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Mortality from cancer among ethnic German immigrants from the Former Soviet Union, in Germany

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ABSTRACT

This study aimed to compare mortality from cancers between ethnic German immigrants and the native German population. We conducted a retrospective cohort study of 34,393 so-called *Aussiedler* from the Former Soviet Union in Germany's largest federal state and ascertained vital status and cause-of-death through population registries. We used direct and indirect standardisation to compare *Aussiedler*, German and Russian federation rates, and Poisson regression for influencing factors. Compared to Germans, male *Aussiedler* had similar all-cancer mortality, standardised mortality ratio (SMR) 0.97 (95% confidence interval: 0.86–1.10), higher mortality from lung and stomach cancers, and lower mortality from prostate cancer; SMR 0.48 (0.25–0.84). Females had lower all-cancer, lung, and breast cancer mortality with SMR (95% CI), 0.76 (0.67–0.89), 0.61 (0.34–1.01) and 0.47 (0.29–0.70), respectively. Compared to the Russian Federation, *Aussiedler* had lower all-cancer mortality; males had similar mortality from lung cancers. Better health care in Germany could have resulted in reduced mortality from certain cancers among *Aussiedler*.

1. Introduction

Throughout the last decades, there have been huge migratory movements in many parts of the world. In Europe, political changes in the late 1980s and early 1990s were followed by a steep increase in migration. Large migration flows occurred from countries of the Former Soviet Union (FSU) and Eastern and Central Europe to Western Europe and Israel.[1,2] *Aussiedler* or 're-settlers' are 'Diaspora' immigrants of German ethnicity whose descendants emigrated to the Russian empire in the 17th and 18th centuries and lived there as a disadvantaged minority.[3] Since the collapse of the Soviet Union, about two million people have migrated to Germany.[4]

It is expected that 'healthy migrant effects' are attenuated in Diaspora immigrants if the vast majority of such populations migrate.[5] According to official estimates, most *Aussiedler* have migrated due to a combination of factors like the pro-return-migration German government policy and discrimination and socio-economic hardships in the FSU.[6] Therefore, their mortality is unlikely to be appreciably modified by selection effects. *Aussiedler* are the largest contributors to European Diaspora migration flows in the 1990s[1] but little is known about their post-migration health experience. Studying their mortality from chronic diseases like cancer may elucidate factors associated with such diseases and could provide information about aetiology and prevention in this particular population, among other migrant groups and the general population.

2. Migration and mortality from cancer

Given the long latency between exposure and disease onset in most cancers, short and medium term cancer mortality

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among first generation immigrants in the destination country is mainly influenced by country-of-origin factors.[7] One exception is lung cancer for which smoking reduction or quitting may result in a reduced risk relatively quickly.[8] There are differences in cancer mortality rates in the FSU and in Germany for different cancer sites as shown in Table 1. Based on calculations from the World Health Organisation (WHO) mortality database,[9] mortality rates for smoking-related cancers are generally higher in the Russian Federation (country of origin for majority of *Aussiedler*) than in Germany, and lower for cancers of the reproductive systems with the exception of cervical cancer.

With increasing length of stay, cancer mortality rates among immigrants converge towards those in the destination country. This has been shown for stomach, colon and prostate cancers.[10] Convergence may occur due to diet acculturation, adaptation of new lifestyles or utilisation of often superior health services. Mortality from cancers whose incidence can be reduced by effective screening programmes and those whose survival depends on availability of treatment options, may decrease in a relatively shorter time. Given the differences in mortality between populations of Germany and the Russian federation and assuming that *Aussiedler* had pre-migration risk factor profiles similar to populations in FSU countries the following scenarios are expected: (i) *Aussiedler* mortality should be lower than in the German population for cancer sites like breast and prostate where mortality in FSU countries is lower or comparable; (ii) *Aussiedler* mortality should be higher or comparable to that of the German population for cancer sites like lung or stomach, where mortality in FSU countries is higher than in Germany and where survival rates are low in both countries. The aim of this study was to compare mortality from cancers among the *Aussiedler* and the native German population with the above scenarios in mind and to determine which factors have an effect on any mortality differences.

