GENUS, LXIII (No. 1-2), 33-64

MARC LUY – GRAZIELLA CASELLI

The impact of a migration-caused selection effect on regional mortality differences in Italy and Germany*

1. INTRODUCTION AND AIM OF THE STUDY

Regional mortality differences are known for many countries but are usually examined solely for single nations. One of the very few exceptions is the comparative description of regional mortality differences in several countries by Caselli and Vallin (2002). Our study deals with regional mortality differences in Germany and Italy. In both countries survival conditions are not uniquely distributed over the whole national areas. However, a more detailed analysis of regional mortality was done solely in Italy (Caselli and Egidi, 1980; Caselli and Reale, 1999; Caselli and Vallin, 2002; Lipsi and Caselli, 2002; Barbi and Caselli, 2003; Caselli *et al.,* 2003). In Germany there are only a few studies about mortality differences on the regional level ("Bundesländer" or NUTS2) focusing mainly on descriptive results without any analysis of the driving causes (Paul, 1992; Sommer, 1998, 2002; Bucher, 2002). Mortality analysis on district level was exclusively done for several specific German regions (Wittwer-Backofen, 1999; Gröner, 2002; Mey, 2002; Scholz and Thoelke, 2002), but until today not in a complete national context.

It is obvious that regional mortality differences are generally caused by the combination of a huge number of different factors operating on the macro level or on the micro level with significant reflections on the macro level. The factors on the macro level contain the demographic structure (age- and cause-specific mortality as well as other demographic conditions and the socio-demographic composition), the economic conditions of the regions (type of development, amount of unemployment, main types of occupation), the medical resources (availability/quality of medical as well as nursing care), and geographical factors (climatic differences, pollution, amount of industry, degree of urbanization). To the micro level factors affecting regional mortality differences on the macro level belong the individual economic status (social status, occupation), life circumstances (living

* This paper is part of the Research Training Network (RTN)-project "*Regional mortality differences in Italy and Germany – Analysis of similarities and differences regarding developments and responsible factors*" (RTN DEMOG, financed by the EU and directed for Italy by Graziella Caselli).

arrangements, life satisfaction), lifestyles (smoking, alcohol consumption, nutrition), and the biological vs. genetic factors caused by the heterogeneity of populations living in the different regions.

The connection between individual migration and macro mortality combines macro and micro level and is the topic of this paper. We want to know if besides the other mentioned factors also migration affects regional mortality differences inside a country. It is known from several studies that migrants are healthier and thus show lower mortality than the immobile population which was described for various countries and ethnic groups for internal as well as for international migrants (e.g. Feinleib *et al.,* 1981; Balarajan *et al.,* 1984; Shai and Rosenwaike, 1987; Tsugane *et al.,* 1989; Nair *et al.,* 1990; Valkonen *et al.,* 1992; Kington *et al.,* 1998; Razum *et al.,* 1998a, 1998b; Singh and Siahpush, 2001, Anson, 2004, Deboosere and Gadeyne, 2005)[1]. Especially in terms of internal migration this phenomenon is explained by a special selection effect which may influence mortality and morbidity rates[2]. This selective migration is expected to operate in two directions entailing the movement of a "select group" of healthy or unhealthy migrants (Shai and Rosenwaike, 1987; McKay *et al.,* 2003; Palloni and Arias, 2003). The movement of healthier individuals is known as the so-called "healthy migrant phenomenon" (Sharma *et al.,* 1990; Kington *et al.,* 1998). On the other hand, it seems that sick migrants are involved in return migration, for example, to be nearer to family or care-giving institutions (Brimblecombe *et al.,* 2000; Lanska and Peterson, 1995; Razum *et al.,* 1998b). The latter phenomenon is also known as "salmon bias" (Palloni and Arias, 2003, 2004)[3].

Beside this, in internal migration studies it is apparent that some migrant groups additionally benefit from a protective effect in terms of retention of a lower incidence of particular diseases, as was shown especially for Italy (Buiatti *et al.,* 1985; Vigotti *et al.,* 1988; Ceppi *et al.,* 1995; Fascioli

[1] Two of the few known exceptions are Scottish and Irish immigrants to England and Wales exhibiting higher mortality rates than the general population of England and Wales (Adelstein *et al.,* 1986; Raftery *et al.,* 1990; Wild and McKeigue, 1997) as well as the Turkish, Surinamese, and Antillean/Aruban male immigrants in the Netherlands showing higher mortality than the native Dutch men (Bos *et al.,* 2004).

[2] For international migration, especially from lesser to more developed countries, Anson (2004) recently suggested an additional explanation on psychological grounds based on the meaning migration has for the immigrants, and the hope engendered in the move.

[3] It should be stressed that the lower mortality of migrants is not only affected by physical condition but also by socioeconomic status (Wei *et al.,* 1996; Harding and Maxwell, 1998; Van Steenbergen *et al.,* 1999). However, this doesn't hold for all ethnic migrant groups, which provides even more support to the "healthy migrant hypothesis" (Abraido-Lanza *et al.,* 1983; King and Locke, 1987).

et al., 1995; Barbone *et al.,* 1996) but also for other countries (Mancuso, 1977; Coggon *et al.*, 1990; Greenberg and Schneider, 1995). Some of these effects may be due to genetic factors or the retention of certain dietary practices, since for instance associations have been found between breast cancer and body size, and daily intake of fat, in particular saturated fat, and alcohol consumption (Toniolo *et al.,* 1989).

It is however unclear whether the healthy migrant phenomenon and the salmon bias are strong enough to contribute to survival conditions on the macro level and thus affect regional mortality differences. Italy and Germany provide an ideal platform for examining if such a migration-caused selection effect on mortality exists since both countries contain areas of considerable emigration movements, namely the south of Italy and the north-eastern part of Germany (the former GDR). Such a comparative analysis gains great interest from the fact that emigration from the south of Italy to the north and to the centre started in the 1960s with the largest movements until the 1970s (Golini, 1974; Ascoli, 1979; Bonifazi and Heins, 2000), while in Germany emigration from the former GDR to West Germany started with the fall of the iron curtain and unification around 1990 (Roloff, 2000; Mai, 2003a; Heiland, 2004).

2. RESEARCH STRATEGY

During the second half of the 20th century regional mortality differences underwent different developments in the two countries. While in Italy they decreased, in Germany they remained at a remarkable level of 8.5 years in life expectancy at birth for men in the years 1997/1999 (compared to 4 years in Italy; see Tables 1 and 2). Both countries, Germany and Italy, show a geographical differentiation of areas with homogeneous survival conditions. In Italy demographers distinguish between three main mortality regions: the north, the centre and the south (in some recent publications the north is further divided into north-east and north-west). This subdivision holds for historical mortality levels as well as for trends until today. For men it can be observed, that in the 2nd half of the 20th century the northern and central regions show the highest decrease in mortality while south Italy improves only in some regions and deteriorates in others (Caselli *et al.,* 2003). In the development of mortality reduction, the south lags behind but among men (especially in the west coast areas) it still shows better survival conditions than the more developed north (Figure 1). Consequently, despite the steeper mortality decline in the north, the north-south divide still persists. For women the geography of mortality is different from that of men. While the north shows similar disadvantages, in some parts of the south women's mortality is also higher than or closer to the national average as compared to men (Figure 2). However, the amount of regional mortality differences is slightly smaller than among men (Table 2).

Compared to Italy, in Germany the difference in the span of regional mortality levels between women and men is much higher (see Table 1). In Germany there are two different kinds of regional mortality differences overlapping each other. Most striking is the distinct east-west differentiation that is due to the special history of these two regions belonging to different political and social regimes for some decades during the last century (Höhn and Pollard, 1991; Heinemann *et al.,* 1996). Especially the developments in mortality following political unification in 1990 have recently attracted international attention and were analyzed in several studies (e.g. Eberstadt, 1994; Nolte *et al.,* 2000a, 2000b; Vaupel *et al.,* 2003; Luy, 2004c, 2005, 2006). Compared to this it is almost unrecognized that especially in western Germany a north-south gradient in mortality also exists. Consequently, as in Italy, there are three regions of different mortality levels, namely the centre-south (in the following simply called "south") with the lowest mortality, followed by the north-west, and the north-east with the highest mortality (see Figures 3 and 4). Contrariwise to the Italian situation, in Germany the north-south gradient is stable in time as well as between the sexes which becomes clear when recent and historical studies on regional mortality differences in Germany are analyzed (Lee, 1984; Paul, 1992; Sommer, 1998, 2002; Bucher, 2002; Luy, 2004a). While the extent of this north-south divergence has even increased in time, the east-west German mortality differences have been decreasing continuously since reunification (Vaupel *et al.,* 2003; Luy, 2003; 2004b, 2004c, 2005, 2006).

The goal of this paper is to test the hypothesis that regional mortality differences such as these are at least partly produced by the healthy migrant phenomenon and the salmon bias. However, a direct estimate of the impact of such a migration-caused selection effect on mortality at a low regional level is practically impossible[4]. The complexity of the connection between migration and health can be seen from studies finding that not only place of birth but also place of death (Strachan *et al.,* 1995) or place where men had

[4] Note that this "migration-caused selection effect" has nothing to do with the kind of selection effect Barbi and Caselli (2003) studied in the context of regional mortality differences in Italy. Barbi and Caselli (2003) dealt with the question whether elderly mortality differences observed in various Italian regions may be linked to different mortality levels at earlier ages and whether this may be explained by different selection or debilitation mechanisms.

