were explained by poor health behavior among non-immigrants with low socioeconomic status, the ‘salmon effect’ that occurs more among low-income earners who cannot allow themselves to receive health treatment in Finland, and other selection biases [25]. It seems that the characteristics of immigration in Finland are different from those of the USSR immigration to Israel, where immigrants have poorer health behavior than the local population [21, 23-24], and the ‘salmon effect’ among them is inhibited due to the comprehensive health services provided to all immigrants.

*Gender differences in the relationship between immigration and mortality*

When examining the relationship between immigration and mortality within the total study population we found that immigration is a risk factor for mortality among both genders, but more so among males, in contrast to previous studies conducted in other Western countries in which the opposite relationship was found, i.e. a higher mortality advantage among male immigrants [6].

Effect modification by gender in the total study population may be explained by the exceptional differences in life expectancy between genders in the USSR in 1990s [3, 10, 24]; this created a situation in which the difference in life expectancy for males between the USSR and Israel in the 1990s was greater than for women. This difference was explained partly by the poorer health habits of males [3, 10], which may also explain the gender difference regarding the strength of the relationship between immigration and mortality at low income. One could hypothesize/ or argue that male immigrants of low socioeconomic status have poorer health habitats and are less inclined to health-promoting behavior. Moreover, previous studies demonstrated a stronger relationship between income and mortality in males than for females [12, 14] similar to our results.

*Strengths and limita­tions of the study*

The main strength of this study lies in the fact that we had apparently widespread real-time population and income data; however, we do not have the tools to determine the reliability of variables in these data sources. Furthermore, the income data in this study are individual income data, excluding partner income, which may harm the quality of the study’s results. On the other hand, marital status of the individual was included in all models.

A further bias related to income data may stem from the fact that income from dividends, social insurance or any other income that is not from wages or self-employed work, was not included in the ‘Income’ variable in this study. However, we could assume that most of the population does not receive a significant income from dividends and that support from social insurance is received according to individual income level and age.

In order to compare groups with similar genetic characteristics, our control group comprised immigrants and children of immigrants who came from Eastern Europe countries and former Soviet states. In contrast, we must remember that the former Soviet states are diverse with respect to health level and health behavior characteristics; this may affect the quality of the study results and maybe there is justification for classification by the state of origin.

We chose to omit from the study population immigrants who came from the region of the Chernobyl disaster (3,533 registered as natives of Ukraine and 677 registered as natives of Belarus), which is considered to have potential long-term health outcomes [9].

This act was intended to prevent a situation of bias stemming from the consequences of this disaster. In contrast, a previous study conducted in Israel did not find higher mortality or morbidity rates among immigrants from these regions [26] and perhaps they could have been included in the current study. Moreover, it is possible that additional immigrants from Ukraine and Belarus registered as being born in the former USSR without further details; this may have limited our ability to screen people born in these countries.

*Consequences for the future*

Decision makers in Israel, as an immigrant-absorbing country, should invest in, and give particular attention to, immigrants of low socioeconomic status whose health outcomes according to this study are worse than those of non-immigrants. The results of this study emphasize the need to examine the relationships between immigration and health outcomes using social stratification. This conclusion is important in view of the ever-growing immigration around the world.

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