3. Materials and methods

3.1. Study population and design

Our study population comprised *Aussiedler* who arrived from countries of the FSU aged 15 years and above, and settled in North Rhine Westphalia (NRW), Germany's most populous federal state, between 1990 and 2001. Methodological details about their selection have been described elsewhere.[11] Briefly, we obtained a list of 281,356 *Aussiedler* containing names, sex, dates of birth and arrival in Germany, first city of residence, and country of origin from the NRW *Aussiedler* reception center. From these, we selected a cohort of 34,393 (16,734 males and 17,659 females) for whom automated record-linkage was possible at local population registries in the first cities of residence. Since allocation to the different federal states at the national level and to first residence in

Table 1 – Standardised death rates[a,b] and rate ratios[c] for selected cancer sites among the 15+ year-old populations of Germany and the Russian Federation for two time-periods as calculated from the WHO mortality database

Cancer site	ICD10	Year	German males	Russian males	Rate ratio	German females	Russian females	Rate ratio
			SDR/100000 population			SDR/100000 population		
Oesophagus	C15	1990	9.0	16.0	1.77	1.5	3.4	2.28
		2002	9.1	12.0	1.31	1.9	1.9	1.02
Stomach	C16	1990	29.5	77.6	2.63	15.4	33.5	2.18
		2002	18.0	53.1	2.95	9.7	21.7	2.24
Colorectal	C18–21	1990	42.0	33.0	0.79	30.3	23.1	0.76
		2002	36.6	36.8	1.01	24.0	24.2	1.01
Larynx	C32	1990	5.1	14.0	2.75	0.3	0.5	1.37
		2002	3.6	11.7	3.22	0.3	0.3	0.94
Lung	C33–34	1990	92.2	132.9	1.44	14.7	13.7	0.93
		2002	76.6	105.1	1.37	20.2	10.9	0.54
Breast	C50	1990	NA	NA	NA	40.0	24.6	0.61
		2002	NA	NA	NA	35.2	30.8	0.87
Cervix uteri	C53	1990	NA	NA	NA	6.2	8.9	1.44
		2002	NA	NA	NA	4.1	8.6	2.13
Prostate	C61	1990	35.3	13.4	0.38	NA	NA	NA
		2002	31.3	18.3	0.58	NA	NA	NA
Leukaemia	C91–95	1990	10.6	8.0	0.76	6.3	4.9	0.78
		2002	10.4	8.1	0.78	6.2	4.9	0.78
All cancers	C00–97	1990	373.1	401.8	1.08	226.9	178.5	0.79
		2002	282.2	354.9	1.26	177.9	170.3	0.96

a Direct standardisation with European Standard population.
b NA implies 'not applicable'.
c Ratio of SDR of Russian Federation:SDR of Germany.

the federal state is done on a quasi-random basis,[12] it can be assumed that our study population is representative of the entire *Aussiedler* population from the FSU in Germany.

Vital status was ascertained through local population registries. Moved participants were censored at last known date of moving, deceased participants at date of death and remaining participants on December 31, 2002. For deceased participants, we established cause-of-death from the NRW statistical office through a record-linkage system using sex, dates of birth and death and last residence as identifiers.[13] ICD9 codes for deaths before 1998, and ICD10 codes for deaths thereafter were obtained this way in 96% of cases. Death certificates were obtained from health offices for the remaining cases, and coded by professional coders. Cause-of-death could not be established in 29 cases (1.8% of all deaths).

