BMJ Open

Comparative analysis of premature mortality among urban immigrants in Bremen, Germany: a retrospective register-based linkage study

Nataliya Makarova,[1,2] Tilman Brand,[1] Claudia Brünings-Kuppe,[3] Hermann Pohlabeln,[4] Sabine Luttmann[5]

To cite: Makarova N, Brand T, Brünings-Kuppe C, *et al*. Comparative analysis of premature mortality among urban immigrants in Bremen, Germany: a retrospective register-based linkage study. *BMJ Open* 2016;**6**:e007875. doi:10.1136/bmjopen-2015-007875

► Prepublication history and additional material is available. To view please visit the journal (http://dx.doi.org/10.1136/bmjopen-2015-007875).

Received 9 February 2015
Revised 19 January 2016
Accepted 20 January 2016

For numbered affiliations see end of article.

Correspondence to
Nataliya Makarova;
makarova@bips.uni-bremen.de

ABSTRACT

Objectives: The main objective of this study was to explore differences in mortality patterns among two large immigrant groups in Germany: one from Turkey and the other from the former Soviet Union (FSU). To this end, we investigated indicators of premature mortality.

Design: This study was conducted as a retrospective population-based study based on mortality register linkage. Using mortality data for the period 2004–2010, we calculated age-standardised death rates (SDR) and standardised mortality ratios (SMR) for premature deaths (<age 65 years). We computed years of potential life lost (YPLL) and analysed the underlying causes of death contributing to premature mortality.

Setting and participants: In this study, we made use of the unique possibilities of register-based research in relation to migration and health. Analyses were performed in three population groups in the federal state of Bremen, Germany: immigrants from Turkey, those from the FSU and the general population.

Results: The SDRs for premature deaths of the two immigrant groups were lower compared to those of the general population. The SMRs remained under 1. Using the indicator of YPLL, we observed higher age-standardised YPLL rates among immigrant populations, particularly among males from the FSU compared to females and population groups 4238/100 000, 95% CI (4119 to 4358). Regarding main causes of premature death, we found larger contributions of infant mortality and diseases of the respiratory system among Turkish immigrants, and of injuries and poisonings, and mental and behavioural disorders among immigrants from the FSU.

Conclusions: While the overall trends favour the immigrant populations, the indicator of YPLL and cause-specific results indicate areas where the healthcare systems responsiveness may need to be improved, including preventive services. Further work with broader databases providing a similar level of differentiation is necessary to substantiate these findings.

Strengths and limitations of this study

- We used a name-based algorithm as well as a combination of different methods for the determination of migrant background, namely, country of birth, birthplace and nationality, to get a more accurate estimation of the immigrant populations.
- We successfully implemented the record linkage method to link registry data with Bremen Mortality Index data.
- Using the concept of premature mortality and indicator of years of potential life lost, we were able to indicate areas where healthcare provision needs to be improved.
- In this study, we touched on the important issue of data availability.
- Limitations of the current study include the absence of population-group-specific denominator data for the years 2004–2009, for which we used an imputation procedure based on available data for 2010 and data on changes in population numbers per nationality group.

INTRODUCTION

Immigrant populations, which typically have a higher concentration of socioeconomic and health disadvantages[1] compared to host populations, are of growing social, demographic and political importance in many countries. Among the potential adverse factors affecting migrant health, inequalities in healthcare access and suboptimal services in host countries are among those amenable by public health measures and thus of particular concern. There is, however, also evidence that immigrant populations often show a better health status compared to the general population of the host country (healthy migrant effect; selective migration etc).[2–5] Despite this evidence, reviewing the topic of migration, an expert commission recently came to the conclusion that the

health status of migrants is on average lower than that of non-migrants.[6] The combination of the selection mechanisms towards healthy migrants and the potential adverse factors in the host country makes it particularly difficult to assess the health situation of migrants. Up to now, comparative research that captures the complexity and heterogeneity of immigrants and at the same time identifies their shared risks is still scarce.[7] Reliable and comparable quantitative data on the patterns of diseases, access to healthcare, overall mortality, as well as specific mortality causes among immigrants are rarely available. This is mainly due to the fact that most data sources do not provide consistent information on the origin of immigrants. In Germany, for example, the Federal Health Monitoring System provides information on foreign populations based on their nationality. This indicator, however, excludes immigrants who have taken up German citizenship, although this group now constitutes a non-negligible part of the immigrant population in Germany.[8] Overall, almost 20% of the population of Germany has a migration background.[9] A recent comprehensive investigation into migrant morbidity and mortality in Germany confirmed the problem of insufficient characterisation of migrant status in official data.[10] They used nationality as the only indicator and found lower mortality among foreign adult population aged 20–60 years compared to Germans. However, there was some evidence that further differences in mortality among immigrant groups were present.[10]

In epidemiology, the study of mortality patterns is central to the goal of assessing the overall health situation, taking the status and accessibility of the healthcare system of one or more demographic groups into account.[11] Population-based mortality data are a continuous and accessible source of health information in most industrialised countries. With higher life expectancy, most deaths occur among the older aged people (75+ years), such that classic mortality and cause of death investigations are strongly influenced by this age group. From a public health perspective, it is even more interesting to pay attention to premature mortality (also referred to as amenable mortality), that is, mortality occurring before the age of the average life expectancy. Premature deaths occurring in young ages refer to 'all those deaths that, given current medical knowledge and technology, could be avoided by the healthcare system through either prevention or treatment'.[12] Evidence derived from the study of premature mortality can be used in public health planning to compare the relative importance of different causes of premature deaths, to set priorities for prevention or healthcare activities, and to compare the premature mortality between different populations.[13]

