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Complete List of Authors:	Kaucher, Simone; UniversitatsKlinikum Heidelberg, Institute of Public Health Deckert, Andreas; UniversitatsKlinikum Heidelberg, Institute of Public Health Becher, Heiko; University Hospital Hamburg Eppendorf, Institute of medical Biometry and Epidemiology Winkler, Volker ; UniversitatsKlinikum Heidelberg, Institute of Public Health
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Migration pattern and mortality of ethnic German migrants from the former Soviet Union: a cohort study in Germany

Simone Kaucher,[1] Andreas Deckert,[1] Heiko Becher,[1,2] Volker Winkler[1]

1 University Hospital Heidelberg, Institute of Public Health, Unit of Epidemiology and Biostatistics, Im Neuenheimer Feld 324, 69120 Heidelberg, Germany
2 University Medical Center Hamburg-Eppendorf, Institute for Medical Biometry and Epidemiology, Martinistraße 52, 20246 Hamburg, Germany

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Corresponding author

Volker Winkler, Institute of Public Health, Unit of Epidemiology and Biostatistics, Im Neuenheimer Feld 324, 69120 Heidelberg, Germany, tel: +49 (0) 6221 56 35049, e-mail: v.winkler@uni-heidelberg.de.

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ABSTRACT

Objective We aimed to investigate all-cause and cause-specific mortality among ethnic German migrants from the former Soviet Union by different immigration periods to describe associations between migration pattern and mortality.

Design We used pooled data from three retrospective cohort studies in Germany.

Participants Ethnic German migrants from the former Soviet Union (called resettlers), who immigrated to Germany since 1990 to the federal states North Rhine-Westphalia and Saarland and to the region of Augsburg (N=59,390).

Outcome All-cause and cause-specific mortality among resettlers in comparison to the German population, separated by immigration period.

Methods Immigration periods were defined following legislative changes in German immigration policy (1990-1992, 1993-1995, 1996+) and resettlers' characteristics were described accordingly. To investigate mortality differences by immigration period, we calculated age standardized mortality rates (ASRs) and standardized mortality ratios (SMRs) of resettlers in comparison to the German population. Additionally, we modeled sex-specific ASRs with Poisson regression, using age, year and immigration period as independent variables.

Results The composition of resettlers changed by immigration period: Since 1993, the percentage of resettlers from the Russian Federation and non-German spouses increased. Higher all-cause mortality was found among resettlers who immigrated in 1996 and after (ASR 628.1, 95%CI [595.3-660.8]), compared to resettlers who immigrated before 1993 (ASR 561.8, 95%CI [537.2-586.4]). SMR analysis showed higher all-cause mortality among resettler men from the last immigration period compared to German men (SMR 1.11, 95%CI [1.04-1.19]), whereas resettlers who immigrated earlier showed lower all-cause mortality. Results from Poisson regression, adjusted for age and year, corroborated those findings.

Conclusions Mortality differences by immigration period suggest different risk-factor patterns and possibly deteriorated integration opportunities. Further research is needed to investigate determinants for integration problems and health related outcomes, independent of period of immigration.

Strengths and limitations

- This study includes a large number of resettlers living in Germany and a mortality follow-up of 20 years, thus we were able to investigate differences of resettlers' health based on their migration pattern, for the first time.
- Since resettlers are distributed randomly to their place of residence, we assume that our results are generalizable to resettlers living in other regions of Germany.
- Data on risk-factor patterns and integration process was not available, since registry data was used.
- Information on statutory basis was only available for a subgroup of the cohort.

INTRODUCTION

In the 18th and 19th century, Germans emigrated to the Russian empire. First, they were privileged compared to the Russian population, but during the World Wars, they became persecuted and suffered increasing discrimination. In the 1930s and thereafter, many ethnic Germans were deported to specific regions within the former Soviet Union (FSU), most of them to Kazakhstan and Siberia. There, they were forced to work in agriculture and were not allowed to return to their places of residence from pre-war years.(1) Since 1953, ethnic Germans and their families, including non-German spouses and their children (descendants), were invited to return to Germany based on the Federal Expellee Law (in German: Bundesvertriebenengesetz). However, migration was hindered by strict emigration regulations in the countries of the FSU. After the collapse of the Soviet Union in 1991, thousands of ethnic Germans and their families, called resettlers (in German: (Spät-) Aussiedler), left the countries of the FSU. By law, upon arrival, resettlers are granted full German citizenship.(2) By 1989, the Institute of German Economy assumed that the integration of resettlers will be easy due to very good conditions for integration.(3) Many of the older resettlers spoke German and were familiar with the German culture and traditions.(4) In 2011, more than 3.2 million resettlers lived in Germany.(2)

After the fall of the Iron Curtain, the countries of the FSU had to handle political and economic challenges. The so-called *transformation crisis* arose for instance in the Russian Federation,(5) but also in the Ukraine and in Kazakhstan.(6, 7) Hence, life expectancy and GDP dropped sharply in those countries (see figure 1).(8)

Due to the high number of immigrating resettlers, the German government began to further regulate the flow of immigration with the help of various legislative changes.(9) In 1989, the law of residence assignment (in German: Wohnortzuweisungsgesetz) was introduced. To avoid agglomerations, incoming resettlers were assigned to their first place of residence based on regional population density and economic performance (in German: Königsteiner Schlüssel), where they had to live for at least two years (since 2005 three years).(10) Besides this, there were hardly any restrictions on admission for resettlers. In 1993, the German government issued the Adjustment of Laws on the Effects of War (in German: Kriegsfolgenbereinigungsgesetz). Due to prior criticism about family separations of resettlers, the involvement of immigrating family members was facilitated. Henceforth, resettlers could immigrate with their full-aged children and other descendants (for example daughter or son-in-law, stepson or stepdaughter). However, annually a maximum number of 220,000 resettlers including family members were allowed to immigrate. From 1996 onwards, laws were again changed and a proof of German language skills was prerequisite for immigration. Only the applicant of the family had to be able to conduct a simple conversation in German. If the applicant passed the test, the whole family was allowed to immigrate.(9) Furthermore, resettlers were penalized by cutting social security and unemployment benefits if they left the assigned place of residence within the first two years.(10) Since 2005, incoming resettlers and all family-members have to proof German language skills before immigrating.(9)

As a consequence of the situation in the FSU countries and the legislative changes in Germany, the amount of immigrating resettlers decreased and a change with regard to the country of origin was observed. Furthermore, the number of incoming resettlers decreased until the end of the 1990s since the majority already immigrated in the years before. The proportion of resettlers from the Russian Federation increased from 28.6% in 1993 to 45% in 2001 (see figure 2).(2, 11, 12) Additionally, the proportion of couples increased where one of the partners had no German background.(11) Furthermore, qualitative research found decreasing German language skills and increasing integration problems among resettlers over time.(9, 10, 13)

Previous studies looking at the health situation of resettlers in Germany found lower all-cause mortality among resettlers in three regionally different cohorts compared to the German population, mainly driven by lower CVD mortality,(14, 15) whereas cancer incidence and mortality showed cancer-specific differences.(16, 17) Data from a small case-control study suggest that those differences may be due to lifestyle factors.(18) Since resettlers used to live within close communities for centuries almost until the World War II, a different genetic pattern to those of the German and the Russian population might be possible. Further analyses from the conducted studies found higher external mortality among resettlers compared to the Germans.(19, 20) Except of Deckert et al.,(19) previous analyses investigated resettlers as a homogenous group. Deckert et al. found differences in mortality with regard to immigration period and immigration age.(19) Nevertheless, those analyses were restricted due to small sample size.

In light of the described developments since 1990, we hypothesize differences in risk-factor patterns in resettlers by immigration period which led to different mortality patterns. Therefore, we first descriptively investigate heterogeneity to describe migration pattern among resettlers in our cohort with respect to sex, age at immigration, country of origin and statutory basis and second, we investigate differences in mortality according to these migration patterns.

METHODS

Study Design and Study Population

We combined data from three resettler cohorts (n=59,390) from different regions of Germany (North Rhine-Westphalia, Saarland and the region of Augsburg). Details on the cohorts and vital status ascertainment are described elsewhere.(16) In brief: Information on vital status was provided from local registration offices, while health authorities provided death certificates, respectively the causes of death, which were classified according to the International Classification of Diseases 10 (ICD-10).

Variables

Person-years (py) were calculated for each sex, calendar year and 5-year age group and the end of follow-up was 31.12.2009. For this study, we further categorized causes of death as follows: all-causes, malignant neoplasms (ICD-10: C00-C97), cardiovascular diseases (CVD) (ICD-10: I00-I99) and external causes (ICD-10: V01-Y84). All deaths from other ICD-10 codes were summarized and categorized as other causes of death. Missing causes of deaths are presented as a separate category.

To investigate migration pattern within the cohort, respective calendar years of legislative changes in Germany were used to categorize years of immigration into the following immigration periods: 1990 until end of 1992, 1993 until end of 1995 and 1996 until end of 2005.

Statistical Analysis

In a first step, we descriptively investigated migration pattern by analysing the association between immigration period and the variables sex, age at immigration, and country of origin for all cohort members. In addition, information on statutory basis was available from the Saarland cohort. Therefore, we selected a subsample with a random procedure (Saarland cohort, n=655).

In a second step, we analysed mortality differences by immigration period to assess the association between resettlers' health and migration pattern. We calculated age-standardized mortality rates (ASRs) according to the European standard population,(21) and standardized mortality ratios (SMRs) in comparison to the general German population,(22) along with exact 95% confidence intervals (95%CIs) for cause of death categories, stratified by immigration periods and sex.(23)

Third, we modeled age-specific rates μ, separated by sex, using Poisson regression according to the following model:

$$log(\mu_{X_1,X_2,X_3}) = \beta_0 + \beta_1 X_1(immigration\ period) + \beta_2 X_2(age\ group) + \beta_3 X_3(year)$$

As independent variables we included immigration period$_{X1}$ as categorical variable with three categories 1990-1992 (Reference group), 1993-1995 and 1996+, age group$_{X2}$ (modeled continuously in 5-year age groups, coded as 1 (0-5 years) to 18 (85+ years)) and year$_{X3}$ (modeled continuously, coded as 1 to 20 (calendar year-1989)). The offset of the model was the log of the py in the respective categories. We addressed possible non-linear associations of age and year on the rates using the fractional polynomials procedure.(24) Using modeled age-specific mortality rates we calculated ASRs by year and immigration period, standardized to the European standard population.(21) For comparison, German ASRs were calculated accordingly, using the WHO mortality database.(22) Statistical analyses were performed using SAS Version 9.4 and STATA Version 14.

RESULTS

Descriptive results

Overall, 797,264 py were accumulated and we observed 5572 deaths during the whole observation period. The median follow-up time was 14.2 years. Cause of death was available for 92% of all deaths. All descriptive results, representing migration patterns by immigration period, are shown in table 1.

Table 1: descriptive results, separated by immigration period

		immigration period		
		1990-1992	**1993-1995**	**1996+**
Total cohort (n=59,390)				
Sex in %	Men	48.6%	48.0%	48.2%
	Women	51.4%	52.0%	51.8%
Mean age at immigration (median; range)	Men	35.7 (34; 0-93)	35.2 (34; 0-93)	34.4 (34; 0-95)
	Women	38.7 (35; 0-93)	38.6 (36; 0-95)	37.0 (36; 0-98)
Country of origin (n; %)	Russian Federation	223 (1.3%)	2015 (10.8%)	7396 (31.6%)
	Kazakhstan	785 (4.5%)	3901 (20.9%)	8803 (37.6%)
	FSU (unspecified)	16,353 (94.2%)	12,708 (68.2%)	7187 (30.7%)
Subsample Saarland cohort (n=655)				
statutory basis in %	unknown	12.9%	4.6%	5.0%
	resettlers	85.0%	80.0%	66.2%
	Non-German spouses	2.2%	15.5%	28.9%

The number of resettler immigrants from the FSU decreased over time, whereas the percentage of resettlers from the Russian Federation increased. The number of immigrants categorized as "unspecified

FSU countries" decreased considerably until the latest immigration period. However, our data showed higher proportion of resettlers from unspecified FSU countries, since not all cohorts had the information on the country of origin. Overall, the descriptive results since 1993 and the proportional changes of countries of origin reflect the observed federal trend. Regarding the statutory basis, we found similar migration patterns in the Saarland subsample to the federal trend. While in the first immigration period the majority of immigrating resettlers were ethnic Germans (85.0%), the percentage decreased in the latest immigration period (66.2%) and the percentage proportion of non-German spouses increased. On average, resettlers of the latest immigration period were younger compared to resettlers from the first immigration period. No difference in sex composition regarding immigration period was observed.

Mortality pattern by immigration period

Results of all-cause and cause-specific ASR and SMR analyses of resettlers from the FSU, separated by sex and immigration period are presented in table 2.