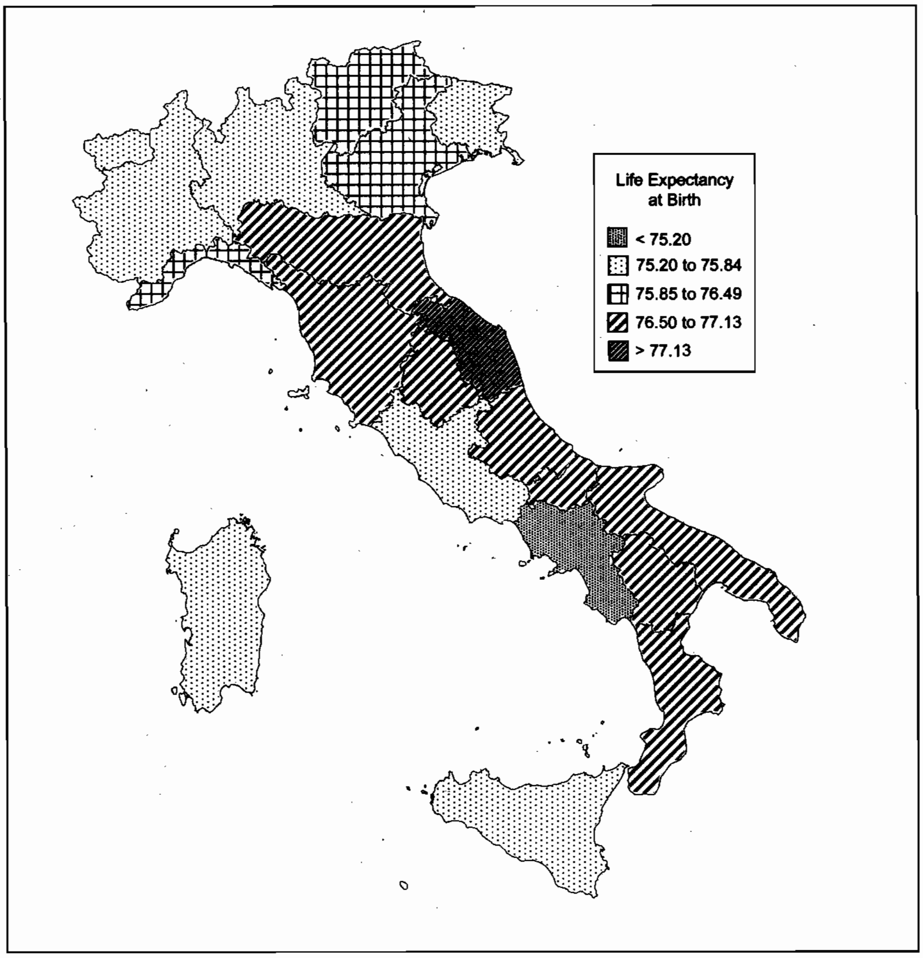
Table 1 – *Number of districts and variance of parameter values for life expectancy at birth and Billeter's* J *for German regions ("Bundesländer"), 1997-1999*

		Life expectancy e_0			Billeter's J		
	Districts	Min	Max	Span	Min	Max	Span
				Men			
North-West	*119*	*73.03*	*77.36*	*4.33*	*-0.48*	*-0.05*	*0.43*
Bremen	2	73.03	74.18	1.15	-0.38	-0.37	0.01
Hamburg	1	74.97	74.97	-	-0.34	-0.34	-
Niedersachsen	47	73.47	76.54	3.07	-0.48	-0.05	0.43
Nordrhein-Westfalen	54	72.43	77.36	4.93	-0.47	-0.11	0.36
Schleswig-Holstein	15	73.46	75.94	2.48	-0.43	-0.28	0.15
North-East	*113*	*69.89*	*75.56*	*5.67*	*-0.46*	*-0.15*	*0.31*
Berlin	1	73.96	73.96	-	-0.28	-0.28	-
Brandenburg	18	70.93	74.93	4.00	-0.37	-0.20	0.17
Mecklenburg-Vorpommern	18	69.89	73.78	3.89	-0.35	-0.15	0.20
Sachsen	29	71.48	75.56	4.08	-0.46	-0.24	0.22
Sachsen-Anhalt	24	71.52	73.88	2.36	-0.44	-0.21	0.23
Thüringen	23	71.67	75.48	3.81	-0.41	-0.17	0.24
South	*208*	*72.48*	*78.42*	*5.94*	*-0.51*	*-0.12*	*0.39*
Baden-Württemberg	44	74.28	77.17	2.89	-0.51	-0.12	0.39
Bayern	96	72.48	78.42	5.94	-0.43	-0.14	0.29
Hessen	26	73.41	77.62	4.21	-0.39	-0.21	0.18
Rheinland-Pfalz	36	73.23	76.08	2.85	-0.42	-0.19	0.23
Saarland	6	73.44	75.22	1.78	-0.36	-0.28	0.08
Germany	**440**	**69.89**	**78.42**	**8.53**	**-0.51**	**-0.05**	**0.46**

Table 1 – cont'd

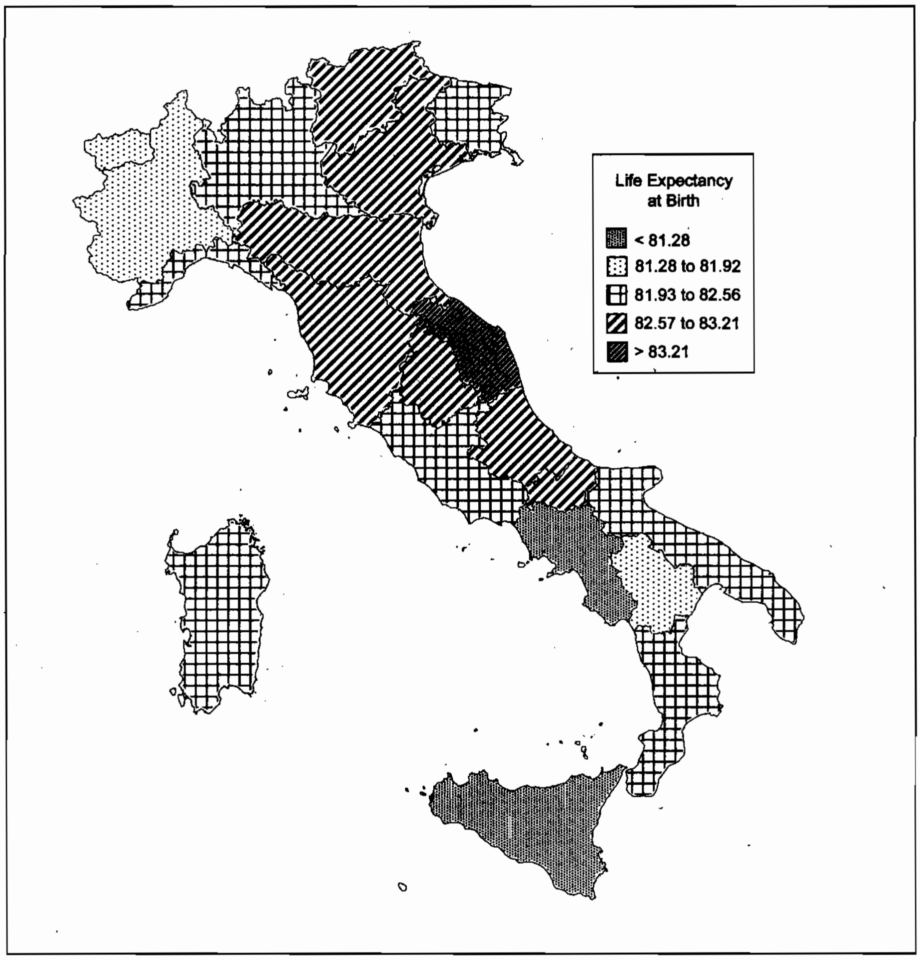
	Life expectancy e_0				Billeter's J		
	Districts	Min	Max	Span	Min	Max	Span
				Women			
North-West	*119*	*79.44*	*83.84*	*4.40*	*-0.78*	*-0.18*	*0.60*
Bremen	2	81.21	81.68	0.47	-0.63	-0.59	0.04
Hamburg	1	80.94	80.94	-	-0.58	-0.58	-
Niedersachsen	47	79.44	83.63	4.19	-0.78	-0.18	0.60
Nordrhein-Westfalen	54	79.44	83.84	4.40	-0.72	-0.25	0.47
Schleswig-Holstein	15	79.61	81.81	2.20	-0.68	-0.44	0.24
North-East	*113*	*78.11*	*82.81*	*4.70*	*-0.78*	*-0.31*	*0.47*
Berlin	1	79.65	79.65	-	-0.49	-0.49	-
Brandenburg	18	79.29	81.42	2.13	-0.65	-0.38	0.27
Mecklenburg-Vorpommern	18	78.85	82.81	3.96	-0.64	-0.31	0.33
Sachsen	29	79.38	82.30	2.92	-0.78	-0.44	0.34
Sachsen-Anhalt	24	78.67	81.48	2.81	-0.71	-0.42	0.29
Thüringen	23	78.11	81.57	3.46	-0.72	-0.37	0.35
South	*208*	*78.73*	*83.96*	*5.23*	*-0.85*	*-0.24*	*0.61*
Baden-Württemberg	44	79.88	83.49	3.61	-0.85	-0.25	0.60
Bayern	96	79.23	83.96	4.73	-0.73	-0.24	0.49
Hessen	26	79.57	83.12	3.55	-0.63	-0.36	0.27
Rheinland-Pfalz	36	78.73	82.32	3.59	-0.74	-0.30	0.44
Saarland	6	79.36	81.44	2.08	-0.59	-0.49	0.10
Germany	**440**	**78.11**	**83.96**	**5.85**	**-0.85**	**-0.18**	**0.67**

Figure 1 – *Regional mortality differences in life expectancy at birth for Italian men, measured for "Regioni" classified in units of the standard deviation (σ = 0.64), 1997-1999*



lived for most of their adult lives (Elford *et al.*, 1990) have an additional impact on mortality. In principle, a study on the connection between migration and regional mortality differences would require both a migration matrix on the level of districts and the statistical separation of population data due to place of birth, place of residence, and age vs. year of migration (for deaths as well as for the living population) which is available neither in Italy nor in Germany. Additionally, such a migration matrix would produce a

Figure 2 – *Regional mortality differences in life expectancy at birth for Italian women, measured for "Regioni" classified in units of the standard deviation (σ = 0.64), 1997-1999*



vast amount of data that would then have to be combined with information about regional mortality.