The use of indicators of premature mortality such as years of potential life lost (YPLL) to quantify health status in population groups is gaining importance.[12 14 15] YPLL offers a method to measure the impact of premature mortality in the population.[16 17]

Previous international comprehensive studies[18] indicate a reduction of premature mortality by more than half since 1970 and outline general trends by sex and underlying causes of death contributing to premature mortality, but do not provide information on vulnerable population groups.[14 19–22]

Few European studies have investigated premature or avoidable mortality among immigrants.[21] These studies, which originate from Sweden,[23] the Netherlands[24] and Estonia,[25] reported heterogeneous premature mortality results for the selected immigrant groups. Components of avoidable mortality used in these studies were chosen from the classical approach of the concept.[12 17] In this respect, the studies from Sweden and the Netherlands included indicators of medical intervention and national health policy in their analysis. The study from Estonia, on the other hand, linked the causes of death to preventable versus treatable conditions. In the studies from Sweden and the Netherlands, the most common causes of death found among immigrant groups were linked to indicators of the health policy field rather than medical intervention. This reflected trends in mortality rates associated with behaviour or lifestyle such as alcohol consumption, smoking and socioeconomic status (eg, working vs non-working population) for which outreach and prevention activities are potentially effective combat tools. Variations in the distribution of diseases in different population groups could be caused by high-exposure risks, unhealthy lifestyle, insufficient medical care or unequal access to healthcare services. Thus, a better understanding of premature mortality patterns in populations may be useful for various aspects of health improvements in populations, including improving access to healthcare services.

In this study, we made use of the exceptional data sources available in the federal state of Bremen, Germany, to investigate premature mortality of immigrants from Turkey and the former Soviet Union (FSU) for the period 2004–2010 in a population-based approach. Turkish and FSU immigrants form the two largest immigrant populations in Germany, each comprising nearly 3 million people. Our main objective is to explore premature mortality to help identify specific diseases and health needs among immigrants from FSU and Turkey, which will be important for setting priorities in medical healthcare provision and prevention activities.

METHODS

Determination of denominator populations

We obtained population figures for the general population living in the federal state of Bremen during the period 2004–2010 from the German Federal Health Monitoring System.[26] The federal health monitoring system, however, does not provide data on immigrant populations by country of origin; instead, it contains numbers of all foreigners by nationality for every federal state and in 5-year age groups.[27] To avoid relying on

nationality only, we searched the full population file for 2010 in the Residents' Registration office in Bremen, using (1) nationality as well as country and place of birth to identify immigrants from the FSU (n=33 497, 5.1% of the general population in the state of Bremen)[9] and (2) the name-based algorithm developed by Razum *et al*[28] as well as a combination of different methods, that is, country of birth and nationality, to identify immigrants from Turkey (n=49 518, 7.5% of the general population in the state of Bremen).[9 29] Detailed descriptions of these two applied approaches can be found in Makarova *et al*.[9] We then used the figures for FSU and Turkish immigrants obtained for 2010 to estimate the missing denominators for 2004–2009. To this end, we initially calculated the percentage increase or decrease in the foreign population in the federal state of Bremen[27] between each consecutive year from 2004 to 2010, going backwards from 2010. In other words, we calculated the development of the foreign population in the state of Bremen in percent between 2010 and 2009, 2009 and 2008, 2008 and 2007, etc. Thereafter, we used the obtained percentage changes to project figures for FSU and Turkish immigrants for 2004–2009, based on the figures for 2010 obtained from the Bremen Residents' Registration office for each of the population groups (see online supplementary figure S1). We used figures at the end of the year. The extraction of data from Residents' Registration office was at the end of the year 2010. No mid-year figures were available for the immigrant groups. For comparability, we used also end-year figures for the reference population.

The denominator population for the full study period was thus stratified into the general population (all residents living in the federal state Bremen, including the two migrant populations) and the population with migrant background from Turkey and from the FSU. The data were available differentiated by sex and categorised in 5-year age groups.

Mortality data and linkage

For the mortality analysis of each of the three population groups of interest, we used data from the Bremen Mortality Index (BreMI). The BreMI is an electronic database providing all information recorded on death certificates of Bremen citizens who died since 1998 including International Classification of Diseases Tenth Version (ICD-10) code of underlying cause of death. Data from the Bremen Residents' Registration office were linked with the BreMI, using only the death registration number.

Statistical analyses

Based on the methodological approach of health monitoring used in Germany and following the recommendations of the Robert Koch Institute, we selected the age of 65 years as upper limit for the calculation of premature mortality.[15]

We calculated age-standardised death rates (SDRs)/100 000, using the European Standard Population (ESP) for ages 0–64 years for both sexes in the different populations, and YPLL for premature deaths. To determine YPLL, we added the age-specific deaths occurring at each age and weighted them by the number of remaining lost years up to the selected age limit of <65 years. For example, a death occurring at 5 years of age is counted as 60 YPLL.[14 15] The indicator is expressed per 100 000 persons. Data were standardised to the ESP.[15] We considered more detailed age-specific death rates (ASDR) per 100 000 person years and calculated ratios of the age-specific death rates in every age and population group for men and women. Furthermore, standardised mortality ratios (SMR) were calculated. Precision was estimated using 95% CIs. We also descriptively analysed leading causes of death contributing to premature mortality based on the main groups of the ICD 10th version. We focused on the 10 leading causes of death for premature mortality.