Table 2: Cause-specific age-standardized rates and standardized mortality ratios with 95% confidence intervals, by sex and immigration period

	immigration period (years)								
	Men								
		1990-1992			**1993-1995**			**1996+**	
	Obs	ASR[§] (95%CI)	SMR (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)
All-Causes	1088	726.5 (681.4-771.6)	**0.85 (0.80-0.90)**	1010	802.6 (749.7-855.5)	0.98 (0.92-1.04)	800	834.2 (770.7-897.7)	**1.11 (1.04-1.19)**
malignant neoplasm (C00-C97)	325	209.9 (186.2-233.7)	0.90 (0.81-1.01)	304	235.6 (208.1-263.1)	1.03 (0.92-1.15)	235	244.4 (211.1-277.8)	1.12 (0.98-1.27)
CVD (I00-I99)	382	267.2 (239.3-295.2)	**0.75 (0.68-0.83)**	329	280.8 (248.1-313.5)	**0.83 (0.74-0.92)**	223	251.6 (215.4-287.8)	**0.86 (0.75-0.98)**
External Causes (V01-Y84)	65	39.7 (29.4-50.1)	**0.77 (0.60-0.98)**	81	58.2 (44.1-72.4)	1.13 (0.91-1.40)	73	53.5 (40.7-66.2)	**1.29 (1.03-1.63)**
Other Causes	242	162.0 (140.6-183.3)	**0.74 (0.65-0.83)**	219	171.0 (146.7-195.4)	**0.82 (0.72-0.93)**	187	206.2 (173.0-239.4)	0.98 (0.85-1.13)
Missing Causes	74			77			82		
	Women								
		1990-1992			**1993-1995**			**1996+**	
	Obs	ASR[§] (95%CI)	SMR (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)
All-Causes	1036	437.2 (409.4-464.9)	**0.83 (0.78-0.88)**	943	443.0 (413.2-472.9)	**0.86 (0.81-0.92)**	695	473.0 (437.3-508.8)	0.96 (0.89-1.04)
malignant neoplasm (C00-C97)	256	119.2 (103.9-134.5)	**0.80 (0.71-0.91)**	213	106.0 (90.2-121.8)	**0.76 (0.66-0.87)**	200	138.7 (119.0-158.3)	1.01 (0.88-1.16)
CVD (I00-I99)	477	189.4 (172.0-206.9)	**0.81 (0.74-0.88)**	440	200.6 (181.2-219.9)	**0.87 (0.79-0.95)**	267	175.6 (154.3-197.0)	**0.85 (0.75-0.96)**
External Causes (V01-Y84)	29	15.6 (9.5-21.7)	**0.69 (0.48-1.00)**	16	10.1 (4.5-15.6)	**0.44 (0.27-0.73)**	14	10.5 (4.9-16.1)	**0.53 (0.31-0.90)**

Other Causes	212	86.9 (74.8-99.0)	**0.70 (0.62-0.81)**	206	94.8 (81.5-108.1)	**0.77 (0.67-0.88)**	143	98.4 (82.0-114.8)	**0.78 (0.67-0.92)**
Missing Causes	62			68			71		

§ per 100.000 person-years

ASRs for all-cause mortality increased significantly until the latest immigration period (ASR (both sexes) 628.1, 95%CI [595.3-660.8]) compared to resettlers from the first immigration period (ASR (both sexes) 561.8, 95%CI [537.2-586.4]). The same trend can be reported for malignant neoplasms. For external mortality, an increase was only found among resettler men who came between 1993 until end of 1995 (ASR 58.2, 95%CI [44.1-72.4]) and in the latest immigration period (ASR 53.5, 95%CI [40.7-66.2]), compared to resettlers who immigrated before 1993 (ASR 39.7, 95%CI [29.4-50.1]). No considerable differences can be reported for CVD mortality and for mortality from other causes by immigration period, in both sexes respectively.

Results from SMR analysis showed additionally that resettler men from the latest immigration period had a significantly higher all-cause mortality (SMR 1.11, 95%CI [1.04-1.19]) and external cause mortality (SMR 1.29, 95%CI [1.03-1.63]) compared to the German male population.

Poisson regression

Results from Poisson regression showed significant effects of immigration period, adjusted for age and year. Male resettlers who came within the second immigration period had a significantly higher all-cause mortality compared to resettlers from the first immigration period (RR=1.13). This effect was even higher for male resettlers who came in 1996 and the years after (RR=1.23). Female resettlers from the second immigration period showed almost the same mortality compared to female resettlers form the first immigration period (RR=1.03, not significant). However, all-cause mortality was significantly higher for female resettlers who came in the last immigration period, compared to resettlers from the first immigration period (RR=1.13). The modeled estimates are presented online in the supplementary material.

Figure 3 presents modeled ASRs, separated by immigration period and sex, from 1990 to 2009 for resettlers and for the general German population. Transformations are shown at the bottom of figure 3. In both sexes, all-cause mortality was lowest among resettlers who came before 1993. Mortality rates among resettlers who came between 1993 and end of 1995 were somewhat higher compared to resettlers who came in the first immigration period, but mortality rates among women were still lower compared to the German population. For male resettlers from the second immigration period, mortality rates crossed the German mortality rates in the mid of 2000s. For resettlers who came in 1996 and the years after, mortality rates were highest, compared to the other immigration periods. Since 2000, mortality rates of male resettlers were even higher compared to mortality rates of German men. For resettler women who came in 1996 and after, mortality rates remain lower compared to the German rates.

DISCUSSION

We found higher all-cause and cancer mortality among resettlers from the last immigration period compared to resettlers who immigrated before 1993. In addition, mortality from external causes among men was found to be increased in resettlers from the last two immigration periods compared to resettlers from the first immigration period, although not significantly. Furthermore, all-cause mortality of resettlers compared to the German population was higher among male resettlers who came after 1996, whereas all-cause mortality among all resettlers who immigrated before 1996 was lower compared to the Germans.

The Russian Federation tried to cut down the German culture in the FSU. Although the German language was not officially banned from public life, in practice an increasing russification process was seen.(25) Consequently, ethnic Germans who wanted to live their German culture left the countries of the FSU immediately. We assume that those resettlers, who left the FSU due to cultural motives, identified themselves as Germans and had a healthier lifestyle behavior compared to the autochthonous population of the FSU countries. Indicators for this are better German language skills from resettlers of the first immigration period and the fact that immigrating couples from the early 1990s were mostly both ethnic Germans. Previous research has shown that German language skills were much better among resettlers who came in the beginning, mainly due to ethnic-mixed couples in the later years.(9, 10, 13) Pure descriptive results corroborate this trend of increasing immigration of ethnic mixed-couples in the later years. Results from ASR analysis support the assumption of different risk-factor patterns depending on immigration period. SMR analysis showed further higher all-cause mortality compared to the German population. This effect was highest among resettlers, who came 1996 and after in younger ages (<30 years) (RR 1.46, 95%CI [1.17-1.81]). Poor literacy skills, which are associated with poor health literacy and poor health outcomes, may also explain the differences in resettlers' health status by migration pattern.(26, 27)

On the other hand, the integration of resettlers had deteriorated during the 1990s. It was shown that increasing language problems are accompanied with a higher risk of withdrawing into the own-ethnic group, which lastly led to integration problems.(13, 28) Furthermore, resettlers who immigrated in the beginning of the 1990s had a considerably better employment outlook compared to resettlers who immigrated in the mid of the 1990s and later. Since the profession of mostly women and academics was not recognized, many resettlers did not work within their profession and had mostly a low position. Additionally, the acceptance of migrants in the autochthonous population decreased during the 1990s considerably.(10, 29) Hence, it can be assumed that the integration of resettlers who came in the beginning was more successful than the integration of resettlers from the later immigration periods, which was also reflected by the legislative changes and the stricter entry requirements. Higher external mortality among resettler men from the latest immigration period, compared to resettler men from the first immigration period, support this assumption. It was shown before that poor integration is associated with mental health problems, as well as with higher risk of suicide and external mortality.(19, 30)

A healthy migrant effect among resettlers is unlikely as discussed elsewhere.(16) In brief: The restrictions on admission for resettlers were never as rigorous as for other migrant groups. Due to their German citizenship, resettlers have the right of social security and unemployment benefit.(31) Furthermore, we investigated that resettlers immigrated mostly with their whole families and we could observe deaths of older study participants within a short period after arrival.(32, 33)

The legislative changes were intended to improve the integration process of resettlers, while agglomerations should have been avoided and the communication with the autochthonous population should have been facilitated. However, legislative changes were seen controversially. Criticism was addressed towards the inconsistent process of the language test and that the importance of geographical proximity to the social network was neglected.(10, 28)

Strengths and limitations

It needs to be stated that our study is based on secondary data without information on risk-factor patterns or on the integration process. Furthermore, data on statutory basis by immigration period were only available from a subgroup of the Saarland cohort. Nevertheless, our descriptive results reflect the migration pattern of immigrating resettlers from the federal level.(11)

We would like to highlight the study design and the long observation period of our study. We were able to investigate mortality for 20 years of follow-up and to distinguish between immigration periods. After arrival, resettlers were assigned to their place of residence at random, therefore, we assume that our study population reflects the entire group of resettlers living in Germany and that our results are generalizable to them.

CONCLUSIONS

Several previous studies found differences in integration process, language skills and statutory basis. However, to our knowledge, there was no quantitative study performed which investigated differences of resettlers' health based on their migration pattern. We do not assume that immigration period itself has an impact on resettlers' health, rather that immigration period may be linked with risk-factor patterns and possibly changing integration opportunities for resettlers, which are influencing their health. Therefore, immigration period can be seen as a proxy for these variables. Further research is needed to investigate the single variables, which are behind the detected migration patterns, especially integration problems, their origin and their impact on health, independent of the immigration period.

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Contributors The cohort study was initiated by HB and performed by VW, HB and AD. SK and VW analysed the data. SK drafted the manuscript and all authors contributed to writing and the interpretation of the results.

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Ethical Approval Ethics Committee of the Medical Faculty, University Hospital Heidelberg.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

Data Sharing Statement If interested in cooperation, the data set will be provided from the corresponding author.

Figure Legends

Figure 1: annual change of GDP per capita growth in % and life expectancy at birth in the 1990s in the Russian Federation, Ukraine and Kazakhstan(8)

Figure 2: Total amount of immigrating FSU resettlers by year (left axis), and composition of countries of origin from immigrating resettlers from the FSU by year (in %, right axis)(12)

Figure 3: modeled age-standardized rates for all-cause mortality for resettlers (separated by immigration period and sex) and the German population, using European Standard population, from 1990 to 2009

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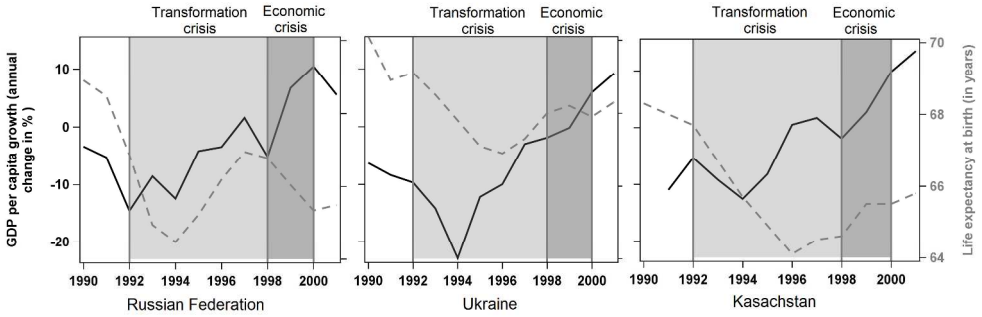

Figure 1: annual change of GDP per capita growth in % and life expectancy at birth in the 1990s in the Russian Federation, Ukraine and Kazakhstan(8)

278x92mm (300 x 300 DPI)