3.2. *Statistical analysis*

We calculated person years cross-classified by sex, 5-year age groups, calendar year, and sub-categories of arrival period. We used official WHO cause-of-death statistics for the whole of Germany[9] to calculate standardised mortality ratios (SMR) for all cancers combined and for specific cancer sites and calculated exact 95% confidence intervals (CI).[14]

To investigate effects of covariables on SMR, we used Poisson regression models, with the logarithm of expected cases as offset, to calculate rate ratios (RR) for cancer sites where at least ten deaths occurred among each sex (lung, colorectal, stomach, female breast, ovary, and prostate). Cancers of the colon and rectum were analysed together to avoid classification errors.[7] We used covariables known to be confounders in migrant comparison studies,[7] categorised as follows: age (< 45 years, 45–64 years, and 65+ years), arrival and calendar periods (1990–1997 and 1998+). Age was included to assess whether mortality differences were uniformly distributed across age categories; calendar year to control for secular trends in mortality among the comparison population[9]; and arrival period to investigate whether possible changes in the migrants' characteristics over the study period affected their mortality. We included all covariables in the models to allow simultaneous comparison of their effects.

In addition, we directly standardised mortality rates for all-cancers and lung cancer (ICD9 162 or ICD10 C34) for *Aussiedler* and the general populations of Germany, and the Russian Federation. The two outcomes were selected because they had sufficient numbers of observed deaths among *Aussiedler* to perform meaningful direct standardisation. We used age and sex-specific mortality rates for each calendar year for Germany and the Russian Federation from the WHO mortality database.[9] For *Aussiedler* we calculated actual rates from the number of observed deaths and person years contributed to each sex, age and calendar year category. We expected large random variations in rates calculated this way that would make interpretation difficult. Thus, we calculated the sex and age-specific (5-year age groups) mortality rates for each calendar year using Poisson regression with the logarithm of person years as offset. Calendar year was entered as continuous variable (1, 2, . . ., 13) in the model to represent the years 1990, 1991, . . ., 2002, respectively. The following model was used:

$$\log\frac{(O_{hij})}{(\mathrm{PY}_{hij})} = \alpha + \beta_1' Age\ group_h + \beta_2' Calendar\ Year_i + \beta_3' Sex_j$$

O is the number of observed deaths in, and PY is the person time contributed to, category: age group h in calendar year i and sex j, α is the intercept, β_1 is the coefficient for age group, β_2 is the coefficient for calendar year, β_3 is the coefficient for sex.

We calculated directly standardised death rates (SDR) per 100,000 persons using the truncated (age 15 years+) European standard population and calculated sex-specific mortality rates for the three populations in each calendar year. For all cancers among *Aussiedler*, we calculated SDR using both actual rates and rates from Poisson regression. Statistical analyses were performed with SAS 9.1.[15]

4. Results

Follow-up yielded 247,143 person years with seven years' mean follow-up. We ascertained vital status in 90.5% of participants. Of those lost to follow-up, 2921 had moved within Germany, 188 moved abroad and the rest to an unknown destination. There were 1657 deaths observed, 1960 expected, yielding an all-cause SMR of 0.85 (95% CI: 0.81; 0.89). Among males SMR was 0.89 (95% CI: 0.83; 0.95) while among females it was 0.81 (95% CI: 0.75; 0.86).

The number of deaths and SMR for various cancer sites is shown in Table 2. Overall, males have all-cancer mortality similar to their German counterparts while females have significantly lower mortality. All-cancer SMR does not reflect mortality differences among cancer sites. SMR for lung cancer in males and for stomach cancer in both sexes combined are significantly above 1. In contrast, SMR for individual reproductive system cancers are <1 and significantly so for cancers of the female breast and prostate. SMR for other sites do not appreciably differ from expectation.

Results from the Poisson regression are shown in Table 3. There are significant effects for sex and arrival period on lung cancer mortality. There are also discernable upward trends in RR with arrival period for breast and ovarian cancer. There are no clear SMR differences by age except for breast cancer where decreasing RR with increasing age are observed. Calendar period shows opposite effects on the SMR for cancers of the stomach, lung, breast and prostate as compared to cancers of the colon and rectum, and ovary. In the former, RR decrease with calendar period while in the latter they increase. Since the effects are rather different by cancer site, an analysis on overall cancer did not appear to be appropriate.