RESULTS

According to our population-based calculations, we estimated the proportion of Turkish and FSU immigrants living in Bremen as measured by the number of general population between 2004 and 2010: 5.1% were from the FSU and 7.5% originated from Turkey (see online supplementary table S1). Over the study period 2004–2010, a total of 774 deaths among Turkish immigrants, 1288 deaths among immigrants from the FSU (see online supplementary table S1) and 52 258 deaths in the general population were identified in the data of the residents' registration office. After record linkage with the BreMI, death certificates were available for 713 deaths among Turkish immigrants and for 1267 deaths among immigrants from the FSU (see online supplementary table S1) Useful mortality information was retrieved for 706 deaths among Turkish immigrants and for 1258 immigrants from the FSU. About 50% (N=360) of all deaths among Turkish immigrants, about 25% (N=350) of those among immigrants from the FSU and about 15% (N=9759) of those in the general population, occurred prematurely. Note that for the general population, no missings could be determined, as only the BreMI database was used. Regarding sex-specific percentage of prematurely occurred death cases, the relation between males and females is conspicuously in the group of FSU immigrants and of the general population compared to Turkish immigrants (table 1).

We further calculated age-standardised death rates/100 000, using the ESP for ages 0–64 years for both sexes in the different populations. The SDR for premature deaths of the two immigrant population groups were lower compared to the general population. The general population's SDR of 207/100 000, 95% CI (203 to 211) was considerably higher compared to those of the immigrants (from Turkey 136/100 000, 95% CI (121

Table 1 Mortality parameters 2004–2010 by sex, population and age group

Mortality parameters	FSU immigrants			Turkish immigrants			General population		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
n overall deaths	656	602	1258	461	245	706	24 688	27 570	52 258
n premature deaths (%)	251 (38.3)	99 (16.4)	350 (27.8)	233 (50.5)	127 (51.8)	360 (51.0)	6432 (26.1)	3327 (12.1)	9759 (18.7)
Age-standardised premature death rates per 100 000 (95% CI)	214 (187 to 241)	76 (60 to 91)	140 (125 to 155)	178 (154 to 203)	94 (77 to 111)	136 (121 to 150)	273 (266 to 279)	142 (137 to 147)	207 (203 to 211)
Standardised mortality ratios (95% CI)	0.79 (0.69 to 0.89)	0.53 (0.43 to 0.64)	0.67 (0.61 to 0.75)	0.63 (0.55 to 0.72)	0.66 (0.55 to 0.79)	0.64 (0.58 to 0.71)	General population=1		
Age-standardised YPLL rates per 100 000 (95% CI)	4238 (4119 to 4358)	1710 (1631 to 1789)	5949 (5808 to 6089)	2560 (2430 to 2581)	1631 (1569 to 1693)	4137 (4042 to 4233)	3880 (3854 to 3907)	2163 (2142 to 2184)	6043 (6011 to 6076)

FSU, former Soviet Union; YPLL, years of potential life lost.

to 150) and from the FSU 140/100 000, 95% CI (125 to 155)). Regarding sex specific SDRs, men in every population group had higher SDRs as compared to women (table 1). Sex and ASDRs comparing the three populations are provided in table 2.

Comparing males and females, we observed generally higher age-specific death rates among males than among females in all population groups. Detailed analyses of ASDRs in age groups comparing immigrant groups to the general population as well as within immigrant groups showed a general trend towards higher premature mortality among men from the FSU in the age group 20–49 years compared to men from the general population. In the younger age groups, there were increased ASDRs among females from the FSU aged 5–19 years compared to the two other groups. The highest under-five-year mortality was found among children with Turkish migrant backgrounds (table 2). We also calculated ratios for age-specific death rates, with the general population as reference (see figure 1). The figure clearly shows the differences as outlined above, but also the similarities mainly regarding under-five-year child mortality.

Similar to the observations we made for SDRs, the SMRs in both immigrant groups remained significantly below 1, indicating lower premature mortality risks than in the general population (table 1). Differentiating between men and women in every immigrant group, the SMR ranged from 0.53, 95% CI (0.43 to 0.64) for women from the FSU to 0.79, 95% CI (0.69 to 0.89) for FSU males, with estimates for Turkish migrants between 0.63, 95% CI (0.55 to 0.72) (males) and 0.66, 95% CI (0.55 to 0.79) (females).

In terms of YPLL, FSU males had the highest age-standardised YPLL rate, while Turkish females had the lowest age-standardised YPLL rate (table 1). In contrast, the age-specific YPLL were the highest among female Turkish migrant children in the age group 0–4 years compared to every other sex and population group (table 3).

Main causes of death

In each of the population groups, neoplasms and diseases of the circulatory system accounted for over 40% of premature deaths. Generally, the proportions of these two major causes of death contributing to premature mortality in all three population groups were higher among men than among women (table 4). We, however, observed differences in specific causes of death in the three population groups. For example, infant mortality and diseases of the respiratory system were higher among Turkish than among FSU immigrants, and injuries and poisonings as well as mental and behavioural disorders were considerably higher among immigrants from the FSU than in the other two groups. Using the BreMI, we were able to ascertain that the premature deaths coded as injuries and poisonings among men from the FSU were often due to alcoholism, alcohol abuse, smoking and intoxication.