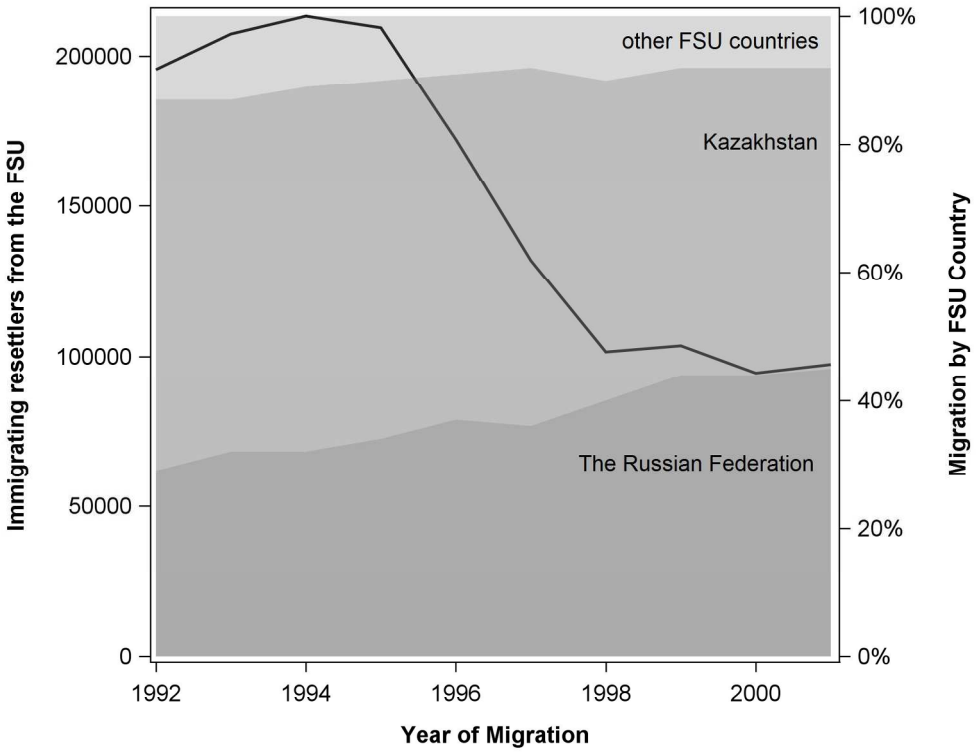

Figure 2: Total amount of immigrating FSU resettlers by year (left axis), and composition of countries of origin from immigrating resettlers from the FSU by year (in %, right axis)(12)

180x140mm (300 x 300 DPI)

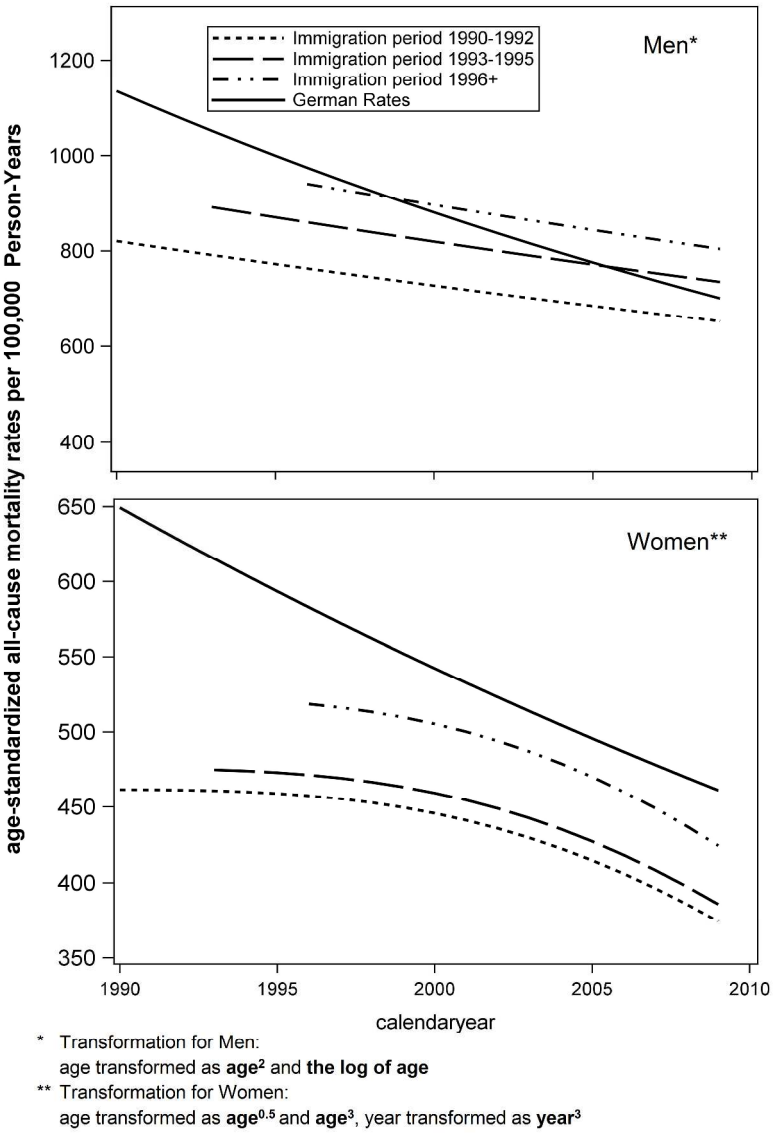

Figure 3: modeled age-standardized rates for all-cause mortality for resettlers (separated by immigration period and sex) and the German population, using European Standard population, from 1990 to 2009

310x431mm (300 x 300 DPI)

Supplementary Material – Poisson Regression estimates and p-values, separated by sex

Poisson Regression β-estimates and p-values for men		
	Estimate	**p-value**
Intercept	-8.641	<0.0001
age group:		
age group^2	0.014	<0.0001
logarithm of age group	0.752	<0.0001
year:		
(calendar year -1989)	-0.012	0.0033
Immigration period:		
1990-1992	Ref.	
1993-1995	0.120	0.0066
1996-2005	0.209	<0.0001

Poisson Regression β-estimates and p-values for women		
	Estimate	**p-value**
Intercept	-9.947	<0.0001
age group:		
age group$^{0.5}$	0.848	<0.0001
age group^3	0.001	<0.0001
year:		
(calendar year-1989)^3	-0.000*	0.0009
Immigration period:		
1990-1992	Ref.	
1993-1995	0.030	0.5083
1996-2005	0.125	0.0123

* Exact estimate: -.0000261

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	In the Title and Abstract (page 1 and 2)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4
Methods			
Study design	4	Present key elements of study design early in the paper	Page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 4 (only a brief description, however, a reference is cited, where detailed information can be found)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Page 4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Pages 4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Pages 4-5
Bias	9	Describe any efforts to address potential sources of bias	Not applicable, since we used registry-data
Study size	10	Explain how the study size was arrived at	Page 4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Pages 4-5

Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Pages 4-5
		(*b*) Describe any methods used to examine subgroups and interactions	Pages 4-5
		(*c*) Explain how missing data were addressed	Page 4 (since registry-data was used, there is no missing data – only missing causes of death)
		(*d*) If applicable, explain how loss to follow-up was addressed	Not applicable since we used registry data
		(*e*) Describe any sensitivity analyses	Not applicable
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 5
		(b) Give reasons for non-participation at each stage	Not applicable, since we used registry data
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 5 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	Page 5; 6-7 (Table 1 & 2)
		(c) Summarise follow-up time (eg, average and total amount)	Page 5
Outcome data	15*	Report numbers of outcome events or summary measures over time	Pages 5-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Pages 6-7, figure 3 and supplementary table
		(*b*) Report category boundaries when continuous variables were categorized	Pages 5-7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not applicable.
Discussion			
Key results	18	Summarise key results with reference to study objectives	Pages 7-8
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Pages 7-9

Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 9

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Migration pattern and mortality of ethnic German migrants from the former Soviet Union: a cohort study in Germany

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Migration pattern and mortality of ethnic German migrants from the former Soviet Union: a cohort study in Germany

Simone Kaucher,[1] Andreas Deckert,[1] Heiko Becher,[1,2] Volker Winkler[1]

1 University Hospital Heidelberg, Institute of Public Health, Unit of Epidemiology and Biostatistics, Im Neuenheimer Feld 324, 69120 Heidelberg, Germany
2 University Medical Center Hamburg-Eppendorf, Institute for Medical Biometry and Epidemiology, Martinistraße 52, 20246 Hamburg, Germany

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Corresponding author

Volker Winkler, Institute of Public Health, Unit of Epidemiology and Biostatistics, Im Neuenheimer Feld 324, 69120 Heidelberg, Germany, tel: +49 (0) 6221 56 35049, e-mail: v.winkler@uni-heidelberg.de.

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ABSTRACT

Objective We aimed to investigate all-cause and cause-specific mortality among ethnic German migrants from the former Soviet Union by different immigration periods to describe associations with migration pattern and mortality.

Design We used pooled data from three retrospective cohort studies in Germany.

Participants Ethnic German migrants from the former Soviet Union (called resettlers), who immigrated to Germany since 1990 to the federal states North Rhine-Westphalia and Saarland and to the region of Augsburg (N=59,390).

Outcome All-cause and cause-specific mortality among resettlers in comparison to the general German population, separated by immigration period.

Methods Immigration periods were defined following legislative changes in German immigration policy (1990-1992, 1993-1995, 1996+). Resettlers' characteristics were described accordingly. To investigate mortality differences by immigration period, we calculated age-standardized mortality rates (ASRs) and standardized mortality ratios (SMRs) of resettlers in comparison to the general German population. Additionally, we modeled sex-specific ASRs with Poisson regression, using age, year and immigration period as independent variables.

Results The composition of resettlers differed by immigration period: Since 1993, the percentage of resettlers from the Russian Federation and non-German spouses increased. Higher all-cause mortality was found among resettlers who immigrated in 1996 and after (ASR 628.1, 95%CI [595.3-660.8]), compared to resettlers who immigrated before 1993 (ASR 561.8, 95%CI [537.2-586.4]). SMR analysis showed higher all-cause mortality among resettler men from the last immigration period compared to German men (SMR 1.11, 95%CI [1.04-1.19]), whereas resettlers who immigrated earlier showed lower all-cause mortality. Results from Poisson regression, adjusted for age and year, corroborated those findings.

Conclusions Mortality differences by immigration period suggest different risk-factor patterns and possibly deteriorated integration opportunities. Health policy should guard the consequences of immigration law alterations with respect to changing compositions of migrant groups and their health status.

Strengths and limitations

- This study includes a large number of resettlers living in Germany and a mortality follow-up of 20 years, thus we were able to investigate differences of resettlers' mortality based on their migration pattern, for the first time.
- Since resettlers are distributed randomly to their place of residence, we assume that our results are generalizable to resettlers living in other regions of Germany.
- Data on risk-factor patterns and integration process was not available, since registry data was used.
- Information on statutory basis was only available for a subgroup of the cohort.

INTRODUCTION

In the 18th and 19th century, Germans emigrated to the Russian empire. At the beginning, they were privileged compared to the Russian population, but since about World War I, they became persecuted and suffered increasing discrimination. In the 1930s and thereafter, many ethnic Germans were deported to specific regions within the former Soviet Union (FSU), most of them to Kazakhstan and Siberia. There, they were forced to work in agriculture and were not allowed to return to their places of residence from pre-war years.(1) Since 1953, ethnic Germans and their families, including non-German spouses and their children (descendants), were invited to return to Germany based on the Federal Expellee Law (in German: Bundesvertriebenengesetz), resulting in immigration waves from Poland and Romania, for instance. Yet, in the countries of the FSU migration was hindered by strict emigration regulations. However, after the collapse of the Soviet Union, a massive emigration of ethnic Germans and their families, called resettlers (in German: (Spät-) Aussiedler), took place.(2) By law, upon arrival, resettlers are granted full German citizenship.(3) By 1989, the Institute of German Economy assumed that the integration of resettlers will be easy due to very good conditions for integration.(4) Many of the older resettlers spoke German and were familiar with the German culture and traditions.(5) Between 1990 and 2005, more than 2 million resettlers from the FSU migrated to Germany.(6)

After the fall of the Iron Curtain, the so-called *transformation crisis* arose and consequently, the countries of the FSU had to handle multiple political and economic challenges. For instance, life expectancy and GDP dropped sharply in the Russian Federation,(7) but also in the Ukraine and in Kazakhstan.(8, 9) (see figure 1).(10)

Due to the high number of immigrating resettlers with a peak of 213,000 from the FSU in 1994,(6) the German government began to further regulate the flow of immigration with the help of various legislative changes.(2) In 1989, the law of residence assignment (in German: Wohnortzuweisungsgesetz) was introduced. To avoid agglomerations, incoming resettlers were allocated to their first place of residence based on regional population density and economic performance (in German: Königsteiner Schlüssel), where they had to live for at least two years (since 2005 three years).(11) Besides this, there were hardly any restrictions on admission for resettlers. In 1993, the German government issued the Adjustment of Laws on the Effects of War (in German: Kriegsfolgenbereinigungsgesetz). Due to prior criticism about family separations of resettlers, the involvement of immigrating family members was facilitated. Henceforth, resettlers could immigrate with other descendants (for example daughter or son-in-law, stepson or stepdaughter). Before 1993, families may not have immigrated because they may have been allocated to different places of residence. Nevertheless, annually a maximum number of about 220,000 resettlers including family members were allowed to immigrate. From 1996 onwards, laws were again changed and a proof of German language skills was prerequisite for immigration. Only the principal applicant of the family had to be able to conduct a simple conversation in German. If the applicant passed the test, the whole family was allowed to immigrate.(2) Furthermore, resettlers were penalized by cutting social security and unemployment benefits if they left the assigned place of residence within the first two years.(11) Since 2005, incoming resettlers and all family-members have to proof German language skills before immigration.(2)

As a consequence of the described developments in the FSU countries as well as the legislative changes in Germany the composition of resettlers changed. In course of the years, the number of immigrating resettlers decreased and an alteration with regard to the country of origin was observed. In addition, the number of incoming resettlers decreased since the majority already immigrated in the years before. The proportion of resettlers from the Russian Federation increased from 28.6% in 1993 to 45% in 2001 (see figure 2).(3, 6, 12) Additionally, the proportion of couples increased where one of the partners had no German background.(11) Furthermore, qualitative research found decreasing German language skills,(2,

11) since the composition of immigrating resettlers changed and the language courses were scaled back during the 1990s.(12, 13) Increasing integration problems among resettlers were seen over time, since the acceptance of the society decreased, as well as the chances in the labor market, and the government spent less money for language courses and social benefits.(2, 11, 14)

Previous studies investigating the health situation of resettlers in Germany found a lower all-cause mortality among resettlers in three regionally different cohorts compared to the general German population, mainly driven by lower CVD mortality,(15, 16) whereas cancer incidence and mortality showed cancer-specific differences.(17, 18) Data from a small case-control study suggest that those differences may be due to lifestyle factors.(19) Since resettlers used to live within encapsulated communities for centuries almost until World War II, a different genetic pattern to those of the German and the Russian population might be possible. Further analyses from the conducted studies found higher external mortality among resettlers compared to the Germans.(20, 21) Except of Deckert et al.,(20, 22) previous analyses investigated resettlers as a homogenous group. Deckert et al. found differences in mortality with regard to immigration period and immigration age.(20, 22) Nevertheless, those analyses were restricted to a small sample.