Results from comparing *Aussiedler* with the German and Russian populations are shown in Figs. 1 and 2. *Aussiedler* have lower all-cancer mortality rates than either of the two groups for both sexes. All-cancer mortality is highest among Russian males and German females. Downward trends are observed for both Russian and German males with much steeper declines among the latter, while the rates among *Aussiedler* remain more or less unchanged. Among females, German rates show a decline over time but rates are unchanged in the other two.

Table 2 – Observed and expected deaths[a] for different cancers sites and the resulting standardised mortality ratios (SMR) with 95% confidence intervals (CI), for the Aussiedler compared to the population of Germany 1990–2002

Cause of death	ICD10 codes	Females				Males			
		Observed	Expected	SMR	(95% CI)	Observed	Expected	SMR	(95% CI)
All cancers	C00–C97	201	263.9	0.76[b]	(0.67; 0.89)	268	276.3	0.97	(0.86; 1.10)
Oesophagus	C15	2	2.3	0.86	(0.10; 3.10)	4	8.4	0.47	(0.13; 1.21)
Stomach	C16	23	15.8	1.45	(0.90; 2.11)	26	18.1	1.44	(0.94; 2.11)
Colorectal	C18–C20	31	36.8	0.84	(0.57; 1.20)	25	33.4	0.75	(0.48; 1.11)
Liver	C22	7	8.3	0.84	(0.34; 1.74)	11	11.1	0.99	(0.49; 1.78)
Pancreas	C25	12	15	0.8	(0.41; 1.40)	9	14.1	0.64	(0.29; 1.21)
Larynx	C32	0	0.5	0	–	3	3.8	0.79	(0.16; 2.32)
Lung	C33–C34	15	24.5	0.61	(0.34; 1.01)	100	74.6	1.34[b]	(1.13; 1.68)
Breast	C50	23	49.1	0.47[b]	(0.29; 0.70)	1	0.3	3.09	(0.08; 17.23)
Cervix	C53	3	6.2	0.48	(0.10; 1.41)				
Uterus	C54–C55	5	7.1	0.7	(0.23; 1.64)				
Ovary	C56	14	16	0.88	(0.48; 1.47)				
Prostate	C61					12	25	0.48[b]	(0.25; 0.84)
Ill-defined site	C80	14	18	0.78	(0.42; 1.31)	19	16.4	1.16	(0.70; 1.83)
Lymphomas	C81–C85	14	11.7	1.2	(0.65; 2.10)	9	11.5	0.78	(0.36; 1.49)
Leukaemia	C91–C95	4	8.5	0.47	(0.13; 1.21)	7	8.9	0.78	(0.31; 1.61)
Others	–	34	44.1	0.77	(0.54; 1.07)	42	50.7	0.83	(0.59; 1.13)

a NA : not applicable.
b $p < 0.05$.

Table 3 – Rate ratios (RR) and 95% confidence intervals (CI), of standardised mortality ratios for different cancer sites, across covariates[a], calculated from Poisson regression models with the logarithm of expected deaths taken as offset

Baseline SMR (95%CI)	Lung cancer 2.26 (1.49; 3.43) RR (95% CI)	Stomach 1.09 (0.46; 2.60) RR (95% CI)	Colorectal 0.91 (0.43; 1.89) RR (95% CI)	Breast 0.76 (0.30; 1.94) RR (95% CI)	Ovary 1.37 (0.43; 4.41) RR (95% CI)	Prostate 0.31 (0.04; 2.25) RR (95% CI)
Sex						
Female	**0.45 (0.26; 0.78)**	1.07 (0.61; 1.89)	1.10 (0.64; 1.87)	NA	NA	NA
Male	1.00	1.00	1.00			
Arrival period						
Before 1997	**0.48 (0.31; 0.74)**	1.04 (0.45; 2.39)	0.95 (0.47; 1.93)	0.42 (0.16; 1.10)	0.57 (0.17; 1.90)	1.20 (0.14; 10.28)
After 1997	1.00	1.00	1.00	1.00	1.00	1.00
Age group						
<45	0.72 (0.32; 1.59)	1.28 (0.49; 3.38)	1.13 (0.40; 3.18)	1.29 (0.42; 3.95)	0.72 (0.09; 6.00)	No deaths
45-64	1.12 (0.76; 1.64)	1.44 (0.79; 2.62)	0.81 (0.45; 1.46)	1.15 (0.45; 2.92)	1.30 (0.43; 3.88)	0.53 (0.12; 2.44)
65+	1.00	1.00	1.00	1.00	1.00	1.00
Calendar period						
Before 1997	1.36 (0.54; 3.42)	1.17 (0.62; 2.21)	0.70 (0.35; 1.41)	1.46 (0.53; 4.03)	0.58 (0.12; 2.74)	3.11 (0.95; 10.19)
After 1997	1.00	1.00	1.00	1.00	1.00	1.00