Consequently, a comparative analysis of a migration-caused selection effect in Italy and Germany requires an indirect concept based on a powerful indicator. Our approach is based on the fact that migration (national as well as international) shows a clear and well-known age pattern (e.g., see Preston *et al.,* 2001). Emigration as well as immigration occurs mainly at the young adult ages between 20 and 40 among women vs. 20 and 50 among men, as

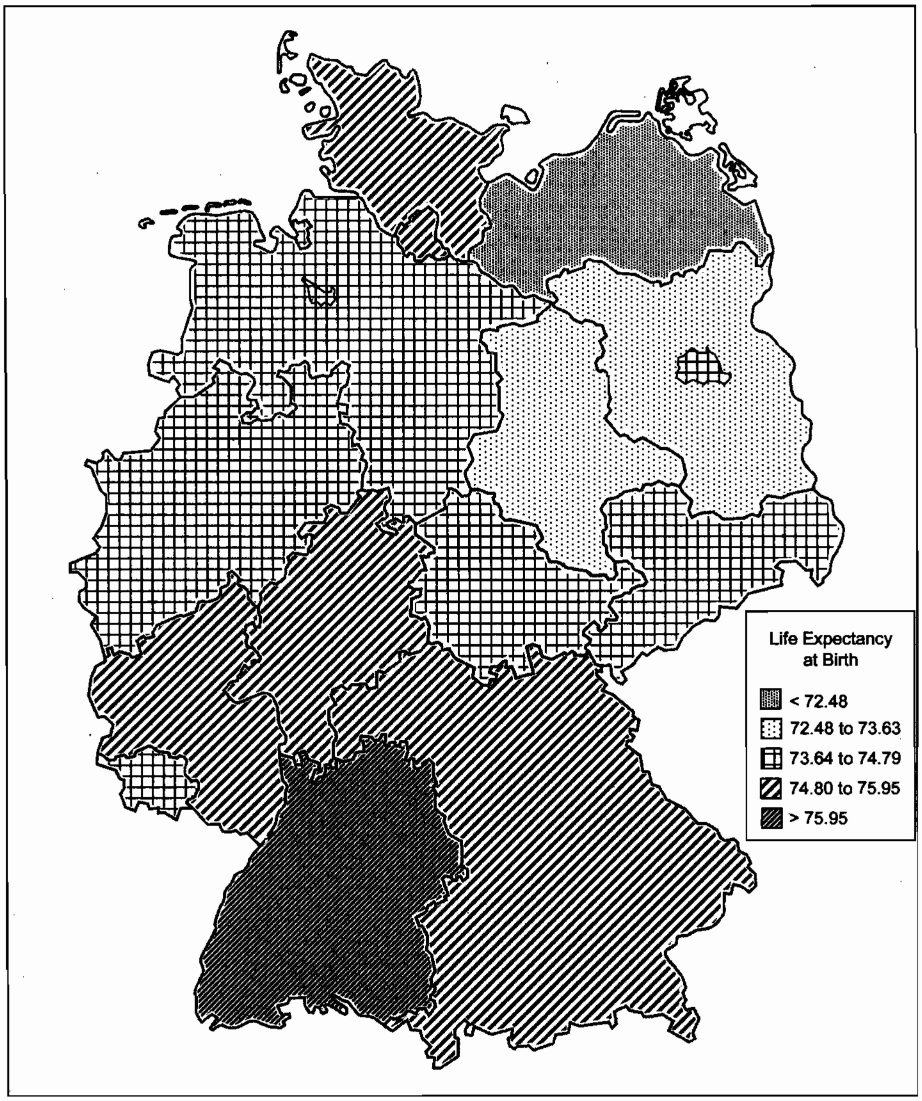
Table 2 – *Number of districts and variance of parameter values for life expectancy at birth and Billeter's* J *for Italian regions ("Regioni"), 1997-1999*

		Life expectancy e_0			Billeter's J		
	Districts	Min	Max	Span	Min	Max	Span
				Men			
North	*46*	*73.75*	*77.70*	*3.95*	*-0.73*	*-0.24*	*0.49*
Emilia Romagna	9	75.00	77.70	2.70	-0.68	-0.45	0.23
Friuli-Venezia Giulia	4	74.84	76.00	1.16	-0.69	-0.44	0.25
Liguria	4	75.46	76.25	0.79	-0.73	-0.67	0.06
Lombardia	11	73.75	76.11	2.36	-0.55	-0.31	0.24
Piemonte	8	74.62	76.13	1.51	-0.69	-0.45	0.24
Trentino-Alto Adige	2	76.05	76.44	0.39	-0.35	-0.24	0.11
Valle D'Aosta	1	74.17	74.17	-	-0.45	-0.45	-
Veneto	7	74.88	76.56	1.68	-0.51	-0.32	0.19
Centre	*21*	*74.80*	*77.74*	*2.94*	*-0.66*	*-0.31*	*0.35*
Lazio	5	75.56	76.02	0.46	-0.53	-0.31	0.22
Marche	4	76.59	77.62	1.03	-0.52	-0.48	0.04
Toscana	10	74.80	77.74	2.94	-0.66	-0.45	0.21
Umbria	2	76.36	77.20	0.84	-0.65	-0.53	0.12
South	*36*	*73.79*	*77.19*	*3.40*	*-0.46*	*-0.11*	*0.35*
Abruzzo	4	76.19	77.19	1.00	-0.46	-0.40	0.06
Basilicata	2	76.81	77.03	0.22	-0.34	-0.30	0.04
Calabria	5	75.53	77.19	1.66	-0.30	-0.19	0.11
Campania	5	73.79	76.94	3.15	-0.35	-0.11	0.24
Molise	2	76.06	76.72	0.66	-0.43	-0.42	0.01
Puglia	5	75.80	76.94	1.14	-0.33	-0.22	0.11
Sardegna	4	75.35	76.29	0.94	-0.41	-0.31	0.10
Sicilia	9	74.69	76.13	1.44	-0.34	-0.21	0.13
Italy	**103**	**73.75**	**77.74**	**3.99**	**-0.73**	**-0.11**	**0.62**

Table 2 – cont'd

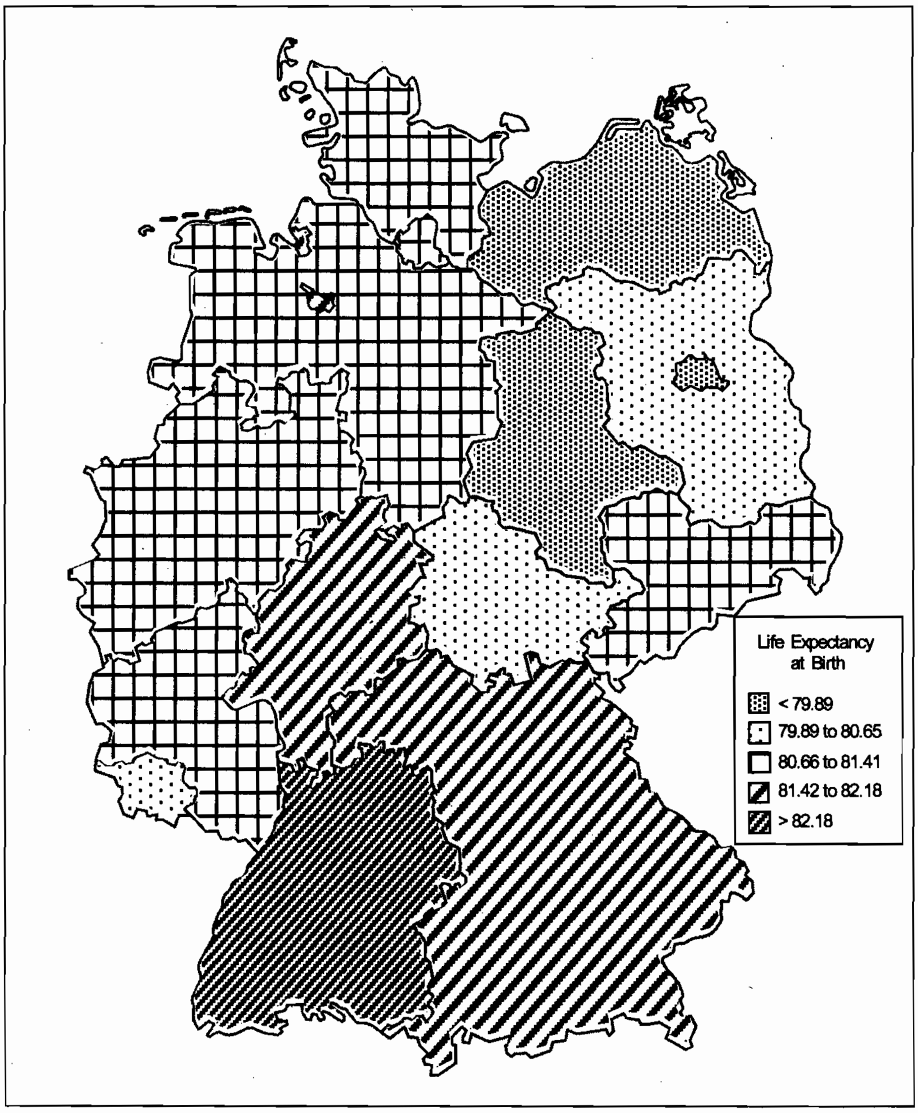
		Life expectancy e_0			Billeter's J		
	Districts	Min	Max	Span	Min	Max	Span
				Women			
North	*46*	*80.91*	*83.64*	*2.73*	*-1.08*	*-0.40*	*0.68*
Emilia Romagna	9	81.59	83.38	1.79	-0.95	-0.62	0.33
Friuli-Venezia Giulia	4	81.62	82.80	1.18	-1.08	-0.66	0.42
Liguria	4	81.74	82.81	1.07	-1.03	-0.95	0.08
Lombardia	11	81.08	83.19	2.11	-0.74	-0.48	0.26
Piemonte	8	80.91	82.35	1.44	-0.97	-0.68	0.29
Trentino-Alto Adige	2	82.76	83.64	0.88	-0.54	-0.40	0.14
Valle D'Aosta	1	82.06	82.06	-	-0.64	-0.64	-
Veneto	7	81.82	83.23	1.41	-0.76	-0.51	0.25
Centre	*21*	*81.64*	*83.29*	*1.65*	*-0.89*	*-0.41*	*0.48*
Lazio	5	81.64	82.10	0.46	-0.70	-0.41	0.29
Marche	4	82.93	83.29	0.36	-0.72	-0.65	0.07
Toscana	10	81.98	83.06	1.08	-0.89	-0.61	0.28
Umbria	2	82.29	82.94	0.65	-0.86	-0.73	0.13
South	*36*	*79.99*	*83.41*	*3.42*	*-0.63*	*-0.28*	*0.35*
Abruzzo	4	82.90	83.41	0.51	-0.63	-0.53	0.10
Basilicata	2	81.66	81.76	0.10	-0.48	-0.41	0.07
Calabria	5	80.72	82.07	1.35	-0.41	-0.28	0.13
Campania	5	79.99	82.76	2.77	-0.50	-0.24	0.26
Molise	2	81.86	82.27	0.41	-0.60	-0.58	0.02
Puglia	5	81.54	82.30	0.76	-0.49	-0.34	0.15
Sardegna	4	81.95	82.37	0.42	-0.55	-0.43	0.12
Sicilia	9	80.46	82.14	1.68	-0.51	-0.33	0.18
Italy	**103**	**79.99**	**83.64**	**3.65**	**-1.08**	**-0.28**	**0.80**