In the light of the described developments since 1990, in the countries of the FSU as well as in Germany, we assume that resettlers differ in risk-factor patterns and integration opportunities in Germany depending on the point in time of immigration. Overall, risk-factor patterns, such as tobacco smoking, alcohol consumption, and nutrition may have changed to an unhealthier lifestyle, as a consequence of changes in resettlers' composition. At the same time deteriorated integration opportunities may have affected health care utilization as well as individual well-being and mental health. Both aspects may have had an impact on the mortality of resettlers. Therefore, we first descriptively investigated heterogeneity to describe migration pattern among resettlers based on immigration periods with respect to sex, age at immigration, country of origin and statutory basis and second, we investigated differences in mortality according to different immigration periods.

METHODS

Study Design and Study Population

The study population consists of three cohort studies (N=59,390), which are located in three different regions of Germany: North-Rhine Westphalia, the Saarland and the city of Augsburg in Bavaria. North-Rhine Westphalia was a quasi-randomly cluster selected sample of resettlers, whereas the Saarland and Augsburg cohorts aimed at complete cohorts of all migrants. Follow-up was done through federal or local registration offices, while health authorities provided death certificates, respectively the causes of death, which were classified according to the International Classification of Diseases 10 (ICD-10). More details on the cohorts and vital status ascertainment are described in Kaucher et al.(17)

Variables

Person-years (py) were calculated for each sex, calendar year and 5-year age group and the end of follow-up was 31.12.2009. For this study, we further categorized causes of death as follows: all-causes, malignant neoplasms (ICD-10: C00-C97), cardiovascular diseases (CVD) (ICD-10: I00-I99) and external causes (ICD-10: V01-Y84). All deaths from other ICD-10 codes were summarized and categorized as other causes of death. Missing causes of deaths are presented as a separate category. For comparison with the mortality of the general German population, the WHO mortality database was used, which bases on the total population of Germany.(23)

Legislative changes may have been partly a reaction on the observed changes in the composition of resettlers, but they may as well have facilitated the changing composition. Thus, respective calendar years of these legislative changes in Germany were used to categorize immigration periods, which can be seen as a proxy for changes in composition of resettlers: 1) immigrated between 1990 until end of 1992, 2) immigrated between 1993 until end of 1995 and 3) immigrated between 1996 until end of 2005.

Statistical Analysis

In a first step, we descriptively investigated migration pattern by analysing the association between immigration period and the variables sex, age at immigration, and country of origin for all cohort members. In addition, information on statutory basis was available from the Saarland cohort. Therefore, we selected a subsample with a random procedure (Saarland cohort, n=655).

In a second step, we analysed mortality differences by immigration period to assess the association with resettlers' mortality and migration pattern. We calculated age-standardized mortality rates (ASRs) according to the European standard population,(24) and standardized mortality ratios (SMRs) in comparison to the general German population,(23) along with exact 95% confidence intervals (95%CIs) for cause of death categories, stratified by immigration periods and sex.(25) For comparison reasons, we also calculated mean ASRs for the general German population.

Third, we modeled age-specific rates μ, separated by sex, using Poisson regression according to the following model:

$$log(\mu_{X_1,X_2,X_3}) = \beta_0 + \beta_1 X_1(immigration\ period) + \beta_2 X_2(age\ group) + \beta_3 X_3(year)$$

For the regression, we calculated the person-years for all cross-classifications of age-group, calendar year and immigration period. As independent variables we included immigration period $_{X1}$ as categorical variable with three categories 1: 1990-1992 (Reference group), 2: 1993-1995 and 3: 1996+, age group $_{X2}$ (modeled continuously in 5-year age groups, coded as 1 (0-5 years) to 18 (85+ years)) and year $_{X3}$ (modeled continuously, coded as 1 to 20 (calendar year-1989)). The offset of the model was the log of the py in the respective categories. We addressed possible non-linear associations of age and year on the rates using the fractional polynomials procedure.(26) Using modeled age-specific mortality rates we calculated ASRs by year and immigration period, standardized to the European standard population.(24) For comparison, German ASRs were calculated accordingly.(23) Statistical analyses were performed using SAS Version 9.4 and STATA Version 14.

RESULTS

Descriptive results

Overall, 797,264 py were accumulated and we observed 5572 deaths during the whole observation period. The median follow-up time was 14.2 years. Cause of death was available for 92% of all deaths. All descriptive results, representing migration patterns by immigration period, are shown in table 1.

Table 1: Descriptive results, separated by immigration period

		immigration period		
		1 (1990-1992)	**2 (1993-1995)**	**3 (1996+)**
Total cohort (n=59,390)				
Sex in %	Men	48.6%	48.0%	48.2%

	Women	51.4%	52.0%	51.8%
Mean age at immigration (median; range)	Men	35.7 (34; 0-93)	35.2 (34; 0-93)	34.4 (34; 0-95)
	Women	38.7 (35; 0-93)	38.6 (36; 0-95)	37.0 (36; 0-98)
Country of origin (n; %)	Russian Federation	223 (1.3%)	2015 (10.8%)	7396 (31.6%)
	Kazakhstan	785 (4.5%)	3901 (20.9%)	8803 (37.6%)
	FSU (unspecified)	16,353 (94.2%)	12,708 (68.2%)	7187 (30.7%)
Subsample Saarland cohort (n=655)				
statutory basis in %	unknown	12.9%	4.6%	5.0%
	resettlers	85.0%	80.0%	66.2%
	Non-German spouses	2.2%	15.5%	28.9%

The number of immigrants categorized as "unspecified FSU countries" decreased considerably to the latest immigration period. However, our data showed higher proportion of resettlers from unspecified FSU countries compared to Germany-wide data, since not all cohorts contained the information on the country of origin. Overall, the descriptive results since 1993 and the proportional changes of countries of origin reflect the observed federal trend. Regarding the statutory basis, we found similar migration patterns in the Saarland subsample to the federal trend. While in the first immigration period the majority of immigrating resettlers were ethnic Germans (85.0%), the percentage decreased subsequently (66.2%), whereas the percentage proportion of non-German spouses increased. On average, resettlers of the latest immigration period were younger compared to resettlers from the first immigration period. No difference in sex composition was observed.

Mortality pattern by immigration period

Results of all-cause and cause-specific ASR and SMR analyses of resettlers from the FSU, separated by sex and immigration period are presented in table 2.

Table 2: Cause-specific age-standardized rates and standardized mortality ratios with 95% confidence intervals, by sex and immigration period

Resettler men by immigration period										German men
	1 (1990-1992)			2 (1993-1995)			3 (1996+)			1990-2009
	Obs	ASR§ (95%CI)	SMR* (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)	ASR
All-Causes	1088	726.5 (681.4-771.6)	**0.85 (0.80-0.90)**	1010	802.6 (749.7-855.5)	0.98 (0.92-1.04)	800	834.2 (770.7-897.7)	**1.11 (1.04-1.19)**	885.7
malignant neoplasm (C00-C97)	325	209.9 (186.2-233.7)	0.90 (0.81-1.01)	304	235.6 (208.1-263.1)	1.03 (0.92-1.15)	235	244.4 (211.1-277.8)	1.12 (0.98-1.27)	237.2
CVD (I00-I99)	382	267.2 (239.3-295.2)	**0.75 (0.68-0.83)**	329	280.8 (248.1-313.5)	**0.83 (0.74-0.92)**	223	251.6 (215.4-287.8)	**0.86 (0.75-0.98)**	368.7
External Causes (V01-Y84)	65	39.7 (29.4-50.1)	**0.77 (0.60-0.98)**	81	58.2 (44.1-72.4)	1.13 (0.91-1.40)	73	53.5 (40.7-66.2)	**1.29 (1.03-1.63)**	53.3
Other Causes	242	162.0 (140.6-183.3)	**0.74 (0.65-0.83)**	219	171.0 (146.7-195.4)	**0.82 (0.72-0.93)**	187	206.2 (173.0-239.4)	0.98 (0.85-1.13)	226.5
Missing Causes	74			77			82			
Resettler women by immigration period										**German women**
	1 (1990-1992)			**2 (1993-1995)**			**3 (1996+)**			**1990-2009**
	Obs	ASR§ (95%CI)	SMR* (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)	ASR
All-Causes	1036	437.2 (409.4-464.9)	**0.83 (0.78-0.88)**	943	443.0 (413.2-472.9)	**0.86 (0.81-0.92)**	695	473.0 (437.3-508.8)	0.96 (0.89-1.04)	546.7
malignant neoplasm (C00-C97)	256	119.2 (103.9-134.5)	**0.80 (0.71-0.91)**	213	106.0 (90.2-121.8)	**0.76 (0.66-0.87)**	200	138.7 (119.0-158.3)	1.01 (0.88-1.16)	145.4
CVD (I00-I99)	477	189.4 (172.0-206.9)	**0.81 (0.74-0.88)**	440	200.6 (181.2-219.9)	**0.87 (0.79-0.95)**	267	175.6 (154.3-197.0)	**0.85 (0.75-0.96)**	246.4
External Causes (V01-Y84)	29	15.6 (9.5-21.7)	**0.69 (0.48-1.00)**	16	10.1 (4.5-15.6)	**0.44 (0.27-0.73)**	14	10.5 (4.9-16.1)	**0.53 (0.31-0.90)**	21.6
Other Causes	212	86.9 (74.8-99.0)	**0.70 (0.62-0.81)**	206	94.8 (81.5-108.1)	**0.77 (0.67-0.88)**	143	98.4 (82.0-114.8)	**0.78 (0.67-0.92)**	133.4
Missing Causes	62			68			71			

*§ per 100.000 person-years; *significant SMR results are bolded*

ASRs for all-cause mortality were significantly higher among resettlers from the latest immigration period (ASR (both sexes) 628.1, 95%CI [595.3-660.8]) compared to resettlers from the first immigration period (ASR (both sexes) 561.8, 95%CI [537.2-586.4]). The same trend can be reported for malignant neoplasms, although not significant. For external mortality, an increase was only found among resettler men who came between 1993 until end of 1995 (ASR 58.2, 95%CI [44.1-72.4]) and in the latest immigration period (ASR 53.5, 95%CI [40.7-66.2]), compared to resettlers who immigrated before 1993

(ASR 39.7, 95%CI [29.4-50.1]). No considerable differences can be reported for CVD mortality and for mortality from other causes, in both sexes respectively.

Results from SMR analysis showed additionally that resettler men from the latest immigration period had a significantly higher all-cause mortality (SMR 1.11, 95%CI [1.04-1.19]) and external cause mortality (SMR 1.29, 95%CI [1.03-1.63]) compared to the general German male population.

Poisson regression

Results from Poisson regression showed significant effects of immigration period, adjusted for age and year. Male resettlers who came within the second immigration period had a significantly higher all-cause mortality compared to resettlers from the first immigration period (RR=1.13). This effect was even higher for male resettlers who came in 1996 and the years after (RR=1.23). Female resettlers from the second immigration period showed almost the same mortality compared to female resettlers form the first immigration period (RR=1.03, not significant). However, all-cause mortality was significantly higher for female resettlers who came in the last immigration period, compared to resettlers from the first immigration period (RR=1.13). The modeled estimates are presented online in the supplementary material.