a NA: Not applicable.

For lung cancer mortality (Fig. 2), rates for male *Aussiedler* are initially in-between those of the two comparison groups, but after 1998 they are more or less similar to Russian rates. Downward trends are observed among male Russian and German populations while *Aussiedler* rates are more stable. Among females, a downward trend among Russians directly contrasts the upward trend among Germans. *Aussiedler* rates are initially lower than either of the other two, but become similar to Russian rates from 1998 onwards. The observed widening disparity between male *Aussiedler* and Germans for lung cancer as seen in Fig. 2 appears to be the combined effect of calendar and arrival periods shown in Table 3.

5. Discussion

Our study shows that *Aussiedler* have lower all-cancer mortality than the general populations of Germany and the Russian Federation. Females have a mortality advantage compared to both populations while males have similar mortality to the German one. As postulated, *Aussiedler* have higher mortality

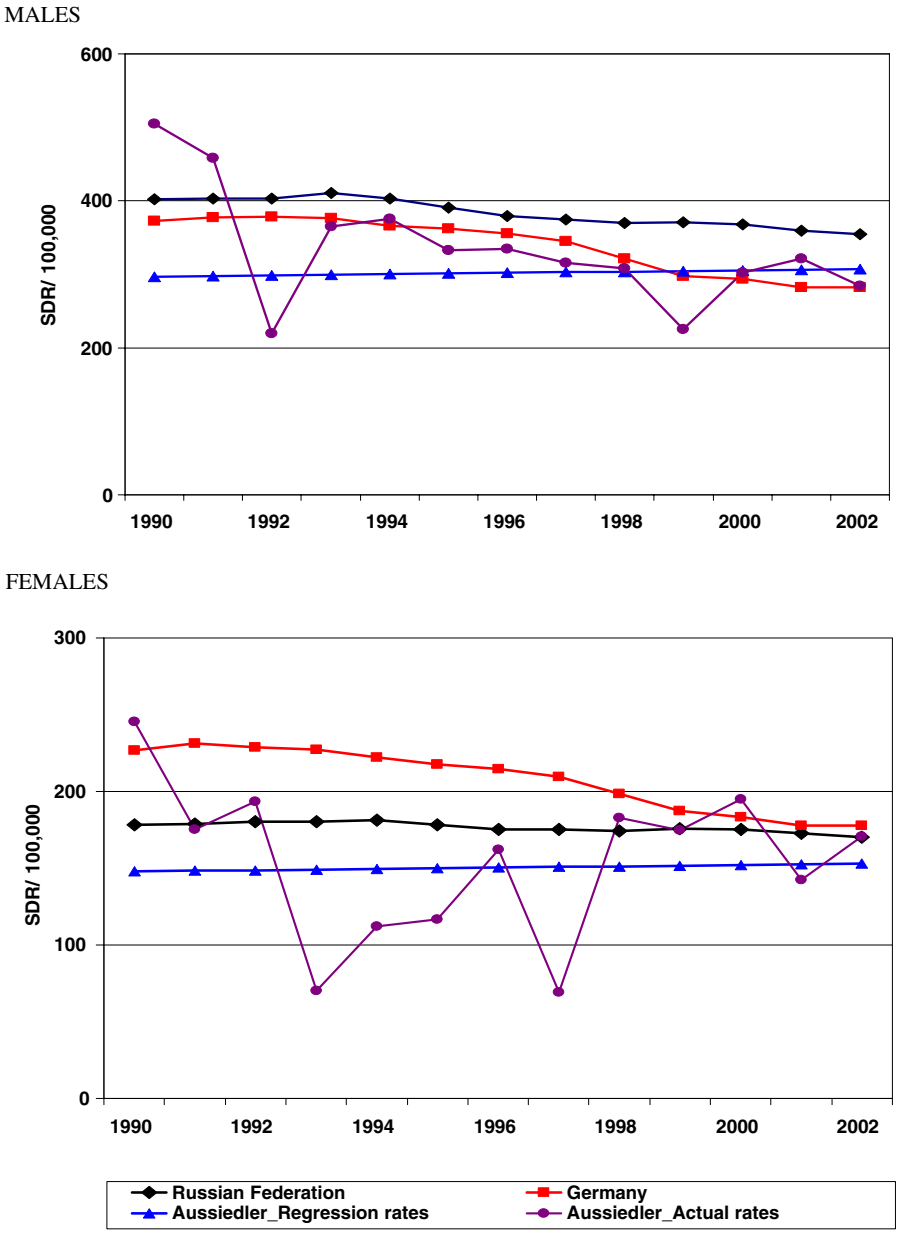

Fig. 1 – Standardised death rate (SDR, standardisation with European standard population) per 100,000 for all cancers among *Aussiedler*, and the general populations of Germany and the Russian Federation, 1990–2002, for males and females.

than the population in Germany among males and both sexes for lung and stomach cancer, respectively, and lower mortality for female breast and prostate cancers. Most covariates have no significant effect on SMR.

Although this study was conducted in one federal state, we believe the results are representative for the entire *Aussiedler* population from the FSU in Germany since allocation to first residency was quasi-randomly done.[12] Furthermore, the cohort was similar to the entire population of *Aussiedler* from FSU in NRW and in Germany in terms of age and sex distribution and arrival patterns (results not shown).

We were able to accurately determine numerator, denominator and exposure (migrant) status since we used a sampling frame including all *Aussiedler* who had settled in one federal state. Since only 0.3% of cohort members returned to the FSU, 'unhealthy re-migration' – the phenomenon that socially successful migrants with a lower mortality risk stay in the host country while less successful ones return home[16] – did not have a major influence on our findings.

As in many migrant studies, individual cohort members were not contacted. We could not assess current or pre-migration individual risk profiles of *Aussiedler*. A significantly different distribution of risk factors like smoking, alcohol consumption, diet, physical activity, reproductive history, health care utilisation, and genetic factors, in the past and during the study period, may account for the observed differences in mortality.

Follow-up was incomplete for about 8% of cohort members who had moved several times after arrival in Germany. Such participants with high residential mobility may have different