Figure 3 – *Regional mortality differences in life expectancy at birth for German men, measured for "Bundesländer" classified in units of the standard deviation (σ = 1.15), 1997-1999*



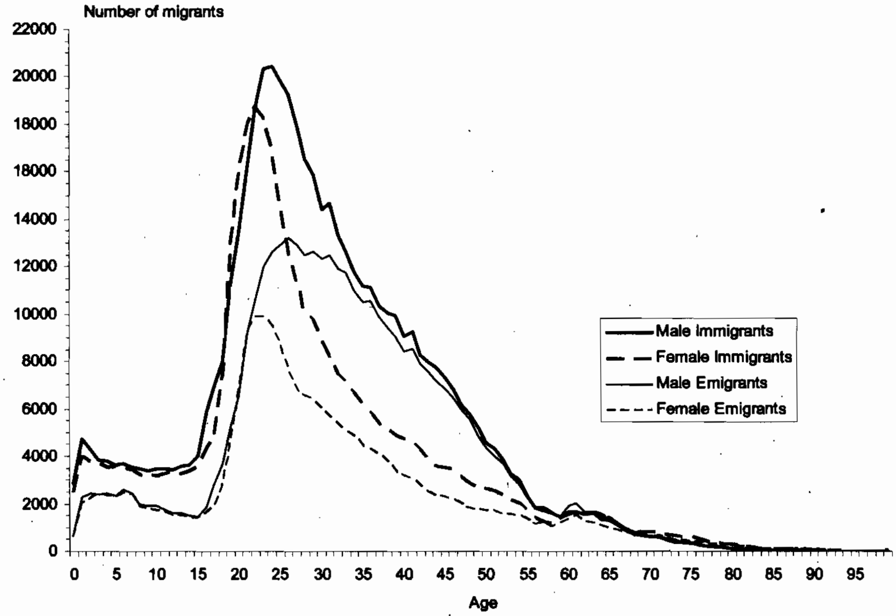
can be seen in Figure 5 for in- and out-migration to and from Germany in the year 2001. The biography of internal migration is almost identical (see Capocaccia and Caselli, 1990:26, 29; Mai, 2003a:41). Thus, if such a migration-caused selection effect exists and is strong enough to contribute to

Figure 4 – *Regional mortality differences in life expectancy at birth for German women, measured for "Bundesländer" classified in units of the standard deviation (σ = 0.76), 1997-1999*



regional mortality differences, we can expect a relationship between the population age structure of the regions with significant migration movements and their level of mortality.

Figure 5 – *Age-specific number of migrants to and from Germany, 2001*



The age structure of a population is generally produced by fertility, mortality, and migration. Fertility influences the base area of a population's age pyramid and leads to a younger population (in the case of high fertility) or to an older one (in the case of low fertility). In contemporary modern societies mortality mainly affects the upper part of the age pyramid and has an aging effect on the population's age structure. Migration occurs mainly during young adulthood and can affect demographic aging in both directions. This depends on two factors: the migration balance and the average age of the population. In a population with an average age above the main migration age groups, immigration leads to the population becoming younger by gaining young adults, while emigration areas are becoming older through the loss of young adults. The same holds vice versa in the case of a population with an average age below the age in which main migration activity starts.

These relationships build the main framework of our indirect research concept. Given that the average ages of the Italian and German emigration areas are above the main migration age we assume that the districts in these areas lose more healthy migrants the younger their populations are. Thus, since especially the emigration areas of southern Italy and north-east Germany are geographically restricted, a migration-caused selection effect on mortality should result in a negative statistical relationship between the population age and the level of mortality in these regional areas. In other words, we should expect that the younger the population in the emigration areas the higher the overall level of mortality is and vice versa. This hypothesis is based on the idea, that – if migrants are health-selected – a younger population loses relatively more healthy individuals by emigration than an older population as a consequence of the described age pattern of migrants. Furthermore, if such a migration-caused selection effect on mortality exists, in Germany the relationship between population age structure and mortality should be concentrated on younger adult age groups, while in Italy the relationship should be stronger in older age groups since the most intensive emigration movements occurred there 20 to 30 years earlier.

An important assumption behind this research strategy is that younger districts inside the emigration areas remain younger compared to the other districts even after emigration has taken place. At first glance this might seem contra intuitive. However, since we compare the younger emigration areas with other emigration areas that themselves are losing population this assumption seems to be justified. We do not know any case where a former younger emigration area lost so many young people that it became older than other emigration areas that have been older some years before. Even if such a case exists it has to be seen as an exception rather than a common situation.

South Italy and north-east Germany differ considerably regarding the main demographic parameters used in this study. As already described, in Germany the north-east is the region with the highest mortality among both sexes, while the south of Italy is the area with higher mortality only for women. South Italian men generally show a mortality level slightly better than men in the developed north (Figure 1). Although the absolute regional differences in life expectancy are considerably higher in Germany, most of the regions show a mortality level falling within the standard deviation around the mean for total Germany, as can be seen in figures 3 and 4. On the contrary, especially among Italian men, the Italian regions are concentrated in the upper and the lower mortality levels (Figure 1). Regarding the populations' age composition of these regions the differences between south Italy and north-east Germany are even bigger (Figures 6 and 7; here the demographic age of the various regions is only shown for one sex since the results are almost identical for women and men)[5]. While the south of Italy is the youngest of all Italian regions (ruled lines in Figures 6 and 7), the north-

[5] According to the chosen measure for the "demographic age" a population is older the more negative (smaller) the value for Billeter's J is. The measure itself is described in detail in the following section.

eastern German regions show a very heterogeneous age structure with an older population in Sachsen, younger populations in Mecklenburg-Vorpommern, Brandenburg, and Berlin, as well as populations having a demographic age close to the German average (Sachsen-Anhalt and Thueringen). These heterogeneous preconditions form a reasonable platform for testing the existence of a migration-caused selection effect on regional mortality differences. If the expected relationship between the populations' age structure and their mortality level exists in both countries, we can assume that this relationship is influenced by a migration-caused selection and probably not due to the specific combination of special demographic conditions that by chance could be observed in one of the two countries.

3. DATA AND METHODS

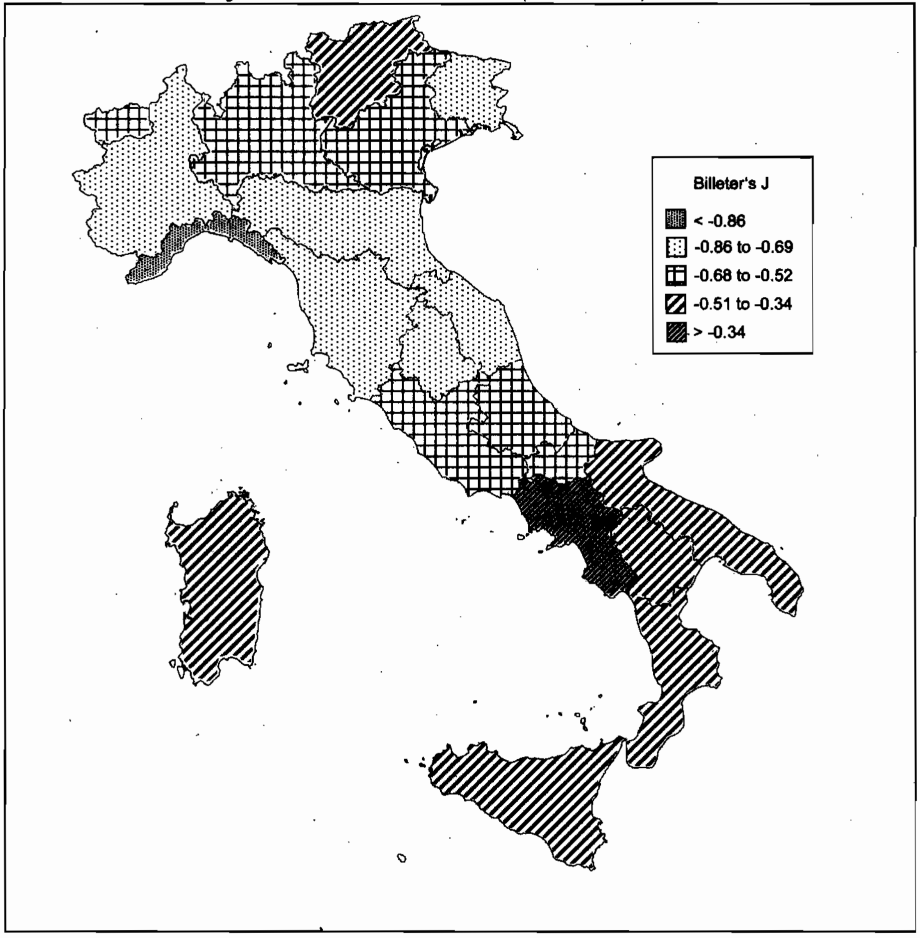
The following analysis is based on sex-specific period life tables for the Italian and German districts for the three calendar years 1997 to 1999. The complete Italian life tables were provided by ISTAT (Istituto Nazionale di Statistica in Rome, Italy)[6]. For Germany abridged life tables were calculated using age-specific population and death data on district level provided by the BBR (Bundesamt für Bauwesen und Raumordnung in Bonn, Germany). The life tables were calculated by standard techniques for transforming age-specific death rates into probabilities of dying (Chiang, 1984)[7]. Life expectancy at birth (e_0) is used as the indicator for overall mortality. For age-specific analysis the chosen indicators are the probability of dying at ages 15 to 40 ($_{25}q_{15}$) and 50 to 75 ($_{25}q_{50}$) as well as the death rate at ages 75 and above (M_{75+}). This choice of indicators was necessary because German data for age-specific deaths on district level end with the age interval 70 to 75 and thus it is not possible to calculate probabilities of dying for ages above 75 for German districts.