Figure 3 presents modeled ASRs, separated by immigration period and sex, from 1990 to 2009 for resettlers and for the general German population. Transformations are shown at the bottom of figure 3. In both sexes, all-cause mortality was lowest among resettlers who came before 1993. Mortality rates among resettlers who came between 1993 and end of 1995 were somewhat higher compared to resettlers who came in the first immigration period, but mortality rates among women were still lower compared to the German population. For male resettlers from the second immigration period, mortality rates crossed the German mortality rates in the mid of 2000s. For resettlers who came in 1996 and the years after, mortality rates were highest, compared to the other immigration periods. Since 2000, mortality rates of male resettlers were even higher compared to mortality rates of German men. For resettler women who came in 1996 and after, mortality rates remained lower compared to the German rates.

DISCUSSION

This is a register based cohort study with mortality as the observed endpoint. We have limited information on covariables which may have an effect on mortality, and therefore this study due to its size, is able to analyse mortality patterns with respect to immigration period, sex and age. Secondary data indicate covariable patterns that may be linked to these variables, however, interpretation of these covariables towards a relation with mortality is difficult. All the following discussion must be seen in the light of this fact.

We considered three immigration periods, defined by year of relevant legislative changes and found significantly higher all-cause mortality among resettlers from the last immigration period compared to resettlers who immigrated before 1993. Cancer mortality showed the same trend, although not significant. In addition, mortality from external causes among men was found to be increased in resettlers from the last two immigration periods compared to resettlers from the first immigration period (not significant). We put special attention to the comparison of resettler mortality with the mortality of the general German population: All-cause mortality among male resettlers from the third immigration period was found to be higher compared to the mortality of the general German population whereas mortality among resettler men who immigrated before 1996 was lower. This result, which considers a time component, is of particular interest, since so far, we only reported overall lower all-cause mortality among resettlers, compared to the general German population.

We believe that the differences in mortality may be linked to the observed changes in the composition of resettlers. As a consequence, resettlers may have had different risk-factor patterns, depending on the immigration period. Some authors found that immigration reasons changed over time: while resettlers who came in the beginning, immigrated mostly because of ethnical, religious and cultural reasons, this changed to more economic and social reasons already in the early 1990s.(27) Indicators for this are better German language skills in the beginning, which deteriorated over time mainly due to an increasing number of ethnic-mixed couples in the later years, which was observed in several studies.(2, 11, 14) Descriptive results hint to increasing immigration of ethnic mixed-couples instead of mainly ethnic German couples in the later years, which may have further influenced the risk-factor pattern. Possibly resettlers who immigrated in later years had an unhealthier lifestyle, e.g. higher prevalence of smoking and alcohol consumption, compared to resettlers who came in the beginning of the 1990s. Significantly higher mortality among resettlers from the second and third immigration periods, compared to resettlers from the first immigration period, support this assumption. This effect was highest among resettlers, who came 1996 and after in younger ages (<30 years) (RR 1.46, 95%CI [1.17-1.81]). Poor literacy skills, which are associated with poor health literacy and poor health outcomes, may also explain the differences in resettlers' mortality by immigration period.(28, 29)

Differences in mortality may also in part be explained by heterogeneous integration opportunities for resettlers, depending on immigration period. Whereas the acceptance of migrants in the autochthonous population was fairly high in the beginning, it decreased considerably during the 1990s.(11, 30) A study found increasing language problems with higher tendencies of withdrawing into resettler peer-groups.(14, 31) Furthermore, resettlers who immigrated in the beginning of the 1990s had considerably better chances on the labor market compared to resettlers who immigrated in the mid of the 1990s and later. Since the profession of mostly women and academics was not recognized, many resettlers did not work within their profession and suffered from social relegation.(11, 30) Hence, it can be assumed that the integration of resettlers who came in the beginning was more successful than the integration of resettlers of the later years.(2) Higher external mortality among resettler men from the latest immigration period, compared to resettler men from the first immigration period, support this assumption. It was shown before that poor integration is associated with mental health problems, as well as with higher risk of suicide and external mortality.(20, 32)

A healthy migrant effect among resettlers is unlikely, due to several reasons: The restrictions on admission for resettlers were never as rigorous as for other migrant groups. Due to their immediately assigned German citizenship, resettlers have the right of social security and unemployment benefit, as well as the right of permanent residence in Germany.(33) Furthermore, we investigated that resettlers immigrated mostly with their whole families and we could observe deaths of older study participants due to severe diseases within a short period after arrival.(22, 34) Nonetheless, to fully rule out a healthy migrant effect, we need to investigate data of resettlers, who remained in the countries of the FSU. However, this data is not yet available. A more detailed discussion about the healthy migrant effect in our study population can be found elsewhere.(17)

The legislative changes were intended to improve the integration process of resettlers, while agglomerations should have been avoided and the communication with the autochthonous population should have been facilitated. Nevertheless, legislative changes were seen controversially. Criticism was addressed towards the inconsistent process of the language test and that the importance of geographical proximity to the social network was neglected.(11, 31)

We do not assume that immigration period itself had an impact on resettlers' mortality, rather that immigration period reflects different risk-factor patterns and changing integration opportunities for

resettlers, thus are influencing mortality. Therefore, immigration period can be seen as a proxy for different risk-factor pattern and integration opportunities.

Strengths and limitations

It needs to be stated that our study is based on secondary data without any information on risk-factor patterns or on the integration process. Information on educational level and socioeconomic status was not available and could not be accounted for. Additionally, data on statutory basis by immigration period were only available from a subgroup of the Saarland cohort. Nevertheless, our descriptive results reflect the migration pattern of immigrating resettlers from the federal level.(12) We compared resettler mortality to the mortality of the general German population, which includes migrants and resettlers, which consequently could lead to an underestimation of SMR results. However, in a sensitivity analysis targeting this issue Deckert found negligible effects of distortion.(22)

We would like to highlight the study design and the long observation period of our study. We were able to investigate mortality for 20 years of follow-up and to distinguish between immigration periods. After arrival, resettlers were assigned to a federal state at random, therefore, we assume that our study population reflects the entire group of resettlers living in Germany and that our results are generalizable to them.

CONCLUSIONS

Migrants are hardly ever homogeneous groups which needs to be taken into account when offering health care prevention and specific support for better integration. This study demonstrated that this migrant group which seemed homogeneous at first glance, showed considerable heterogeneity by period of immigration. Further research on resettlers' migration pattern and integration problems, their origin and their impact on health may help to substantially improve current and future challenges related to immigration. Health policy should guard the consequences of immigration law alterations with respect to changing compositions of migrant groups and their health status.

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Contributors The cohort study was initiated by HB and performed by VW, HB and AD. SK and VW analysed the data. SK drafted the manuscript and all authors contributed to writing and the interpretation of the results.

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Ethical Approval Ethics Committee of the Medical Faculty, University Hospital Heidelberg.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

Data Sharing Statement If interested in cooperation, the data set will be provided from the corresponding author.

Figure Legends

Figure 1: annual change of GDP per capita growth in % and life expectancy at birth in the 1990s in the Russian Federation, Ukraine and Kazakhstan(10)

Figure 2: Total amount of immigrating FSU resettlers by year (left axis), and composition of countries of origin from immigrating resettlers from the FSU by year (in %, right axis)(6)

Figure 3: modeled age-standardized rates for all-cause mortality for resettlers (separated by immigration period and sex) and the German population, using European Standard population, from 1990 to 2009

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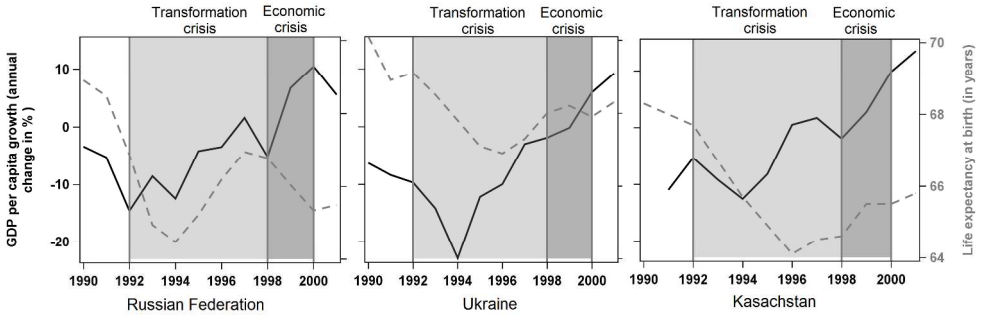

Figure 1: annual change of GDP per capita growth in % and life expectancy at birth in the 1990s in the Russian Federation, Ukraine and Kazakhstan(8)

278x92mm (300 x 300 DPI)

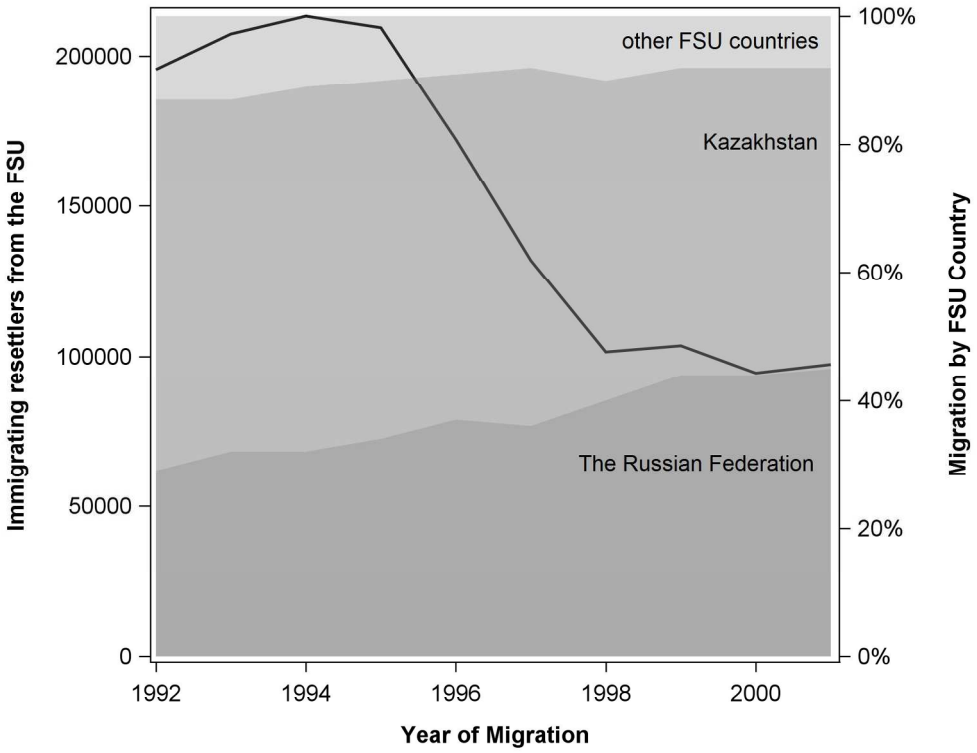

Figure 2: Total amount of immigrating FSU resettlers by year (left axis), and composition of countries of origin from immigrating resettlers from the FSU by year (in %, right axis)(12)

180x140mm (300 x 300 DPI)

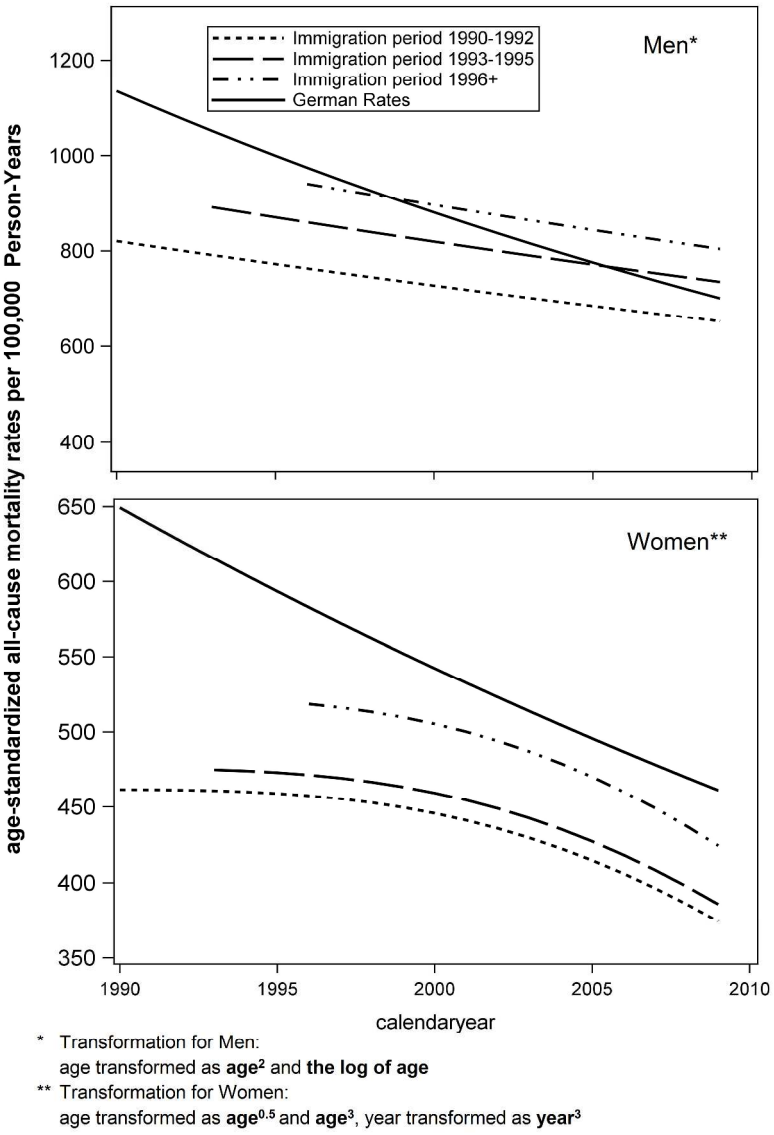

Figure 3: modeled age-standardized rates for all-cause mortality for resettlers (separated by immigration period and sex) and the German population, using European Standard population, from 1990 to 2009