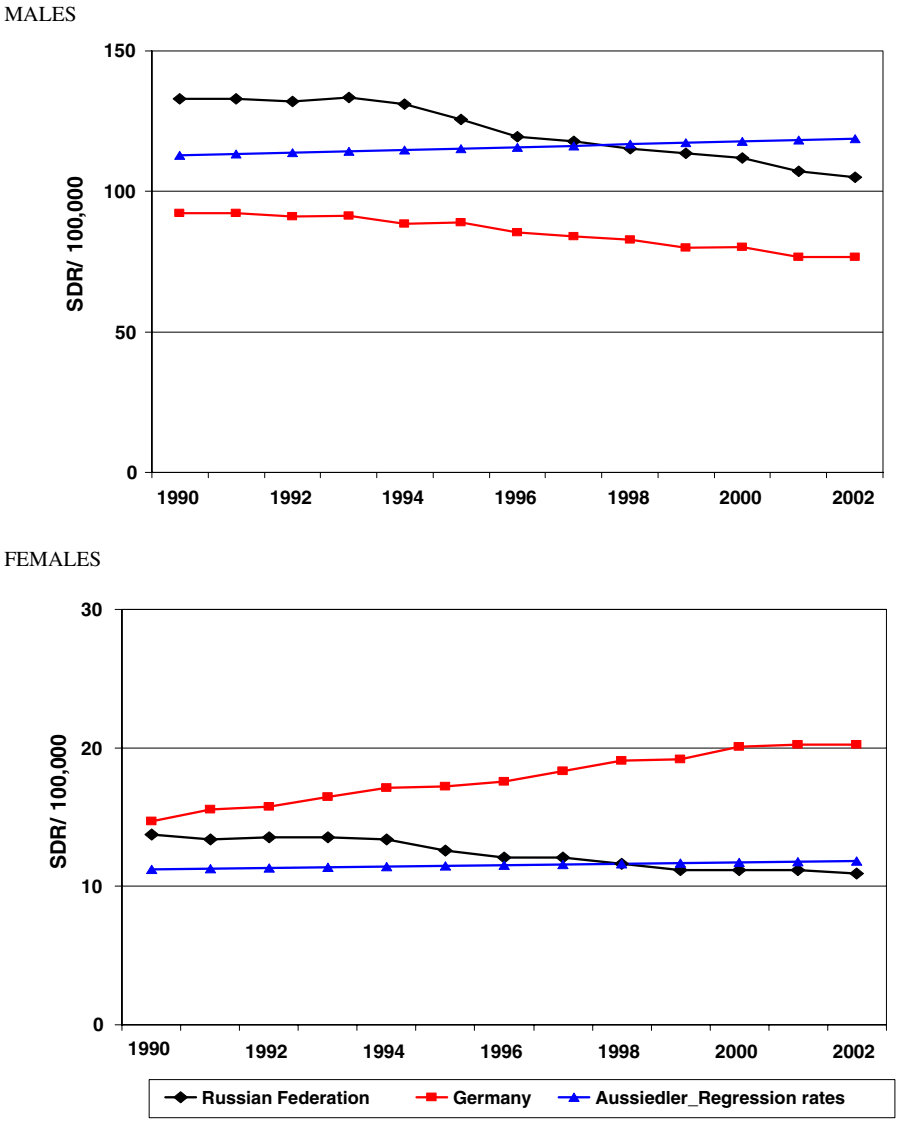

Fig. 2 – Standardised death rate (SDR, standardisation with European standard population) per 100,000 for lung cancers among *Aussiedler*, and the general populations of Germany and the Russian Federation, 1990–2002, for males and females.

cancer mortality from the remaining cohort. The magnitude and direction of this difference is difficult to determine without further follow up but a strong effect on overall results is unlikely.

Observed SMR were in line with expectations given what is known about cancer pathogenesis, latency and risk factors. With mean follow-up of 7 years, it is unlikely that risk factors in Germany have played an appreciable role in the aetiology of most cancers in the cohort. Mortality rates should therefore reflect those in FSU countries assuming that *Aussiedler* had risk factor profiles similar to populations in those countries. However, supposedly better health care in Germany could lead to reduced mortality from cancers amenable to health care. This seems to be the case for cancers of the breast and reproductive system. The age-standardised incidence rate of breast cancer in Germany was about twice the rate in the Russian Federation and Kazakhstan in 2000.[17] The corresponding SDR was higher in Germany at the beginning of the 1990s and comparable to or lower than the SDR in these countries by 2002.[17,18] The lower SMR among the *Aussiedler* therefore suggests that they may have similar incidence to populations in FSU countries and have benefited from those factors responsible for lower mortality in Germany despite its comparably higher incidence.