Table 2 Age-specific death rates 2004–2010 by sex, population group, per 100 000 person years, up to age 64 years

	FSU immigrants		Turkish immigrants		General population	
	Rate (n, cases of death)					
Age at death, years	Male	Female	Male	Female	Male	Female
0–4	129 (9)	43 (3)	126 (22)	151 (25)	136 (133)	111 (101)
5–19	35 (5)	23 (3)	35 (17)	9 (4)	23 (74)	16 (49)
20–34	110 (42)	27 (12)	28 (13)	15 (7)	65 (299)	27 (124)
35–49	346 (75)	130 (33)	117 (52)	40 (14)	269 (1459)	142 (721)
50–64	560 (120)	192 (48)	725 (129)	382 (77)	1038 (4469)	523 (2332)
n=total	245 (251)	87 (99)	133 (233)	79 (127)	347 (6434)	184 (3327)

FSU, former Soviet Union.

DISCUSSION

In this study, we examined and compared patterns of premature/avoidable mortality among immigrants from Turkey and the FSU to those of the host population in the federal state of Bremen, Germany. Through the exploration of premature mortality, we aimed to identify specific health problems contributing to premature death and derive information to identify priority areas in medical care or prevention for migrant populations. We combined different methodological approaches for analysing premature/avoidable mortality: we selected the age of <65 years for analysing premature deaths and calculated different mortality indicators including YPLL. Additionally, to gain further insight into mortality patterns, we documented the leading causes of death based on the main groups of the ICD 10th version.

When using standardised death rates and mortality ratios to assess premature mortality, we found lower mortality rates in the two immigrant groups compared with the rate in the general population. We did not observe differences in the distribution of the two leading causes of premature mortality: neoplasms and diseases of the circulatory system accounted for over 40% of premature deaths in each of the three population groups.

The lower mortality among Turkish immigrants compared to that of the general population could be explained, for example, by the 'healthy migrant effect'.[5] Migrant workers tended generally to represent a healthier and younger population and, consequently, based on the selection effect, a conditional relatively lower mortality compared to the general population. Moreover, based on data we obtained from the Bremen Residents'

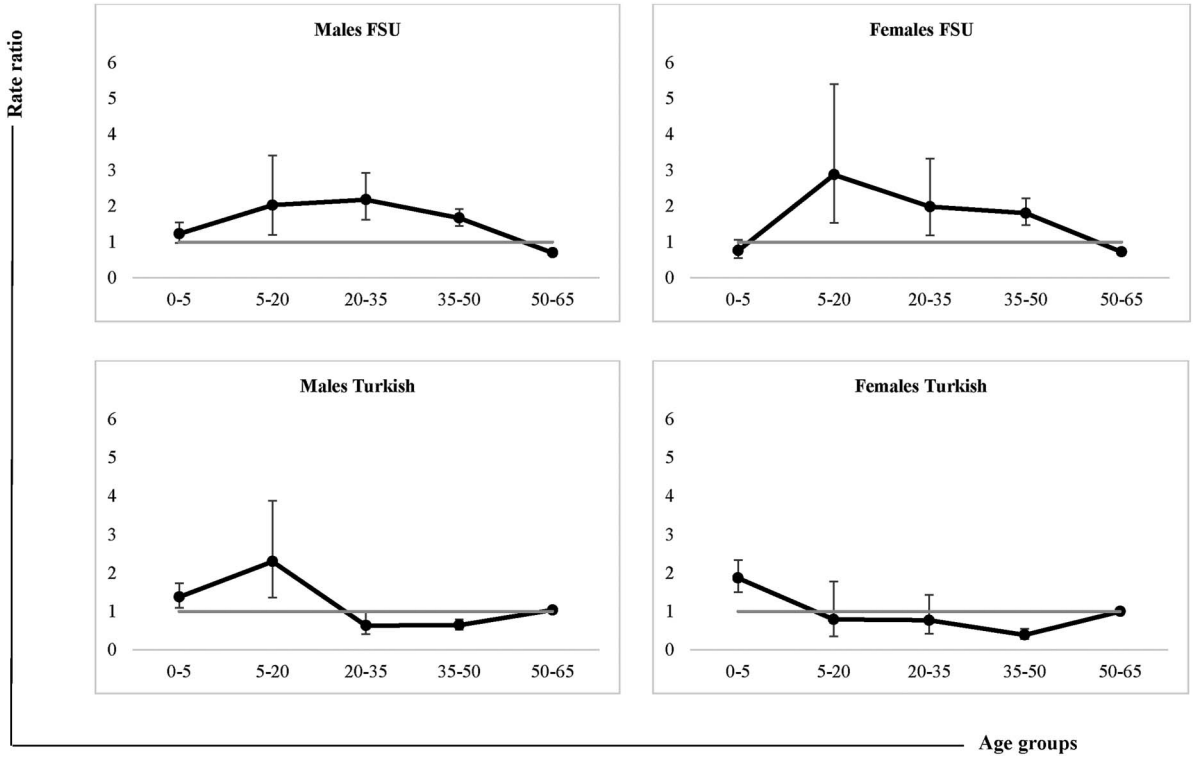

Figure 1 Rate ratios for age-specific death rates, 2004–2010, by sex and immigrant group. General population=1. Error bars denote 95% CI. FSU, former Soviet Union.