An estimation of the demographic age of a population mainly depends on the chosen measure. Each measure for the demographic age of a population is necessarily a simplification of the complex age structure. This causes problems and restrictions comparable to using the parameter life expectancy or standardized mortality rates as indicators for overall mortality (Vaupel, 2002; Luy, 2004a). The decision about the used measure requires

[6] The complete series of life tables for the Italian districts can be downloaded from http://www.demo.istat.it

[7] Since the relationship between age structure and mortality level is analyzed separately for Italy and Germany, the use of life tables calculated by different methods does not affect the reliability of the gained results.

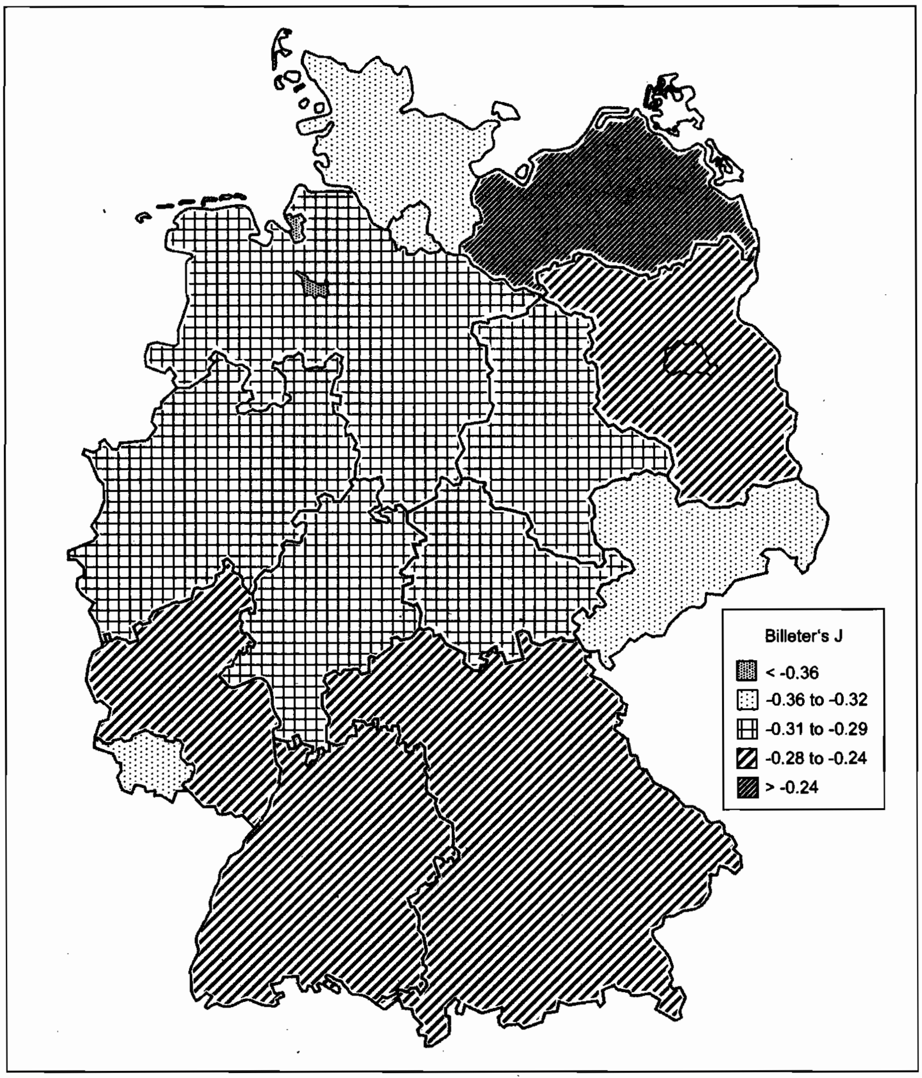
Figure 6 – *Billeters' J for Italian women, measured for "Regioni" classified in units of the standard deviation (σ = 0.17), 1997-1999*



an orientation on the basic research question of the analysis. For our purpose the measure for the demographic age has to include the complete age range and should be calculated as easily as possible to provide clear and understandable results. Additionally, the measure should be sensitive to demographic changes and able to identify any differences between populations regarding the complete age composition.

As already described, the age structure of a population is produced by fertility, mortality and migration. Demographic aging of a population is additionally dependent on the given age structure at a certain moment of time. Fertility affects a population's age composition at the bottom of the age pyramid, mortality in recent times mainly on its top. Migration occurs

Figure 7 – *Billeter's* J *for German men, measured for "Bundesländer" classified in units of the standard deviation (σ = 0.04), 1997-1999*



mainly during young adulthood. For our purposes we need a measure that separates these three population segments. One measure that fulfils the mentioned demands was developed by the Swiss economist Billeter (1954). His measure is almost unknown in international research on demographic aging. In Germany it was recently rediscovered in several studies on demographic aging since it is seen to provide reliable results indicating differences between and changes in the age composition of populations (e.g. Dinkel, 1989; Dinkel and Lebok, 1997; Heigl, 1998; Heigl and Mai, 1999; Mai, 2003b). Following a demographic intention, Billeter subdivided the population into three generations: the pre-reproductive population (from age 0 to 14, thus the generation of children), the reproductive population (from age 15-49, thus the generation of parents), and the post-reproductive population (from age 50 onwards, thus the generation of grandparents). According to Billeter (1954) these subgroups characterize the present and future potential of demographic development. The formula for Billeter's J is:

$$J = \frac{P_{0-14} - P_{50+}}{P_{15-49}}.$$

According to Billeter's J demographic aging is defined by a relative increase of the population in post-reproductive ages as opposed to the population in pre-reproductive ages. The measure can provide positive values (if $P_{0\text{-}14} > P_{50+}$) as well as negative values (if $P_{0\text{-}14} < P_{50+}$), which is typical for today's populations in developed countries. The value zero represents a situation where pre- and post-reproductive age groups have the same size, but has no indication like a norm and thus has the same meaning as any other value. The positive or negative sign indicates the relative and absolute majority of pre- vs. post-reproductive age groups. Furthermore, the values +1 and –1 indicate that exactly half of the population lives in the age groups 0-14 vs. 50+. The most important meaning of J for its interpretation is that the smaller (in general the more negative) the value of J is, the older the population and *vice versa*. Furthermore, Billeter's J can be used in comparative static perspective (for comparing two populations at a given year) as well as in dynamic perspective (for analyzing the development of demographic aging in a given time-span).

Note that regarding the analysis of population ageing Billeter's J cannot be seen as a perfect measure. Obviously, Billeter considered the youngest age groups and thus fertility as the most important feature of a population's demographic development. In Billeter's formula the pre-reproductive age groups are the smallest. Consequently, changes in the ages 0-14 affect Billeter's J much more than changes in the age groups 15-49 and 50+. However, since the denominator of Billeter's formula contains the reproductive age group that is identical to the main migration ages and given that the levels of fertility do not differ significantly between the districts in southern Italy and north-east Germany Billeter's J is the most suitable measure for the age structure of a population in the required context of this study[8].

To test the hypothesis of a migration-caused selection effect affecting regional mortality differences, the 103 Italian districts ("Province") are grouped into the regions north, centre, and south, the 440 German districts ("Kreise") into the regions north-west, north-east, and south (see Tables 1 and 2). For each of these regions it is examined whether, among the districts belonging to them, a linear relationship exists between the populations' age structure (measured by Billeter's J) and the mentioned indicators for overall and age-specific mortality (e_0 vs. ${}_{25}q_{15}$, ${}_{25}q_{50}$, and M_{75+}). To estimate the power as well as the statistical significance of the correlation, Pearson's r is used. The analyses are made sex-specific and separately for Italy and Germany.

4. RESULTS

In the presented results for the relationship between population and overall mortality measured by life expectancy at birth in Figures 8 to 11 we chose identical scales for Italy and Germany in order to also allow for a comparison between the two countries. In the graphs the values for Billeter's J are set on the x-axes (with the younger populations on the right side and the older populations on the left), while the indicator for the mortality level are on the y-axes. Although the analysis is focused on southern Italy and north-east Germany the graphs additionally include the districts of north and centre Italy as well as south and north-west Germany. In this way it is possible to assess whether the results for the emigration areas in southern Italy and north-east Germany differ from the others which is important to support or reject the hypothesis of a migration-caused selection effect.