Also, prostate cancer mortality was lower among *Aussiedler*. SDR for this cancer are similar among males older than 65 years in the FSU and Germany and lower in Germany for those aged below 65 years[18] though survival is better in Western Europe.[19] This means that incidence is probably lower in FSU countries but survival is worse in older age groups. Such a scenario would explain lower mortality among *Aussiedler* assuming they had similar risk profiles to the populations in the countries of origin. It cannot be excluded, however, that for breast and prostate cancer, *Aussiedler* had lower incidence than the general populations in FSU countries since heterogeneity has been observed among regions and other ethnic minorities.[20,21] Since no data are available on cancer incidence for this group in Russia, this remains speculative.

Regarding lung cancer, results are as postulated. Smoking related mortality among males is substantially higher in Eastern than Western Europe[22] and the degree of the disadvantage is as expected (see Table 1). We observed a male:female ratio of lung cancer mortality of 10:1 among the *Aussiedler*, similar to the sex ratio in the Russian Federation over the last decades.[18] This suggests an identical sex distribution of risk factors, like smoking, currently or in the past, among the two groups. A study showed that there are no appreciable differences in smoking prevalence between *Aussiedler* and the rest of the German population but no differentiation between sexes was done.[23] Thus it is still possible that male *Aussiedler* smoke equal or more than their German counterparts while for females it is the opposite. This would explain the significant effect of sex on the SMR for lung cancer. Overall, it appears that in males, *Aussiedler* smoke more than Germans and females the opposite. It seems, though, that male *Aussiedler* who arrived in later years are particular heavy smokers with consequently higher SMR for lung cancer.

The observed higher stomach cancer mortality among *Aussiedler* is in line with expectations. Country-of-origin effects play a major role in the development of stomach cancer since pathogenesis starts in childhood. Rates in FSU countries are higher than in Germany[18] and the high rates in *Aussiedler* reflect this. The higher RR among age groups below 65 years could be due to cohort effects of poor hygienic conditions which facilitate infection with Helicobacter Pylori. After World War II these improved faster in Germany than in the FSU.

Lower mortality from colorectal cancer among *Aussiedler* reflects rates in the FSU which have been lower than in Germany until 2000.[18] Rates among *Aussiedler* are similar to rates observed among the population of the Russian Federation over the study period. Since colorectal cancer is largely influenced by diet[24] any possible effects of diet acculturation are unlikely to be observed in our cohort because of the short duration of follow up. This suggests that *Aussiedler*'s pre-migration dietary habits may have been similar to those of other FSU populations.

Effects of various covariates on SMR for different cancer sites were non-significant but there are discernable trends in effects of calendar year and arrival period. Increases in SMR with calendar period observed for stomach, colorectal, and breast cancer, reflect secular decline in mortality from these cancers among the general population of Germany as well as underlying increases in mortality rates among *Aussiedler*. Increases in RR with arrival period for cancers of the breast and ovary, though non-significant, may reflect changes in the composition of *Aussiedler* over time. The proportion of "real" ethnic Germans has progressively decreased over time and spouses of non-German ethnicity (male and female) made up to 72% of *Aussiedler* arrivals in 2001 compared to less than 20% in 1989.[25] It is possible that the integration in this group has been worse compared to those arriving earlier which could have led to less utilisation of preventive and curative services.

Our results support the hypothesis that cancer mortality in recent migrants is considerably influenced by pre-migration factors and that its pattern thus resembles the pattern in the population of origin. For malignancies like breast cancer, where mortality was lower in the FSU, *Aussiedler* have a lower mortality than Germany's general population. Conversely, for neoplasms like lung cancer, for which mortality is higher in the FSU, there is no such mortality advantage and mortality among *Aussiedler* is even higher. In addition to country-of-origin effects, the quality and accessibility of health care in the host country seem to play a role which should not be neglected.

The results have implications for researchers and policy makers in many countries experiencing large scale migration. Additional research, specifically tailored to Diaspora and other migrant populations, is needed to further elucidate the role of the different determinants of cancer mortality and to identify which factors can be integrated into prevention and treatment programmes.

Conflict of interest statement

None declared.

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