Table 3 Age-specific YPLL per 100 000 for all cases of death for the age at death <65 years, between 2004 and 2010, by sex, immigrant and age group

Age at death, years	FSU immigrants		Turkish immigrants		General population	
	Male	Female	Male	Female	Male	Female
0–4	8344	2800	8177	9286	8831	6697
5–19	1734	1111	1784	429	1131	770
20–34	4138	1204	975	566	2373	1003
35–49	7018	2986	2642	653	5705	2797
50–64	4799	2073	3987	3014	6888	3710
Total	4840	1859	2647	1667	4516	2414

FSU, former Soviet Union; YPLL, years of potential life lost.

Registration office, we assume a certain degree of re-migration of elderly Turkish immigrants in Turkey, possibly leading to reduced premature mortality in this population group.

The 'healthy migrant' effect was probably not present among immigrants from the FSU as they did not primarily come to Germany as young workers, but rather as repatriates. The overall lower premature mortality in this population group can possibly be explained by the 'social support'[30] provided by the comprehensive social security and insurance system in Germany, which is better than those in the FSU countries.[31–33] In addition, the immigrants from the FSU benefited from better access to high-quality healthcare leading to better health.[34 35] The reason for better health and thus lower mortality compared, for example, to migrant workers, was because immigrants from the FSU were included in the system as ethnic Germans and not as a formerly temporary accepted population.

Only with the indicator of YPLL and when looking at specific causes of death and analyses conducted in specific age groups, were we able to demonstrate that certain subgroups among the immigrant groups had higher premature mortality compared with that of the general population. The indicator of YPLL provides a common denominator for judging the priority to be given with regard to planning and organisation of healthcare or prevention to each cause of mortality in identified risk age groups.[36 37] For instance, we observed increased years of life lost among Turkish children, especially females, for death at ages between 0–4 years. Further analyses showed increased mortality in relation to pregnancy and infant mortality, especially due to extreme immaturity among Turkish immigrants. In terms of setting priorities and thinking about developing migrant-sensitive health systems, one focus could be on strengthening health literacy of mothers. Patients with a Turkish migrant background should be informed that, for example, consanguineous marriages can lead to an increased risk for genetic disorders and infant mortality,[38] and obstetricians should be able to give qualified information to support early diagnosis to prevent deaths. The setting of health development strategies relating to avoidable mortality and evaluation of their achievement also provides a powerful means of audit.[39]

We observed that, compared to Turkish men and those in the general population, men from the FSU lost more years of life if the death occurred between 20 and 50 years. Premature deaths in this population group coded as injuries and poisonings as well as mental and behavioural disorders were often noted as being associated with alcoholism, alcohol abuse, smoking and intoxication. Our results are, in general, in line with those reported in studies conducted in European countries,[23–25] which highlight lifestyle-related mortality attributable to alcohol consumption, smoking and intoxication. Explicitly focusing on Germany, Deckert

Table 4 Causes of death contributing to premature mortality between 2004 and 2010 for three population groups; percentage in relation to the total number of premature death cases

Cause of death (main groups of the ICD 10)*	FSU immigrants		Turkish immigrants		General population	
	Male (%)	Female	Male	Female	Male	Female
Neoplasms (C00-D48)	19.1	10.6	14.2	10.8	19.6	15.1
Diseases of the circulatory system (I00-I99)	13.7	4.9	15.6	7.8	14.8	5.6
Mental and behavioural disorders (F00-F99)	11.4	1.7	3.3	0.3	7.9	2.1
Injuries, poisonings (S00-T98)	12.3	2.0	6.7	0.6	5.3	1.6
Diseases of the digestive system (K00-K93)	0.9	2.0	2.2	0.6	3.6	1.9
Diseases of the respiratory system (J00-J99)	2.0	0.3	5.3	1.7	3.2	1.9
Certain conditions originating in the perinatal period (P00-P96)	2.0	0.9	4.2	3.9	–	–
Certain infectious and parasitic diseases (A00-B99)	1.7	1.1	1.7	2.2	2.2	1.2
Endocrine, nutritional and metabolic diseases (E00-E90)	0.9	0.9	–	–	1.7	0.6
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99)	2.6	0.6	–	–	–	–

*ICD, 10th version.
FSU, former Soviet Union; ICD, International Classification of Diseases.

et al suggest that the increased mortality from cardiovascular diseases, external causes of death and suicides, and in middle-aged men, could reflect detrimental drinking patterns, which are popular in blue-collar working men in Russia.[40 41] These drinking patterns are associated with cardiomyopathy in young men.[34] The composition of the group of German repatriates changed dramatically between 1990 and 1999, with the majority of the German repatriates being of Russian ethnicity at the end of this period. Theoretically, a large proportion of the German repatriates residing in Bremen from 2004 could also be of Russian ethnicity. There are some theories that the lifestyle of the ethnic Germans in the FSU was completely different to the autochthonous population, hence, in Germany, the higher YPLL might mainly affect the ethnic Russian immigrants.[34 41] Furthermore, studies originating from the Russian Federation link premature mortality to hazardous alcohol and nicotine consumption.[42–44] Such findings raise two important questions: (1) whether immigrants from the FSU bring their lifestyle habits along to Germany[35] and keep them over the time after migration; and (2) whether this group can be reached through better healthcare integration and support for the adoption of a healthier lifestyle?

With regard to setting priorities in the group of FSU immigrants, sex-specific interventions in this population group to reduce alcohol, nicotine and substance consumption, appear to be of importance, and individual and community-based interventions need to be explored.