310x431mm (300 x 300 DPI)

Supplementary Material – Poisson Regression estimates and p-values, separated by sex

Poisson Regression β-estimates and p-values for men		
	Estimate	**p-value**
Intercept	-8.641	<0.0001
age group:		
age group^2	0.014	<0.0001
logarithm of age group	0.752	<0.0001
year:		
(calendar year -1989)	-0.012	0.0033
Immigration period:		
1990-1992	Ref.	
1993-1995	0.120	0.0066
1996-2005	0.209	<0.0001

Poisson Regression β-estimates and p-values for women		
	Estimate	**p-value**
Intercept	-9.947	<0.0001
age group:		
age group$^{0.5}$	0.848	<0.0001
age group^3	0.001	<0.0001
year:		
(calendar year-1989)^3	-0.000*	0.0009
Immigration period:		
1990-1992	Ref.	
1993-1995	0.030	0.5083
1996-2005	0.125	0.0123

* Exact estimate: -.0000261

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	In the Title and Abstract (page 1 and 2)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4
Methods			
Study design	4	Present key elements of study design early in the paper	Page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 4 (only a brief description, however, a reference is cited, where detailed information can be found)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Page 4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Pages 4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Pages 4-5
Bias	9	Describe any efforts to address potential sources of bias	Not applicable, since we used registry-data
Study size	10	Explain how the study size was arrived at	Page 4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Pages 4-5

Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Pages 4-5
		(*b*) Describe any methods used to examine subgroups and interactions	Pages 4-5
		(*c*) Explain how missing data were addressed	Page 4 (since registry-data was used, there is no missing data – only missing causes of death)
		(*d*) If applicable, explain how loss to follow-up was addressed	Not applicable since we used registry data
		(*e*) Describe any sensitivity analyses	Not applicable
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 5
		(b) Give reasons for non-participation at each stage	Not applicable, since we used registry data
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 5 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	Page 5; 6-7 (Table 1 & 2)
		(c) Summarise follow-up time (eg, average and total amount)	Page 5
Outcome data	15*	Report numbers of outcome events or summary measures over time	Pages 5-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Pages 6-7, figure 3 and supplementary table
		(*b*) Report category boundaries when continuous variables were categorized	Pages 5-7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not applicable.
Discussion			
Key results	18	Summarise key results with reference to study objectives	Pages 7-8
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Pages 7-9

Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 9

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Migration pattern and mortality of ethnic German migrants from the former Soviet Union: a cohort study in Germany

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Migration pattern and mortality of ethnic German migrants from the former Soviet Union: a cohort study in Germany

Simone Kaucher,[1] Andreas Deckert,[1] Heiko Becher,[1,2] Volker Winkler[1]

1 University Hospital Heidelberg, Institute of Public Health, Unit of Epidemiology and Biostatistics, Im Neuenheimer Feld 324, 69120 Heidelberg, Germany
2 University Medical Center Hamburg-Eppendorf, Institute for Medical Biometry and Epidemiology, Martinistraße 52, 20246 Hamburg, Germany

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Corresponding author

Volker Winkler, Institute of Public Health, Unit of Epidemiology and Biostatistics, Im Neuenheimer Feld 324, 69120 Heidelberg, Germany, tel: +49 (0) 6221 56 35049, e-mail: v.winkler@uni-heidelberg.de.

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ABSTRACT

Objective We aimed to investigate all-cause and cause-specific mortality among ethnic German migrants from the former Soviet Union by different immigration periods to describe associations with migration pattern and mortality.

Design We used pooled data from three retrospective cohort studies in Germany.

Participants Ethnic German migrants from the former Soviet Union (called resettlers), who immigrated to Germany since 1990 to the federal states North Rhine-Westphalia and Saarland and to the region of Augsburg (N=59,390).

Outcome All-cause and cause-specific mortality among resettlers in comparison to the general German population, separated by immigration period.

Methods Immigration periods were defined following legislative changes in German immigration policy (1990-1992, 1993-1995, 1996+). Resettlers' characteristics were described accordingly. To investigate mortality differences by immigration period, we calculated age-standardized mortality rates (ASRs) and standardized mortality ratios (SMRs) of resettlers in comparison to the general German population. Additionally, we modeled sex-specific ASRs with Poisson regression, using age, year and immigration period as independent variables.

Results The composition of resettlers differed by immigration period: Since 1993, the percentage of resettlers from the Russian Federation and non-German spouses increased. Higher all-cause mortality was found among resettlers who immigrated in 1996 and after (ASR 628.1, 95%CI [595.3-660.8]), compared to resettlers who immigrated before 1993 (ASR 561.8, 95%CI [537.2-586.4]). SMR analysis showed higher all-cause mortality among resettler men from the last immigration period compared to German men (SMR 1.11, 95%CI [1.04-1.19]), whereas resettlers who immigrated earlier showed lower all-cause mortality. Results from Poisson regression, adjusted for age and year, corroborated those findings.

Conclusions Mortality differences by immigration period suggest different risk-factor patterns and possibly deteriorated integration opportunities. Health policy should guard the consequences of immigration law alterations with respect to changing compositions of migrant groups and their health status.

Strengths and limitations

- This study includes a large number of resettlers living in Germany and a mortality follow-up of 20 years, thus we were able to investigate differences of resettlers' mortality based on their migration pattern, for the first time.
- Since resettlers are distributed randomly to their place of residence, we assume that our results are generalizable to resettlers living in other regions of Germany.
- Data on risk-factor patterns and integration process was not available, since registry data was used.
- Information on statutory basis was only available for a subgroup of the cohort.

INTRODUCTION

In the 18th and 19th century, Germans emigrated to the Russian empire. At the beginning, they were privileged compared to the Russian population, but since about World War I, they became persecuted and suffered increasing discrimination. In the 1930s and thereafter, many ethnic Germans were deported to specific regions within the former Soviet Union (FSU), most of them to Kazakhstan and Siberia. There, they were forced to work in agriculture and were not allowed to return to their places of residence from pre-war years.(1) Since 1953, ethnic Germans and their families, including non-German spouses and their children (descendants), were invited to return to Germany based on the Federal Expellee Law (in German: Bundesvertriebenengesetz), resulting in immigration waves from Poland and Romania, for instance. Yet, in the countries of the FSU migration was hindered by strict emigration regulations. However, after the collapse of the Soviet Union, a massive emigration of ethnic Germans and their families, called resettlers (in German: (Spät-) Aussiedler), took place.(2) By law, upon arrival, resettlers are granted full German citizenship.(3) By 1989, the Institute of German Economy assumed that the integration of resettlers will be easy due to very good conditions for integration.(4) Many of the older resettlers spoke German and were familiar with the German culture and traditions.(5) Between 1990 and 2005, more than 2 million resettlers from the FSU migrated to Germany.(6)

After the fall of the Iron Curtain, the so-called *transformation crisis* arose and consequently, the countries of the FSU had to handle multiple political and economic challenges. For instance, life expectancy and GDP dropped sharply in the Russian Federation,(7) but also in the Ukraine and in Kazakhstan.(8, 9) (see figure 1).(10)

Due to the high number of immigrating resettlers with a peak of 213,000 from the FSU in 1994,(6) the German government began to further regulate the flow of immigration with the help of various legislative changes.(2) In 1989, the law of residence assignment (in German: Wohnortzuweisungsgesetz) was introduced. To avoid agglomerations, incoming resettlers were allocated to their first place of residence based on regional population density and economic performance (in German: Königsteiner Schlüssel), where they had to live for at least two years (since 2005 three years).(11) Besides this, there were hardly any restrictions on admission for resettlers. In 1993, the German government issued the Adjustment of Laws on the Effects of War (in German: Kriegsfolgenbereinigungsgesetz). Due to prior criticism about family separations of resettlers, the involvement of immigrating family members was facilitated. Henceforth, resettlers could immigrate with other descendants (for example daughter or son-in-law, stepson or stepdaughter). Before 1993, families may not have immigrated because they may have been allocated to different places of residence. Nevertheless, annually a maximum number of about 220,000 resettlers including family members were allowed to immigrate. From 1996 onwards, laws were again changed and a proof of German language skills was prerequisite for immigration. Only the principal applicant of the family had to be able to conduct a simple conversation in German. If the applicant passed the test, the whole family was allowed to immigrate.(2) Furthermore, resettlers were penalized by cutting social security and unemployment benefits if they left the assigned place of residence within the first two years.(11) Since 2005, incoming resettlers and all family-members have to proof German language skills before immigration.(2)

As a consequence of the described developments in the FSU countries as well as the legislative changes in Germany the composition of resettlers changed. In course of the years, the number of immigrating resettlers decreased and an alteration with regard to the country of origin was observed. In addition, the number of incoming resettlers decreased since the majority already immigrated in the years before. The proportion of resettlers from the Russian Federation increased from 28.6% in 1993 to 45% in 2001 (see figure 2).(3, 6, 12) Additionally, the proportion of couples increased where one of the partners had no German background.(11) Furthermore, qualitative research found decreasing German language skills,(2,

11) since the composition of immigrating resettlers changed and the language courses were scaled back during the 1990s.(12, 13) Increasing integration problems among resettlers were seen over time, since the acceptance of the society decreased, as well as the chances in the labor market, and the government spent less money for language courses and social benefits.(2, 11, 14)

Previous studies investigating the health situation of resettlers in Germany found a lower all-cause mortality among resettlers in three regionally different cohorts compared to the general German population, mainly driven by lower CVD mortality,(15, 16) whereas cancer incidence and mortality showed cancer-specific differences.(17, 18) Data from a small case-control study suggest that those differences may be due to lifestyle factors.(19) Since resettlers used to live within encapsulated communities for centuries almost until World War II, a different genetic pattern to those of the German and the Russian population might be possible. Further analyses from the conducted studies found higher external mortality among resettlers compared to the Germans.(20, 21) Except of Deckert et al.,(20, 22) previous analyses investigated resettlers as a homogenous group. Deckert et al. found differences in mortality with regard to immigration period and immigration age.(20, 22) Nevertheless, those analyses were restricted to a small sample.

In the light of the described developments since 1990, in the countries of the FSU as well as in Germany, we assume that resettlers differ in risk-factor patterns and integration opportunities in Germany depending on the point in time of immigration. Overall, risk-factor patterns, such as tobacco smoking, alcohol consumption, and nutrition may have changed to an unhealthier lifestyle, as a consequence of changes in resettlers' composition. At the same time deteriorated integration opportunities may have affected health care utilization as well as individual well-being and mental health. Both aspects may have had an impact on the mortality of resettlers. Therefore, we first descriptively investigated heterogeneity to describe migration pattern among resettlers based on immigration periods with respect to sex, age at immigration, country of origin and statutory basis and second, we investigated differences in mortality according to different immigration periods.

METHODS

Study Design and Study Population

The study population consists of three cohort studies (N=59,390), which are located in three different regions of Germany: North-Rhine Westphalia, the Saarland and the city of Augsburg in Bavaria. North-Rhine Westphalia was a quasi-randomly cluster selected sample of resettlers, whereas the Saarland and Augsburg cohorts aimed at complete cohorts of all migrants. Follow-up was done through federal or local registration offices, while health authorities provided death certificates, respectively the causes of death, which were classified according to the International Classification of Diseases 10 (ICD-10). More details on the cohorts and vital status ascertainment are described in Kaucher et al.(17)

Variables

Person-years (py) were calculated for each sex, calendar year and 5-year age group and the end of follow-up was 31.12.2009. For this study, we further categorized causes of death as follows: all-causes, malignant neoplasms (ICD-10: C00-C97), cardiovascular diseases (CVD) (ICD-10: I00-I99) and external causes (ICD-10: V01-Y84). All deaths from other ICD-10 codes were summarized and categorized as other causes of death. Missing causes of deaths are presented as a separate category. For comparison with the mortality of the general German population, the WHO mortality database was used, which bases on the total population of Germany.(23)

Legislative changes may have been partly a reaction on the observed changes in the composition of resettlers, but they may as well have facilitated the changing composition. Thus, respective calendar years of these legislative changes in Germany were used to categorize immigration periods, which can be seen as a proxy for changes in composition of resettlers: 1) immigrated between 1990 until end of 1992, 2) immigrated between 1993 until end of 1995 and 3) immigrated between 1996 until end of 2005.