An Italian-German comparison shows the big differences between the two countries regarding their demographic conditions. While the mortality level is much more heterogeneous among German districts (e_0 ranges from 69.89 to 78.42 among German men and from 78.11 to 83.96 among German women, while in Italy e_0 ranges from 73.75 to 77.74 among men and from 79.99 to 83.64 among women; see also Tables 1 and 2), the Italian districts

[8] Alternatively, we could have used the share of the analyzed age groups as indicator for the age structure regarding the mortality analysis of ages 15-40, 50-75 and 75+. We preferred using only one measure for the age composition of a population for all different analysis since this study is focused on mortality differences rather than on aspects of population aging. Using different age measures would result in an additional aspect to be taken into account for interpreting the results of this study.

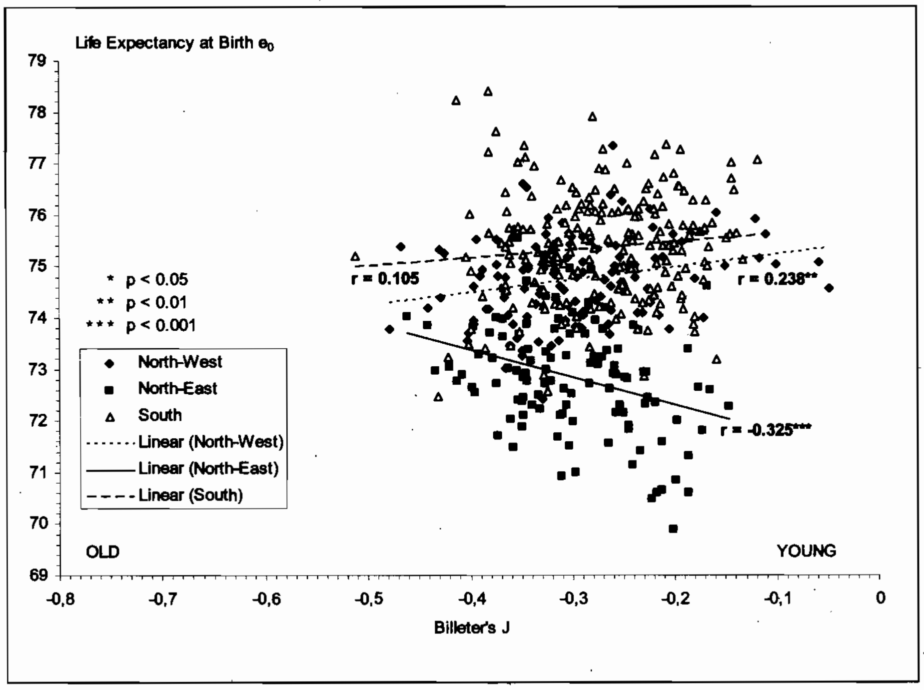
show more differences in their demographic age (Billeter's *J* ranges from -0.11 to -0.73 among Italian men and from -0.28 to -1.08 among Italian women, while in Germany *J* ranges from -0.05 to -0.51 among men and from -0.18 to -0.85 among women; see also Tables 1 and 2). Generally, the German population is younger than the Italian population, but life expectancy is higher in Italy[9]. These results hold similarly for both sexes.

The reason for the higher variability in life expectancy among German districts is mainly due to the high mortality in the north-eastern regions (graphically represented as black squares in the figures for Germany). On the other side, the reason for the more heterogeneous distribution of population age among Italian districts is a consequence of bigger differences in regional fertility as compared to Germany, resulting in relatively old populations with very low values for *J* especially in the north and in the centre of Italy (represented by white triangles and grey rhombi in the figures for Italy).

The central research question of this study is if there exists a statistical relationship between the age composition of populations and their mortality level among the north-eastern German and south Italian districts. As can be seen in Figures 8 and 9, among men the expected relationship can be found in both regions with high statistical significance. In southern Italy the relationship is stronger with Pearson's *r* being -0.552, among north-eastern German districts Pearson's *r* equals -0.325. According to the basic hypothesis, if this result is due to a migration-caused selection effect, then among north-eastern German districts the relationship with Billeter's *J* should be stronger for mortality at younger adult ages, while among southern Italian districts the relationship should be more emphasized at older ages. Table 3 shows that these relationships can be found with positive correlation between Billeter's *J* and the chosen indicators for age-specific mortality (meaning the younger the population in terms of Billeter's *J* the higher the mortality level). Among north-eastern German districts the correlation with Billeter's *J* is strongest with the probability of dying at ages 15 to 40 ${}_{25}q_{15}$ ($r = 0.256$), followed by the probability of dying at ages 50 to 75 ${}_{25}q_{50}$ ($r = 0.247$) and the death rate at ages 75 and above M_{75+} ($r = 0.214$). In all cases the correlation is statistically significant but slightly loses significance at the oldest age groups (see Table 3). Among southern Italian districts no statistically significant correlation can be found between Billeter's *J* and

9 As already mentioned, a comparison of German and Italian life expectancy on district level is slightly distorted by the fact that the methods used for calculating the life tables are different, which ultimately could influence the absolute parameter values. Anyway, also according to the official life tables for the total populations, Italy shows the higher expectancy.

Figure 8 – *Relationship between Billeter's* J *and life expectancy at birth* e_0 *for the 440 German districts with Pearson's* r *and statistical significance, males 1997-1999*

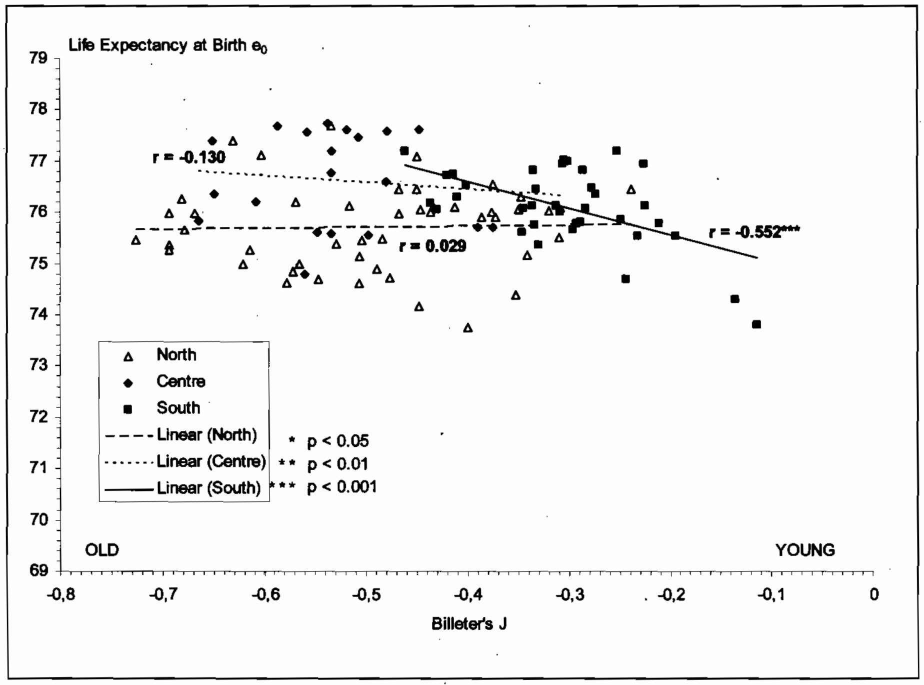


${}_{25}q_{15}$, but there is a strong statistically significant correlation between J and ${}_{25}q_{50}$ ($r = 0.464$) and especially between J and M_{75+} ($r = 0.730$; see Table 3).

Among women similar results can be found for the southern Italian regions (Figure 10). Here the correlation between Billeter's J and life expectancy at birth e_0 is the strongest of all cases ($r = -0.708$). As for men, this relationship is not statistically significant at ages 15 to 40, but highly statistically significant at ages 50 to 75 ($r = 0.705$) and at ages 75 and above ($r = 0.654$). Among women in the north-eastern German districts no statistically significant correlation between population age and mortality level can be found. However, also here, the sign of Pearson's r corresponds to the basic hypotheses (see Figure 11 and Table 3).

Finally we look at the correlation between population age and mortality level in the other German and Italian regions. Among German men in the north-western districts we find a statistically significant positive correlation between Billeter's J and life expectancy at birth e_0, meaning the younger the population in terms of Billeter's J the lower the overall mortality (or the

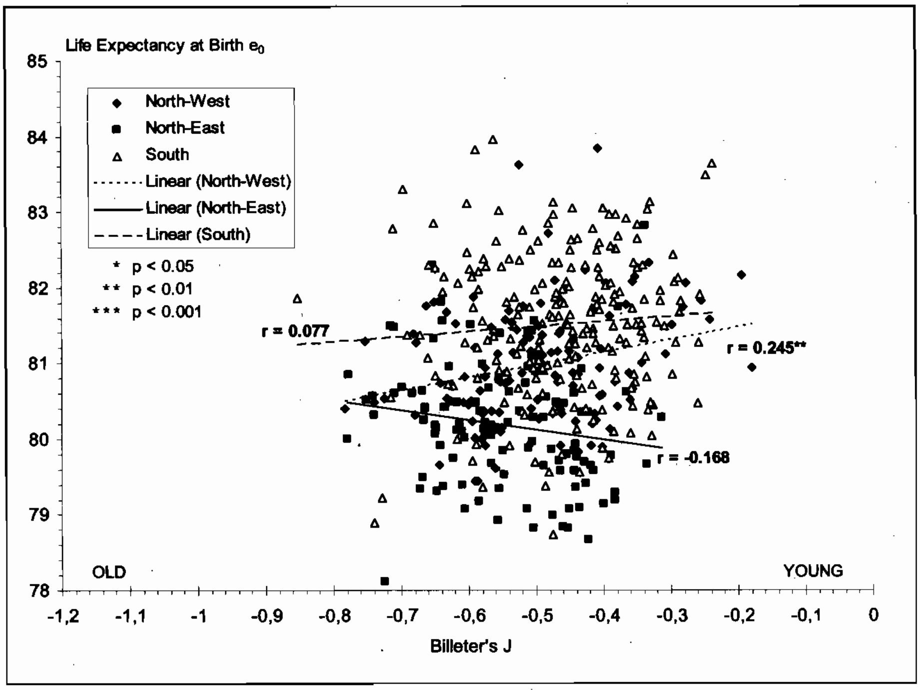
Figure 9 – *Relationship between Billeter's* J *and life expectancy at birth* e_0 *for the 103 Italian districts with Pearson's* r *and statistical significance, males 1997-1999*



higher life expectancy at birth). The correlation coefficients indicate that the reason for this finding is located in the mortality of the age groups 15 to 49 where Pearson's *r* for the relationship between *J* and ${}_{25}q_{50}$ equals -0.292 with high statistically significance (Table 3). In the southern German districts no statistically significant relationship exists between overall mortality and age of the population, but there is a statistically significant correlation in opposite directions between *J* and ${}_{25}q_{50}$ vs. M_{75+}. Almost the same relationships can be stated for women in the southern and north-western German districts (see Table 3).