We also observed slightly higher ASDR among women from the FSU aged 5–19 years compared to those of other women in this age group. Explanations for this unique mortality reverse—lower overall premature mortality and increased age-specific mortality in this population group—could include factors associated with transition from childhood to adulthood: alcohol, smoking, violence, drugs, transport accidents, etc.[45] Pregnancy and childbirth in adolescence could also pose higher risks for premature mortality.[46]

Our study has several strengths and limitations. To the best of our knowledge, this is the first study that contemporaneously analysed premature/avoidable mortality among two large immigrant population groups living in Germany. This is also the first study that tested different approaches as well as their combination to identify both immigrant groups in the Residents' Registration office and after that to link personal data to the electronically database BreMI—the unique form to document and monitor mortality on the federal state level.

In this study, we touched on the important issue of the availability of data. Mortality data are widely available and easy to obtain in many European countries. The coding of the underlying cause of death according to ICD-10 offers a standardised methodological basis. The epidemiological concept of avoidable mortality has been studied among immigrants in some European studies, for example, in Sweden, the Netherlands and Estonia, using registry linkage.[23–25] For Estonia, Baburin *et al* documented the most important preventable causes of death among men as being accidental poisonings, suicide and alcohol-related diseases.[25] For Sweden, Westerling *et al* also assumed that observed variations in mortality reflected differences in smoking and alcohol habits.[23] Stirbu *et al* assessed mortality in a number of immigrant groups in the Netherlands, including immigrants from Turkey. The study population comprised mainly women, and Turkish immigrants had a higher risk of death from maternity-related conditions compared to the native Dutch population.[24] Our own investigations highlight the need for a differentiated epidemiological assessment of premature mortality, and indicate specific risks for particular groups, most notably young and middle-aged men from the FSU. We believe that further investigations in premature mortality for immigrant and ethnic minority groups in Germany and the European region will be useful and informative for epidemiological surveillance and for evidence-based interventions. More standardisation of methodological approaches will enhance the opportunities for comparisons within and across countries.

Several limitations merit consideration. The population group-specific denominator data for the years 2004–2009 were missing. To calculate them, we used an imputation procedure based on available data for 2010 and data on changes in foreign population numbers. Although this procedure introduces some imprecision, we believe that it does not invalidate the overall findings. Further, the numbers of deaths in specific age-bands and subgroups were small, and thus need to be interpreted with caution. Missing data—namely, missing death certificates—were higher among Turkish immigrants (see online supplementary table S1) after record linkage with the Bremen Mortality Index. We argue that this is due to higher re-migration of elderly Turkish immigrants.

A further limitation of this study is the inconsistent usage of methodology for defining of our cohort. We used a name-based algorithm, as developed by Razum *et al*,[28 29] as well as a combination of different methods, that is, country of birth and nationality for determination of Turkish immigrants. Onomatology, the science of the origin of names, is a well-established discipline. Humpert and Schneiderheinze[47] described name-based algorithms to identify immigrants in German residence registries in cases where the place of origin was not available. Degioanni and Darlu used the Bayesian approach for inferring geographical origins of immigrants through surnames.[48] The name-based algorithm, proposed by Razum et al, achieves a specificity of >99.9%[29] and was successfully applied in our data set, resulting in the identification of about 90% of Turkish immigrants.[9]

For various reasons, the name-based algorithms do not yield satisfactory results if applied to immigrants from the FSU. Therefore, we used the available

information of country of birth, nationality and place of birth as well as a combination of all three approaches. Currently, this information seems to be sufficient to identify first generation immigrants from the FSU.

Children born in Germany from the early 1990s onward have German citizenship/nationality and hence could not be identified using our search methods. Prospectively, the creation of an identical name-based algorithm in this population group will be of interest. Comprehensive work will be needed to make these individuals recognisable in the national statistics.[9]

The most pronounced limitation in this analysis is the small number of premature deaths: 360 among Turkish immigrants and 350 for those originating from the FSU. This fact may affect the transferability of the results to other federal states. To improve the transferability, similar analyses should be performed in other federal states in Germany. It would be possible in the federal state of Rheinland-Pfalz, where the Data Management System Mortality is well implemented and similar to the BreMI.

Another limitation is the representativeness of the sample. The federal state of Bremen with around 600 000 inhabitants is the smallest federal state in Germany. Owing to the political and economic situation in Bremen, representativeness for many other issues is also difficult to establish. However, we were able to test and validate the usage of previously disregarded data sources for health research in vulnerable population groups.

When comparing the results obtained in this study, for example, the age-standardised mortality rates for premature deaths before the age of 65 years, with those from the health monitoring system for the population of Bremen, the results are consistent (207 per 100 000 for the 2004–2010 period compared to 241 per 100 000 in 2004 and 209 per 100 000 in 2010). The consistency of the results in the general population may provide indications for the validity and transferability to immigrant populations.

CONCLUSION

Our analyses of premature mortality demonstrated differences and similarities between the immigrant and the general population in Bremen, Germany. While the overall trends surprisingly favour the immigrant populations, age and cause-specific results indicate areas where the healthcare system's responsiveness may need to be improved, including preventive services. Further work with broader databases providing a similar level of differentiation is necessary to substantiate the findings.