Statistical Analysis

In a first step, we descriptively investigated migration pattern by analysing the association between immigration period and the variables sex, age at immigration, and country of origin for all cohort members. In addition, information on statutory basis was available from the Saarland cohort. Therefore, we selected a subsample with a random procedure (Saarland cohort, n=655).

In a second step, we analysed mortality differences by immigration period to assess the association with resettlers' mortality and migration pattern. We calculated age-standardized mortality rates (ASRs) according to the European standard population,(24) and standardized mortality ratios (SMRs) in comparison to the general German population,(23) along with exact 95% confidence intervals (95%CIs) for cause of death categories, stratified by immigration periods and sex.(25) Therefore, expected numbers of death for SMR calculation relate to resettlers who immigrated in the respective immigration periods. For comparison reasons, we also calculated mean ASRs for the general German population.

Third, we modeled age-specific rates μ, separated by sex, using Poisson regression according to the following model:

$$log\left(\mu_{X_1,X_2,X_3}\right) = \beta_0 + \beta_1 X_1(immigration\ period) + \beta_2 X_2(age\ group) + \beta_3 X_3(year)$$

For the regression, we calculated the person-years for all cross-classifications of age-group, calendar year and immigration period. As independent variables we included immigration period $_{X1}$ as categorical variable with three categories 1: 1990-1992 (Reference group), 2: 1993-1995 and 3: 1996+, age group $_{X2}$ (modeled continuously in 5-year age groups, coded as 1 (0-5 years) to 18 (85+ years)) and year $_{X3}$ (modeled continuously, coded as 1 to 20 (calendar year-1989)). The offset of the model was the log of the py in the respective categories. We addressed possible non-linear associations of age and year on the rates using the fractional polynomials procedure.(26) Using modeled age-specific mortality rates we calculated ASRs by year and immigration period, standardized to the European standard population.(24) For comparison, German ASRs were calculated accordingly.(23) Statistical analyses were performed using SAS Version 9.4 and STATA Version 14.

RESULTS

Descriptive results

Overall, 797,264 py were accumulated and we observed 5572 deaths during the whole observation period. The median follow-up time was 14.2 years. Cause of death was available for 92% of all deaths. All descriptive results, representing migration patterns by immigration period, are shown in table 1.

Table 1: Descriptive results, separated by immigration period

	immigration period		
	1 (1990-1992)	**2 (1993-1995)**	**3 (1996+)**
Total cohort (n=59,390)			

Sex in %	Men	48.6%	48.0%	48.2%
	Women	51.4%	52.0%	51.8%
Mean age at immigration (median; range)	Men	35.7 (34; 0-93)	35.2 (34; 0-93)	34.4 (34; 0-95)
	Women	38.7 (35; 0-93)	38.6 (36; 0-95)	37.0 (36; 0-98)
Country of origin (n; %)	Russian Federation	223 (1.3%)	2015 (10.8%)	7396 (31.6%)
	Kazakhstan	785 (4.5%)	3902 (20.9%)	8803 (37.6%)
	FSU (unspecified)	16,358 (94.2%)	12,718 (68.2%)	7190 (30.7%)
Subsample Saarland cohort (n=655)				
statutory basis in %	unknown	12.9%	4.6%	5.0%
	resettlers	85.0%	80.0%	66.2%
	Non-German spouses	2.2%	15.5%	28.9%

The number of immigrants categorized as "unspecified FSU countries" decreased considerably to the latest immigration period. However, our data showed higher proportion of resettlers from unspecified FSU countries compared to Germany-wide data, since not all cohorts contained the information on the country of origin. Overall, the descriptive results since 1993 and the proportional changes of countries of origin reflect the observed federal trend. Regarding the statutory basis, we found similar migration patterns in the Saarland subsample to the federal trend. While in the first immigration period the majority of immigrating resettlers were ethnic Germans (85.0%), the percentage decreased subsequently (66.2%), whereas the percentage proportion of non-German spouses increased. On average, resettlers of the latest immigration period were younger compared to resettlers from the first immigration period. No difference in sex composition was observed.

Mortality pattern by immigration period

Results of all-cause and cause-specific ASR and SMR analyses of resettlers from the FSU, separated by sex and immigration period are presented in table 2.

Table 2: Cause-specific age-standardized rates and standardized mortality ratios with 95% confidence intervals, by sex and immigration period

Resettler men by immigration period										German men
	1 (1990-1992)			2 (1993-1995)			3 (1996+)			1990-2009
	Obs	ASR§ (95%CI)	SMR* (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)	ASR
All-Causes	1088	726.5 (681.4-771.6)	**0.85 (0.80-0.90)**	1010	802.6 (749.7-855.5)	0.98 (0.92-1.04)	800	834.2 (770.7-897.7)	**1.11 (1.04-1.19)**	885.7
malignant neoplasm (C00-C97)	325	209.9 (186.2-233.7)	0.90 (0.81-1.01)	304	235.6 (208.1-263.1)	1.03 (0.92-1.15)	235	244.4 (211.1-277.8)	1.12 (0.98-1.27)	237.2
CVD (I00-I99)	382	267.2 (239.3-295.2)	**0.75 (0.68-0.83)**	329	280.8 (248.1-313.5)	**0.83 (0.74-0.92)**	223	251.6 (215.4-287.8)	**0.86 (0.75-0.98)**	368.7
External Causes (V01-Y84)	65	39.7 (29.4-50.1)	**0.77 (0.60-0.98)**	81	58.2 (44.1-72.4)	1.13 (0.91-1.40)	73	53.5 (40.7-66.2)	**1.29 (1.03-1.63)**	53.3
Other Causes	242	162.0 (140.6-183.3)	**0.74 (0.65-0.83)**	219	171.0 (146.7-195.4)	**0.82 (0.72-0.93)**	187	206.2 (173.0-239.4)	0.98 (0.85-1.13)	226.5
Missing Causes	74			77			82			
Resettler women by immigration period										**German women**
	1 (1990-1992)			**2 (1993-1995)**			**3 (1996+)**			**1990-2009**
	Obs	ASR§ (95%CI)	SMR* (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)	Obs	ASR (95%CI)	SMR (95%CI)	ASR
All-Causes	1036	437.2 (409.4-464.9)	**0.83 (0.78-0.88)**	943	443.0 (413.2-472.9)	**0.86 (0.81-0.92)**	695	473.0 (437.3-508.8)	0.96 (0.89-1.04)	546.7
malignant neoplasm (C00-C97)	256	119.2 (103.9-134.5)	**0.80 (0.71-0.91)**	213	106.0 (90.2-121.8)	**0.76 (0.66-0.87)**	200	138.7 (119.0-158.3)	1.01 (0.88-1.16)	145.4
CVD (I00-I99)	477	189.4 (172.0-206.9)	**0.81 (0.74-0.88)**	440	200.6 (181.2-219.9)	**0.87 (0.79-0.95)**	267	175.6 (154.3-197.0)	**0.85 (0.75-0.96)**	246.4
External Causes (V01-Y84)	29	15.6 (9.5-21.7)	**0.69 (0.48-1.00)**	16	10.1 (4.5-15.6)	**0.44 (0.27-0.73)**	14	10.5 (4.9-16.1)	**0.53 (0.31-0.90)**	21.6
Other Causes	212	86.9 (74.8-99.0)	**0.70 (0.62-0.81)**	206	94.8 (81.5-108.1)	**0.77 (0.67-0.88)**	143	98.4 (82.0-114.8)	**0.78 (0.67-0.92)**	133.4
Missing Causes	62			68			71			

*§ per 100.000 person-years; *significant SMR results are bolded*

ASRs for all-cause mortality were significantly higher among resettlers from the latest immigration period (ASR (both sexes) 628.1, 95%CI [595.3-660.8]) compared to resettlers from the first immigration period (ASR (both sexes) 561.8, 95%CI [537.2-586.4]). The same trend can be reported for malignant neoplasms, although not significant. For external mortality, an increase was only found among resettler men who came between 1993 until end of 1995 (ASR 58.2, 95%CI [44.1-72.4]) and in the latest immigration period (ASR 53.5, 95%CI [40.7-66.2]), compared to resettlers who immigrated before 1993

(ASR 39.7, 95%CI [29.4-50.1]). No considerable differences can be reported for CVD mortality and for mortality from other causes, in both sexes respectively.

Results from SMR analysis showed additionally that resettler men from the latest immigration period had a significantly higher all-cause mortality (SMR 1.11, 95%CI [1.04-1.19]) and external cause mortality (SMR 1.29, 95%CI [1.03-1.63]) compared to the general German male population.

Poisson regression

Results from Poisson regression showed significant effects of immigration period, adjusted for age and year. Male resettlers who came within the second immigration period had a significantly higher all-cause mortality compared to resettlers from the first immigration period (RR=1.13). This effect was even higher for male resettlers who came in 1996 and the years after (RR=1.23). Female resettlers from the second immigration period showed almost the same mortality compared to female resettlers form the first immigration period (RR=1.03, not significant). However, all-cause mortality was significantly higher for female resettlers who came in the last immigration period, compared to resettlers from the first immigration period (RR=1.13). The modeled estimates are presented online in the supplementary material.

Figure 3 presents modeled ASRs, separated by immigration period and sex, from 1990 to 2009 for resettlers and for the general German population. Transformations are shown at the bottom of figure 3. In both sexes, all-cause mortality was lowest among resettlers who came before 1993. Mortality rates among resettlers who came between 1993 and end of 1995 were somewhat higher compared to resettlers who came in the first immigration period, but mortality rates among women were still lower compared to the German population. For male resettlers from the second immigration period, mortality rates crossed the German mortality rates in the mid of 2000s. For resettlers who came in 1996 and the years after, mortality rates were highest, compared to the other immigration periods. Since 2000, mortality rates of male resettlers were even higher compared to mortality rates of German men. For resettler women who came in 1996 and after, mortality rates remained lower compared to the German rates.

DISCUSSION

This is a register based cohort study with mortality as the observed endpoint. We have limited information on covariables which may have an effect on mortality, and therefore this study due to its size, is able to analyse mortality patterns with respect to immigration period, sex and age. Secondary data indicate covariable patterns that may be linked to these variables, however, interpretation of these covariables towards a relation with mortality is difficult. All the following discussion must be seen in the light of this fact.

We considered three immigration periods, defined by year of relevant legislative changes and found significantly higher all-cause mortality among resettlers from the last immigration period compared to resettlers who immigrated before 1993. Cancer mortality showed the same trend, although not significant. In addition, mortality from external causes among men was found to be increased in resettlers from the last two immigration periods compared to resettlers from the first immigration period (not significant). We put special attention to the comparison of resettler mortality with the mortality of the general German population: All-cause mortality among male resettlers from the third immigration period was found to be higher compared to the mortality of the general German population whereas mortality among resettler men who immigrated before 1996 was lower. This result, which considers a time component, is of particular interest, since so far, we only reported overall lower all-cause mortality among resettlers, compared to the general German population.