Among Italian men in the districts in the north and in the centre as well as among Italian women in the centre there are no statistically significant relationships between population age and the level of mortality. This holds for both overall mortality and age-specific mortality (see Table 3). Beside the findings regarding the south of Italy, only among women in the northern districts a statistically significant correlation between Billeter's *J* and the mortality indicators can be found. Here the relationship is in opposite

Figure 10 – *Relationship between Billeter's* J *and life expectancy at birth* e_0 *with Pearson's* r *for the 440 German districts and statistical significance, females 1997-1999*

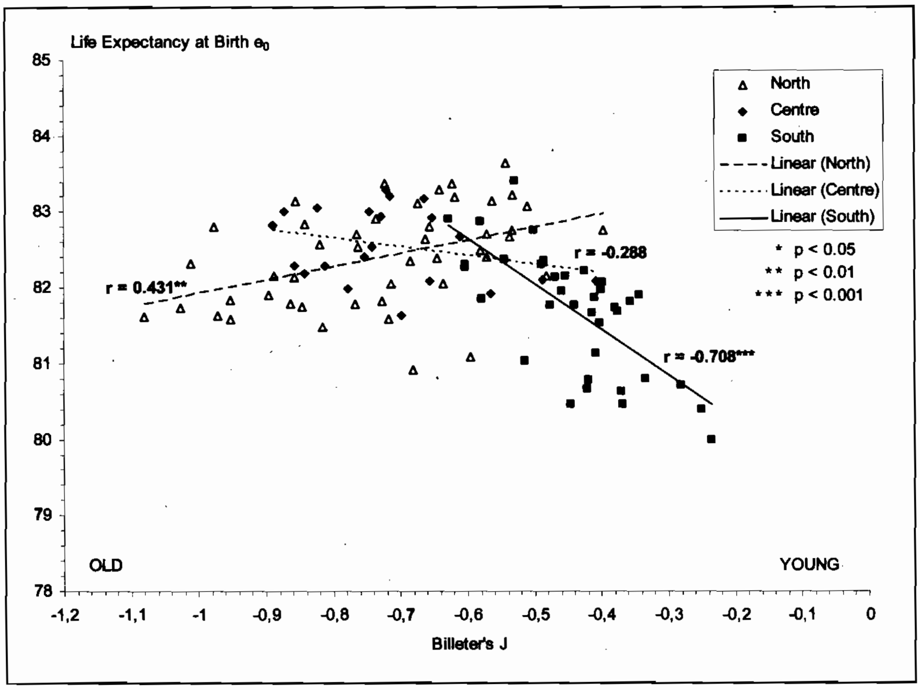


direction to the correlation in the south, meaning the younger the population in terms of Billeter's *J* the lower the mortality (similar to the findings for the north-western German districts). This result is mainly due to the mortality conditions in the younger and middle adult age groups, with r = 0.431 between J and e_0, r = -0.404 between J and $_{25}q_{15}$, and r = -0.414 between J and $_{25}q_{50}$. The correlation between Billeter's J and the death rate at ages 75 and above (M_{75+}) is not statistically significant.

5. SUMMARY AND CONCLUSIONS

The aim of this study was to test the hypothesis that a migration-caused selection effect belongs to the group of factors contributing to and causing regional mortality differences. This effect is thought to be a consequence of individual decisions of migrating to and living in special areas, causing heterogeneous areas with healthier people in some regions on the one side

Figure 11 – *Relationship between Billeter's* J *and life expectancy at birth* e_0 *for the 103 Italian districts with Pearson's* r *and statistical significance, females 1997-1999*



and areas with frailer populations on the other. Since a direct investigation of the impact of spatial population movements on mortality at low regional level is not possible we used an indirect indicator providing information to support or reject the basic hypothesis.

The decisive idea of this study is that if a migration-caused selection effect exists, then there should be a statistical correlation between the age composition of a population and its mortality level resulting from the typical biography of migrations that are concentrated among age groups 20 to 40. Since the south of Italy and north-eastern Germany (the former GDR) are almost clearly restricted emigration areas, such a correlation should be expected especially in these regions. Furthermore, in north-eastern Germany the corresponding relationship between mortality conditions and population age should be stronger at lower adult ages, since the emigration from the former GDR started around 1990, while in Italy the most intensive population movements from the south to the centre and the north occurred in the 1960s and 1970s. Consequently, in south Italy a migration-caused selection effect should be manifest in a correlation between population age and mortality at higher ages than in Germany.

Table 3 – *Pearson's r with statistical significance for the relationship between Billeter's J and the mortality indicators used for Germany and Italy, 1997-1999*

	e_0	$_{25}q_{15}$	$_{25}q_{50}$	M_{75+}
Germany, Men				
North-West	0.238 **	-0.057	-0.292 **	0.093
North-East	-0.325 ***	0.256 **	0.247 **	0.214 *
South	0.105	0.006	-0.136 *	0.231 ***
Germany, Women				
North-West	0.245 **	-0.215 *	-0.441 ***	0.110
North-East	-0.168	0.181	0.119	0.176
South	0.077	-0.181 **	-0.335 ***	0.228 ***
Italy, Men				
North	0.029	-0.238	0.130	0.025
Centre	-0.130	0.164	0.064	0.065
South	-0.552 ***	0.078	0.464 **	0.730 ***
Italy, Women				
North	0.431 ***	-0.404 **	-0.414 **	-0.195
Centre	-0.288	-0.026	0.297	0.342
South	-0.708 ***	0.113	0.705 ***	0.654 ***

Notes: * $p<0.05$; ** $p<0.01$; *** $p<0.001$.

Using the data for the years 1997 to 1999 on Italian and German district level we found that among women and men in south Italy as well as among men in north-eastern Germany the expected correlation exists with high statistical significance. Among the districts in both regions life expectancy at birth is lower the younger the populations are in terms of Billeter's *J*. Also regarding the correlation between population age and age-specific mortality, the basic hypothesis was strongly supported with a high statistically significant relationship among younger adult ages in north-eastern Germany and among higher adult ages in south Italy. Only among north-eastern German women no statistically significant relationship between population age and mortality was found. However, the directions of the correlation also fit the basic hypothesis. That in this case the expected correlation is not statistically significant might be explained by the fact that female migration generally takes place some years later than male migration. Since female mortality is very low at younger ages this could be insufficient to produce a statistically significant migration-caused selection effect among women in north-eastern Germany.

The question is whether we should expect the contrary relationship between mortality and population age in the other regions, namely north and centre Italy, and north-west and south Germany. The answer is no, since the immigration areas in both countries are not as geographically restricted as the emigration areas. To figure out a positive migration-caused selection effect in immigration areas it would be necessary to concentrate on immigration districts only. The areas of north and centre Italy as well as north-west and south Germany are too heterogeneous regarding migration history to expect a clear relationship between mortality and population age. But bearing in mind the results of south Italy and north-eastern Germany it is very likely that at least some parts of the found correlation between population age and mortality in the other regions might also be due to the healthy migrant phenomenon and the salmon bias.

To conclude, the results of this study provide strong evidence that a migration-caused selection effect affecting regional mortality differences in Italy and in Germany does exist, with a stronger impact in Italy as compared to Germany. To quantify this effect more generally it is necessary to further distinguish subgroups also among the emigration areas and to find an appropriate statistical model to describe the statistical relationship. The inclusion of a time perspective might also be helpful, as well as figuring out the main causes of death among which this selection effect is most effective. However, the aim of this paper was to find an indirect indicator to test the hypothesis of a migration-caused selection effect affecting regional mortality levels. The found correlation between mortality and population age in both southern Italy and north-eastern Germany are stronger than we expected. Consequently, the hypothesis of a migration-caused selection effect affecting regional mortality differences cannot be rejected on the basis of this study. The healthy migrant phenomenon and the salmon bias seem to belong to the group of general factors that are responsible for the existence of regional differences in survival conditions even on the macro level and that work independently from the societal and economic background of the regions.

Acknowledgements

The authors cordially thank Hansjörg Bucher from BBR (Bundesamt für Bauwesen und Raumordnung in Bonn, Germany) and Marco Marsili from ISTAT (Istituto Nazionale di Statistica in Rome, Italy) for providing the German and Italian data on district level to carry out this analysis.

References

ANSON J. (2004), "The migrant mortality advantage: a 70 month follow-up of the Brussels population", *European Journal of Population* 20:191-218.

ASCOLI U. (1979), *Movimenti migratori in Italia*, Il Mulino.

ABRAIDO-LANZA A.F., DOHRENWEND B.P., NG-MAK D.S., TURNER J.B. (1983), "The Latino mortality paradox: A test of the 'salmon bias' and healthy migrant hypothesis", *American Journal of Public Health,* 89(10):1543-1548.