Author affiliations
[1]Unit of Social Epidemiology, Department Prevention and Evaluation, Leibniz Institute for Prevention Research and Epidemiology—BIPS, Bremen, Germany
[2]Department of General and Interventional Cardiology, University Medical Center Hamburg-Eppendorf (UKE), University Heart Center (UHZ), Hamburg, Germany
[3]Unit of IT, Data Management and Medical Documentation, Department of Biometry and Data Management, Leibniz Institute for Prevention Research and Epidemiology—BIPS, Bremen, Germany
[4]Unit of Statistical Modelling of Primary Data, Department of Biometry and Data Management, Leibniz Institute for Prevention Research and Epidemiology —BIPS, Bremen, Germany
[5]Unit of Translational Cancer Epidemiology, Department of Clinical Epidemiology, Leibniz Institute for Prevention Research and Epidemiology—BIPS, Bremen, Germany

Acknowledgements The authors thank Professor Hajo Zeeb from the Leibniz Institute for Prevention Research and Epidemiology for the encouragement and many useful discussions. They also thank Dr Florence Samkange-Zeeb for proofreading and a lot of good recommendations concerning the contents as well as textual, as a native English speaker.

Contributors NM conceptualised the study, its design and methods. She conducted the analyses and presented the results. TB and HP were involved in the conceptualisation of methods and statistical analyses. SL was involved in the acquisition, management and interpretation of data. CB-K carried out the linkage approach and was partly involved in the data management as well as data interpretation. TB, HP, SL and CB-K critically revised the manuscript and approved the final version.

Funding This study is a part of the PhD project at the University of Bremen and the Leibniz Institute for Prevention Research and Epidemiology—BIPS, Germany. The funding was provided partly through the Friedrich Ebert Foundation and the Leibniz Institute for Prevention Research and Epidemiology—BIPS. The publication of this article was funded by the Open Access fund of the Leibniz Association.

Competing interests None declared.

Ethics approval All research work with the BreMI follow a specific set of rules and requires clearance by the Bremen Senator for Health. All linkage procedures were conducted by authorised personnel only, and the study centre received an anonymised data set. Under these conditions, no ethical approval was required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing No additional data are available.

REFERENCES

1. Bhopal RS. *Migration, ethnicity, race, and health in multicultural societies*. Oxford University Press, 2013.
2. Solé-Auró A, Crimmins EM. Health of immigrants in European countries. *International Migration Review* 2008;42:861–76.
3. Schenk L. Migration und Gesundheit–Entwicklung eines Erklärungs-und Analysemodells für epidemiologische Studien. *Int J Public Health* 2007;52:87–96.
4. Spallek J, Razum O. Erklärungsmodelle für die gesundheitliche Situation von Migrantinnen und Migranten. Health Inequalities Determinanten und Mechanismen gesundheitlicher Ungleichheit. 2008:271–88.
5. Razum O. *Migration, Mortalitat und der Healthy-migrant-Effekt. Gesundheitliche Ungleichheit*. Springer, 2006:255–70.
6. Brzoska P, Ellert U, Kimil A, *et al*. Reviewing the topic of migration and health as a new national health target for Germany. *Int J Public Health* 2015;60:13–20.
7. Bhopal RS, Rafnsson SB, Agyemang C, *et al*. Mortality from circulatory diseases by specific country of birth across six European countries: test of concept. *Eur J Public Health* 2012;22:353–9.
8. Spallek J, Kaatsch P, Spix C, *et al*. [Name-based identification of cases of Turkish origin in the childhood cancer registry in Mainz]. *Gesundheitswesen* 2006;68:643–9.
9. Makarova N, Reiss K, Zeeb H, *et al*. [Improved opportunities for the identification of people with a migrant background for mortality