We believe that the differences in mortality may be linked to the observed changes in the composition of resettlers. As a consequence, resettlers may have had different risk-factor patterns, depending on the immigration period. Some authors found that immigration reasons changed over time: while resettlers who came in the beginning, immigrated mostly because of ethnical, religious and cultural reasons, this changed to more economic and social reasons already in the early 1990s.(27) Indicators for this are better German language skills in the beginning, which deteriorated over time mainly due to an increasing number of ethnic-mixed couples in the later years, which was observed in several studies.(2, 11, 14) Descriptive results hint to increasing immigration of ethnic mixed-couples instead of mainly ethnic German couples in the later years, which may have further influenced the risk-factor pattern. Possibly resettlers who immigrated in later years had an unhealthier lifestyle, e.g. higher prevalence of smoking and alcohol consumption, compared to resettlers who came in the beginning of the 1990s. Significantly higher mortality among resettlers from the second and third immigration periods, compared to resettlers from the first immigration period, support this assumption. This effect was highest among resettlers, who came 1996 and after in younger ages (<30 years) (RR 1.46, 95%CI [1.17-1.81]). Poor literacy skills, which are associated with poor health literacy and poor health outcomes, may also explain the differences in resettlers' mortality by immigration period.(28, 29)

Differences in mortality may also in part be explained by heterogeneous integration opportunities for resettlers, depending on immigration period. Whereas the acceptance of migrants in the autochthonous population was fairly high in the beginning, it decreased considerably during the 1990s.(11, 30) A study found increasing language problems with higher tendencies of withdrawing into resettler peer-groups.(14, 31) Furthermore, resettlers who immigrated in the beginning of the 1990s had considerably better chances on the labor market compared to resettlers who immigrated in the mid of the 1990s and later. Since the profession of mostly women and academics was not recognized, many resettlers did not work within their profession and suffered from social relegation.(11, 30) Hence, it can be assumed that the integration of resettlers who came in the beginning was more successful than the integration of resettlers of the later years.(2) Higher external mortality among resettler men from the latest immigration period, compared to resettler men from the first immigration period, support this assumption. It was shown before that poor integration is associated with mental health problems, as well as with higher risk of suicide and external mortality.(20, 32)

A healthy migrant effect among resettlers is unlikely, due to several reasons: The restrictions on admission for resettlers were never as rigorous as for other migrant groups. Due to their immediately assigned German citizenship, resettlers have the right of social security and unemployment benefit, as well as the right of permanent residence in Germany.(33) Furthermore, we investigated that resettlers immigrated mostly with their whole families and we could observe deaths of older study participants due to severe diseases within a short period after arrival.(22, 34) Nonetheless, to fully rule out a healthy migrant effect, we need to investigate data of resettlers, who remained in the countries of the FSU. However, this data is not yet available. A more detailed discussion about the healthy migrant effect in our study population can be found elsewhere.(17)

The legislative changes were intended to improve the integration process of resettlers, while agglomerations should have been avoided and the communication with the autochthonous population should have been facilitated. Nevertheless, legislative changes were seen controversially. Criticism was addressed towards the inconsistent process of the language test and that the importance of geographical proximity to the social network was neglected.(11, 31)

We do not assume that immigration period itself had an impact on resettlers' mortality, rather that immigration period reflects different risk-factor patterns and changing integration opportunities for

resettlers, thus are influencing mortality. Therefore, immigration period can be seen as a proxy for different risk-factor pattern and integration opportunities.

Strengths and limitations

It needs to be stated that our study is based on secondary data without any information on risk-factor patterns or on the integration process. Information on educational level and socioeconomic status was not available and could not be accounted for. Additionally, data on statutory basis by immigration period were only available from a subgroup of the Saarland cohort. Nevertheless, our descriptive results reflect the migration pattern of immigrating resettlers from the federal level.(12) We compared resettler mortality to the mortality of the general German population, which includes migrants and resettlers, which consequently could lead to an underestimation of SMR results. However, in a sensitivity analysis targeting this issue Deckert found negligible effects of distortion.(22)

We would like to highlight the study design and the long observation period of our study. We were able to investigate mortality for 20 years of follow-up and to distinguish between immigration periods. After arrival, resettlers were assigned to a federal state at random, therefore, we assume that our study population reflects the entire group of resettlers living in Germany and that our results are generalizable to them.

CONCLUSIONS

Migrants are hardly ever homogeneous groups which needs to be taken into account when offering health care prevention and specific support for better integration. This study demonstrated that this migrant group which seemed homogeneous at first glance, showed considerable heterogeneity by period of immigration. Further research on resettlers' migration pattern and integration problems, their origin and their impact on health may help to substantially improve current and future challenges related to immigration. Health policy should guard the consequences of immigration law alterations with respect to changing compositions of migrant groups and their health status.

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Contributors The cohort study was initiated by HB and performed by VW, HB and AD. SK and VW analysed the data. SK drafted the manuscript and all authors contributed to writing and the interpretation of the results.

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Figure Legends

Figure 1: annual change of GDP per capita growth in % and life expectancy at birth in the 1990s in the Russian Federation, Ukraine and Kazakhstan(10)

Figure 2: Total amount of immigrating FSU resettlers by year (left axis), and composition of countries of origin from immigrating resettlers from the FSU by year (in %, right axis)(6)

Figure 3: modeled age-standardized rates for all-cause mortality for resettlers (separated by immigration period and sex) and the German population, using European Standard population, from 1990 to 2009

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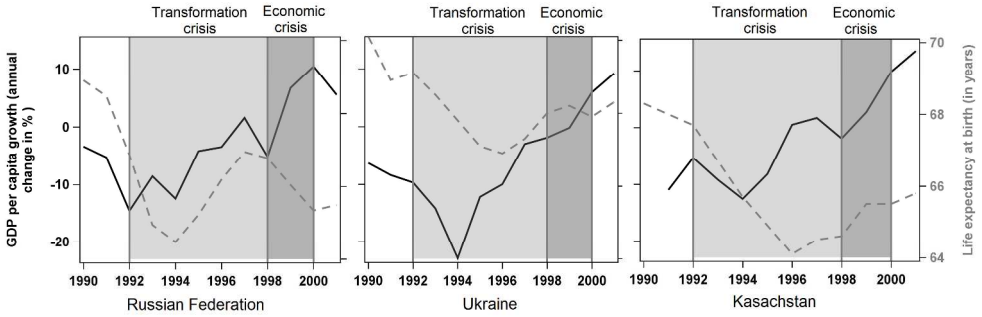

Figure 1: annual change of GDP per capita growth in % and life expectancy at birth in the 1990s in the Russian Federation, Ukraine and Kazakhstan(8)

278x92mm (300 x 300 DPI)

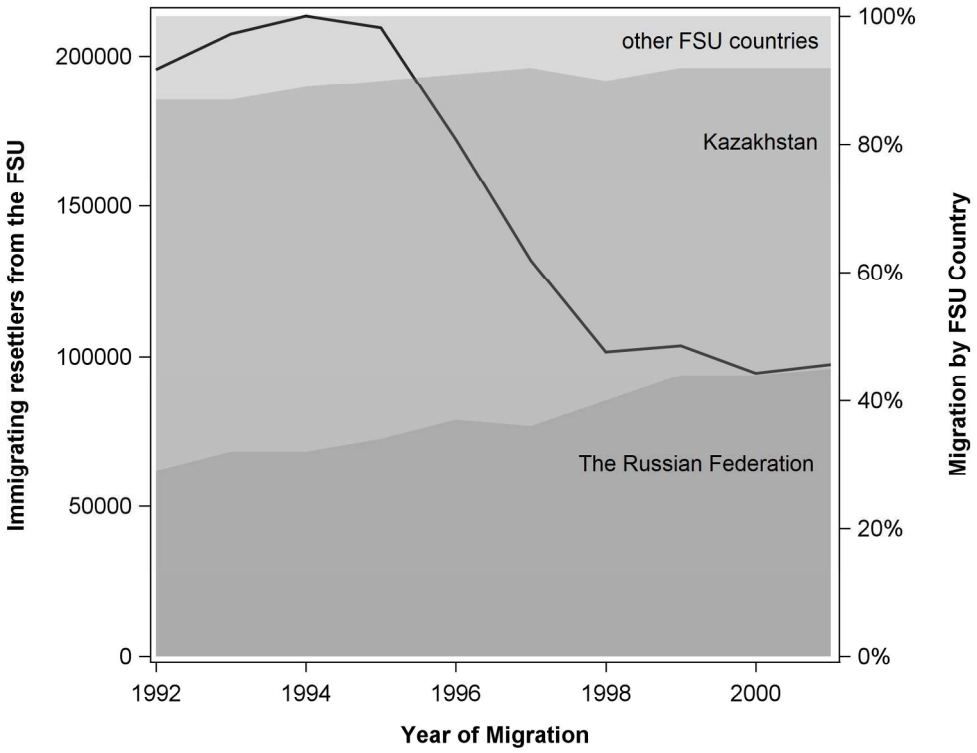

Figure 2: Total amount of immigrating FSU resettlers by year (left axis), and composition of countries of origin from immigrating resettlers from the FSU by year (in %, right axis)(12)

180x140mm (300 x 300 DPI)

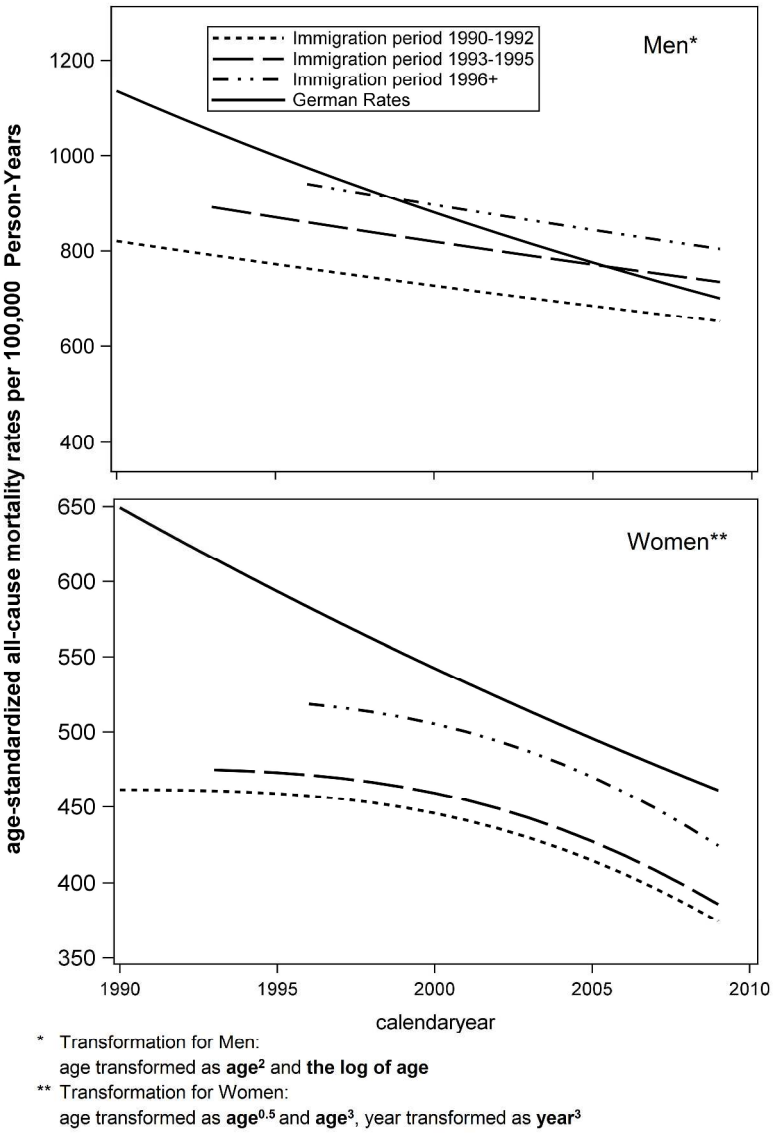

Figure 3: modeled age-standardized rates for all-cause mortality for resettlers (separated by immigration period and sex) and the German population, using European Standard population, from 1990 to 2009

310x431mm (300 x 300 DPI)

Supplementary Material – Poisson Regression estimates and p-values, separated by sex

Poisson Regression β-estimates and p-values for men		
	Estimate	**p-value**
Intercept	-8.641	<0.0001
age group:		
age group^2	0.014	<0.0001
logarithm of age group	0.752	<0.0001
year:		
(calendar year -1989)	-0.012	0.0033
Immigration period:		
1990-1992	Ref.	
1993-1995	0.120	0.0066
1996-2005	0.209	<0.0001

Poisson Regression β-estimates and p-values for women		
	Estimate	**p-value**
Intercept	-9.947	<0.0001
age group:		
age group$^{0.5}$	0.848	<0.0001
age group^3	0.001	<0.0001
year:		
(calendar year-1989)^3	-0.000*	0.0009
Immigration period:		
1990-1992	Ref.	
1993-1995	0.030	0.5083
1996-2005	0.125	0.0123

* Exact estimate: -.0000261

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	In the Title and Abstract (page 1 and 2)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4
Methods			
Study design	4	Present key elements of study design early in the paper	Page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 4 (only a brief description, however, a reference is cited, where detailed information can be found)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Page 4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Pages 4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Pages 4-5
Bias	9	Describe any efforts to address potential sources of bias	Not applicable, since we used registry-data
Study size	10	Explain how the study size was arrived at	Page 4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Pages 4-5

Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Pages 4-5
		(*b*) Describe any methods used to examine subgroups and interactions	Pages 4-5
		(*c*) Explain how missing data were addressed	Page 4 (since registry-data was used, there is no missing data – only missing causes of death)
		(*d*) If applicable, explain how loss to follow-up was addressed	Not applicable since we used registry data
		(*e*) Describe any sensitivity analyses	Not applicable
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 5
		(b) Give reasons for non-participation at each stage	Not applicable, since we used registry data
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 5 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	Page 5; 6-7 (Table 1 & 2)
		(c) Summarise follow-up time (eg, average and total amount)	Page 5
Outcome data	15*	Report numbers of outcome events or summary measures over time	Pages 5-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Pages 6-7, figure 3 and supplementary table
		(*b*) Report category boundaries when continuous variables were categorized	Pages 5-7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not applicable.
Discussion			
Key results	18	Summarise key results with reference to study objectives	Pages 7-8
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Pages 7-9

Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 9

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.