research using the example of Bremen]. *Gesundheitswesen* 2013;75:360–5.
10. Kohls M. Federal Agency of Migration and Refugees—BAMF (eds.). Morbidität und Mortalität von Migranten in Deutschland. Research Report in German. Nürnberg, 2011. http://nbn-resolving.de/urn:nbn:de:0168-ssoar-259992 (accessed 6 Jan 2015).
11. Rogers RG, Crimmins EM. *International handbook of adult mortality*. Springer Science & Business Media, 2011.
12. Castelli A, Nizalova O. Avoidable mortality: what it means and how it is measured. No. 063cherp. 2011. http://www.york.ac.uk/media/che/documents/papers/researchpapers/CHERP63_avoidable_mortality_what_it_means_and_how_it_is_measured.pdf (accessed 6 Jan 2015).
13. Gardner JW, Sanborn JS. Years of potential life lost (YPLL)-what does it measure? *Epidemiology* 1990;1:322–9.
14. Castelli A, Nizalova O. Avoidable mortality: what it means and how it is measured. 2011. http://www.oecd.org/els/health-systems/49105858.pdf (accessed 6 Jan 2015).
15. Gaber E, Wildner M. *Mortality, causes of death and regional disparities*. Berlin: Robert Koch-Institut, 2011.
16. Vlajinac H, Marinkovic J, Kocev N, *et al*. Years of life lost due to premature death in Serbia (excluding Kosovo and Metohia). *Public Health* 2008;122:277–84.
17. Beltrán-Sánchez H. Avoidable mortality. In: Rogers, RG, Crimmins EM, eds. International handbook of adult mortality. Springer, 2011:491–508.
18. Gay JG, Paris V, Devaux M, *et al*. Mortality amenable to health care in 31 OECD countries. Estimates and Methodological Issues. OECD Health Working Papers, No. 55, OECD Publishing, 2011. http://dx.doi.org/10.1787/5kgj35f9f8s2-en (accessed 6 Jan 2015).
19. Wong MD, Chung AK, Boscardin WJ, *et al*. The contribution of specific causes of death to sex differences in mortality. *Public Health Rep* 2006;121:746.
20. Dubey M, Mohanty SK. Age and sex patterns of premature mortality in India. *BMJ Open* 2014;4:e005386.
21. Renard F, Tafforeau J, Deboosere P. Premature mortality in Belgium in 1993–2009: leading causes, regional disparities and 15 years change. *Arch Public Health* 2014;72:34.
22. Arcà M, di Orio F, Forastiere F, *et al*. Years of potential life lost (YPLL) before age 65 in Italy. *Am J Public Health* 1988;78:1202–5.
23. Westerling R, Rosén M. 'Avoidable'mortality among immigrants in Sweden. *Eur J Public Health* 2002;12:279–86.
24. Stirbu I, Kunst A, Bos V, *et al*. Differences in avoidable mortality between migrants and the native Dutch in the Netherlands. *BMC Public Health* 2006;6:78.
25. Baburin A, Lai T, Leinsalu M. Avoidable mortality in Estonia: exploring the differences in life expectancy between Estonians and non-Estonians in 2005–2007. *Public Health* 2011;125:754–62.
26. System FHM. Indicator 2.3: population on December, 31, of the respective year. Classification: years, region Bremen, age, sex, nationality. 2014. http://www.gbe-bund.de
27. System FHM. Indicator 2.4: foreign population on December, 31, of the respective year. Classification: years, region Bremen, age, sex, nationality. 2014. http://www.gbe-bund.de
28. Razum O, Zeeb H, Beck K, *et al*. Combining a name algorithm with a capture–recapture method to retrieve cases of Turkish descent from a German population-based cancer registry. *Eur J Cancer* 2000;36:2380–4.
29. Razum O, Zeeb H, Akgün S. How useful is a name-based algorithm in health research among Turkish migrants in Germany? *Trop Med Int Health* 2001;6:654–61.
30. Wilkinson RG, Marmot MG. *Social determinants of health: the solid facts*. World Health Organization, 2003.
31. Andreev EM, Nolte E, Shkolnikov VM, *et al*. The evolving pattern of avoidable mortality in Russia. *Int J Epidemiol* 2003;32:437–46.
32. Benemann M. Russisches Gesundheitssystem: Mit Fallpauschalen aus der Krise? *Deutsches Arzteblatt-Arztliche Mitteilungen-Ausgabe B* 2010;107:2220.
33. World Health Organization. *The world health report 2000: health systems: improving performance*. World Health Organization, 2000.
34. Deckert A, Winkler V, Meisinger C, *et al*. Myocardial infarction incidence and ischemic heart disease mortality: overall and trend results in repatriates, Germany. *Eur J Public Health* 2014;24:127–33.
35. Kuhrs E, Winkler V, Becher H. Risk factors for cardiovascular and cerebrovascular diseases among ethnic Germans from the former Soviet Union: results of a nested case-control study. *BMC Public Health* 2012;12:190.
36. Breslow NE, Day NE. *Statistical methods in cancer research*. Lyon: International Agency for Research on Cancer, 1987.
37. Bhopal RS. *Concepts of epidemiology: an integrated introduction to the ideas, theories, principles and methods of epidemiology*. Oxford: Oxford University Press, 2002.
38. Korkmaz A, Aydın Ş, Çamurdan AD, *et al*. Analysis of infant mortality causes and a new national mortality registration system in Turkey. *Turk Pediatr J* 2013;56:105–21.
39. Akgün S, Rao C, Yardim N, *et al*. Estimating mortality and causes of death in Turkey: methods, results and policy implications. *Eur J Public Health* 2007;17:593–9.
40. Deckert A, Winkler V, Meisinger C, *et al*. Suicide and external mortality pattern in a cohort of migrants from the former Soviet Union to Germany. *J Psychiatr Res* 2015:63:36–42.
41. Deckert A, Winkler V, Paltiel A, *et al*. Time trends in cardiovascular disease mortality in Russia and Germany from 1980 to 2007-are there migration effects? *BMC Public Health* 2010;10:488.
42. Leon DA, Chenet L, Shkolnikov VM, *et al*. Huge variation in Russian mortality rates 1984–94: artefact, alcohol, or what? *Lancet* 1997;350:383–8.
43. Leon DA, Saburova L, Tomkins S, *et al*. Hazardous alcohol drinking and premature mortality in Russia: a population based case-control study. *Lancet* 2007;369:2001–9.
44. Zaridze D, Brennan P, Boreham J, *et al*. Alcohol and cause-specific mortality in Russia: a retrospective case–control study of 48,557 adult deaths. *Lancet* 2009;373:2201–14.
45. Bobadilla JL, Costello CA, Mitchell F. *Premature death in the new independent states*. National Academies Press, 1997.
46. World Health Organization. *50 Facts: Global health situation and trends 1955–2025*. WHO online, World health report. 1998.
47. Humpert A, Schneiderheinze K. Stichprobenziehung für telefonische Zuwandererumfragen: Einsatzmöglichkeiten der Namenforschung. Article in German. ZUMA Nachrichten 2000; 24:47. http://nbn-resolving.de/urn:nbn:de:0168-ssoar-208052 (accessed 14 Jan 2016).
48. Degioanni A, Darlu P. A Bayesian approach to infer geographical origins of migrants through surnames. *Ann Hum Biol* 2001;28:537–45.