ADELSTEIN A.M., MARMOT M.G., DEAN G., BRADSHAW J.S. (1986), "Comparison of mortality of Irish immigrants in England and Wales with that of Irish and British nationals", *Irish Medical Journal,* 79(7):185-189.

BALARAJAN R., RALEIGH V.S. (1997), "Patterns of mortality among Bangladeshis in England and Wales", *Ethnicity & Health,* 2(1-2):5-12.

BARBI E., CASELLI G. (2003), "Selection effects on regional mortality differences in survivorship in Italy", *Genus,* 59(2):37-61.

BARBONE F., FILIBERTI R., FRANCESCHI S., TALAMINI R., CONTI E., MONTELLA M., LA VECCHIA C. (1996), "Socioeconomic status, migration and the risk of breast cancer in Italy", *International Journal of Epidemiology,* 25(3):479-487.

BILLETER E.P. (1954), "Eine Maßzahl zur Beurteilung der Altersverteilung einer Bevölkerung", *Schweizerische Zeitschrift für Volkswirtschaft und Statistik,* 90:496-505.

BONIFAZI C., HEINS F. (2000), "Long-term trends of internal migration in Italy", *International Journal of Population Geography,* 6:111-131.

BOS V., KUNST A.E., KEIJ-DEERENBERG I.M., GARSSEN J., MACKENBACH J.P. (2004), "Ethnic inequalities in age- and cause-specific mortality in the Netherlands", *International Journal of Epidemiology,* 33(5):1112-1119.

BRIMBLECOMBE N., DORLING D., SHAW M. (2000), "Migration and geographical inequalities in health in Britain", *Social Science and Medicine,* 50:861-878.

BUCHER H. (2002), "Die Sterblichkeit in den Regionen der Bundesrepublik Deutschland und deren Ost-West-Lücke seit der Einigung", in CROMM J., SCHOLZ R.D. (eds.), *Regionale Sterblichkeit in Deutschland,* Augsburg, Göttingen: WiSoMed, 33-38.

BUIATTI E., GEDDES M., KRIEBEL D., SANTUCCI M., BIGGERI A. (1985), "A case control study of lung cancer in Florence, Italy: II. Effect of migration from the south", *Journal of Epidemiology & Community Health,* 39(3):251-255.

CAPOCACCIA R., CASELLI G. (1990), *Popolazione residente per età e sesso nelle province italiane. Anni 1972-1981*, Roma: Fonti e Strumenti, n. 2, Dipartimento di Scienze Demografiche dell'Università degli Studi di Roma "La Sapienza".

CASELLI G., EGIDI V. (1980), *Le differenze territoriali di mortalità in Italia. Tavole di mortalità provinciali (1971-72)*, Roma: Istituto di Demografia dell'Università.

CASELLI G., REALE A. (1999), "Does cohort analysis contribute to the study of the geography of mortality?", *Genus*, 55(1-2):27-59.

CASELLI G., VALLIN J. (2002), "Les variations géographiques de la mortalité", in CASELLI G., VALLIN J., WUNSCH G. (eds.), *Démographie: analyse et synthèse III, les déterminants de la mortalité*, Paris, INED, 373-415.

CASELLI G., CERBARA L., HEINS F., LIPSI R.M. (2003), "What impact do contextual variables have on the changing geography of mortality in Italy?", *European Journal of Population*, 19:339-373.

CEPPI M., VERCELLI N., DECARLI A., PUNTONI R. (1995), "The mortality rate of the province of birth as a risk indicator for lung and stomach cancer mortality among Genoa residents born in other Italian provinces", *European Journal of Cancer*, 31(2):193-197.

CHIANG C.L. (1984), *The life table and its applications*, Malabar, Krieger.

COGGON D., OSMOND C., BARKER D.J. (1990), "Stomach cancer and migration within England and Wales", *British Journal of Cancer*, 61(4):573-574.

DEBOOSERE P., GADEYNE S. (2005), "Adult migrant mortality advantage in Belgium: evidence using census and register data", *Population-E 60* (4-5):655-698.

DINKEL R.H. (1989), *Demographie. Band 1: Bevölkerungsdynamik.* München, Vahlen.

DINKEL R.H., LEBOK U. (1997), "Demographische Alterung in den alten und neuen Ländern Deutschlands", *Geographische Rundschau*, 3:169-172.

EBERSTADT N. (1994), "Demographic shocks after communism: Eastern Germany, 1989-93", *Population and Development Review*, 20(1):137-152.

ELFORD J., PHILLIPS A., THOMSON A.G., SHAPER A.G. (1990), "Migration and geographic variations in blood pressure in Britain", *British Medical Journal (Clinical Research Ed.)*, 300(6720):291-295.

FASCIOLI S., CAPOCACCIA R., MARIOTTI S. (1995), "Cancer mortality in migrant populations within Italy", *International Journal of Epidemiology*, 24(1):8-18.

FEINLEIB M., HUNT B.M., INGSTER-MOORE L., HAENSZEL W.D., LAMBERT P.M., ZEINER-HENRIKSEN T., ROGOT E. (1981), "The British-Norwegian migrant study – analysis of parameters of mortality differentials associated with angina", *Biometrics*, 38 supplement:55-74.

GOLINI A. (1974), *Distribuzione della popolazione, migrazioni interne e urbanizzazione in Italia*, Istituto di Demografia, Università degli Studi di Roma.

GREENBERG M., SCHNEIDER D. (1995), "Migration and the cancer burden of New Jersey Blacks", *New Jersey Medicine*, 92(8):509-511.

GRÖNER G. (2002), "Zu Entwicklung und regionalen Unterschieden der Sterblichkeit in Baden-Württemberg um 1990", in CROMM J., SCHOLZ R.D. (eds.), *Regionale Sterblichkeit in Deutschland*, Augsburg and Göttingen, WiSoMed, Cromm, 39-64.

HARDING S., MAXWELL R. (1998), "Differences in the mortality of migrants", in DREVER F., WHITEHEAD M. (eds.), *Health Inequalities*, London: ONS.

HEIGL A. (1998), *Determinanten regionaler Altersstrukturdifferenzen in Bayern. Eine sozio-demographische Analyse*, Frankfurt am Main *et al.*, Lang.

HEIGL A., MAI R. (1998), "Demographische Alterung in den Regionen der EU", *Zeitschrift für Bevölkerungswissenschaft*, 23(3):293-317.

HEILAND F. (2004), "Trends in East-West German migration from 1989 to 2002", *Demographic Research*, 11:173-194.

HEINEMANN L., DINKEL R.H., GÖRTLER E. (1996), "Life expectancy in Germany: possible reasons for the increasing gap between East and West Germany", *Reviews on Environmental Health*, 11(1-2):15-26.

HÖHN C., POLLARD J. (1991), "Mortality in the two Germanies in 1986 and trends 1976-1986", *European Journal of Population*, 7:1-28.

KING H., LOCKE F.B. (1987), "Health effects of migration: U.S. Chinese in and outside the Chinatown", *International Migration Review*, 21(3):555-575.

KINGTON R., CARLISLE D., MCCAFFREY D., MYERS H., ALLEN W. (1998), "Racial differences in functional status among elderly U.S. migrants from the south", *Social Science & Medicine*, 47(6):831-840.

LANSKA D.J., PETERSON P.M. (1995), "Effects of interstate migration on the geographic distribution of stroke mortality in the United States", *Stroke*, 26(4):554-561.

LEE W.R. (1984), "Mortality levels and agrarian reform in early 19th century Prussia. Some regional evidence", in BENGTSSON T., FRIDLIZIUS G., OHLSSON R. (eds.), *Pre-industrial population change. The mortality decline and short-term population movements*, Stockholm, Almquist and Wiksell International, 161-190.

LIPSI R.M., CASELLI G. (2002), *Evoluzione della geografia della mortalità in Italia. Tavole provinciali e probabilità di morte per causa, anni: 1971-1973, 1981-1983, 1991-1993*, Rome, Dipartimento di Scienze Demografiche.

LUY M. (2003), *Mortality in Eastern and Western Germany before and after reunification – new insights from the German Life Expectancy Survey*, paper presented at the 2003 PAA Annual Meeting, Minneapolis, Minnesota.

LUY M. (2004a), *Mortalitätsanalyse in der Historischen Demographie – die Erstellung von Periodensterbetafeln unter Anwendung der Growth-Balance-Methode und statistischer Testverfahren*, Wiesbaden, VS Verlag für Sozialwissenschaften.

LUY M. (2004b), "Verschiedene Aspekte der Sterblichkeitsentwicklung in Deutschland von 1950 bis 2000", *Zeitschrift für Bevölkerungswissenschaft*, 29(1):3-62.

LUY M. (2004c), "Mortality differences between Western and Eastern Germany before and after Reunification. A macro and micro level analysis of developments and responsible factors", *Genus*, 60(3-4):99-141.

LUY M. (2005), "West-Ost-Unterschiede in der Sterblichkeit unter besonderer Berücksichtigung des Einflusses von Lebensstil und Lebensqualität", in GÄRTNER K., GRÜNHEID E., LUY M. (eds.), *Lebensstile, Lebensphasen, Lebensqualität – Interdisziplinäre Analysen von Gesundheit und Sterblichkeit aus dem Lebenserwartungssurvey des BiB*, Wiesbaden, VS Verlag für Sozialwissenschaften, 333-364.

LUY M. (2006), "Mortality tempo adjustment: an empirical application", *Demographic Research*, 15:561-590.

MAI R. (2003a), *Abwanderung aus Ostdeutschland. Strukturen und Milieus der Altersselektivität und ihre regionalpolitische Bedeutung*. Frankfurt am Main *et al.*, Lang.

MAI R. (2003b), *Die Alten der Zukunft. Eine bevölkerungsstatistische Datenanalyse*, Opladen, Leske + Budrich.

MANCUSO T.F. (1977), "Lung cancer among black migrants. Interaction of host and occupational environment factors", *Journal of Occupational Medicine*, 19(8):531-532.

MCKAY L., MACINTYRE S., ELLAWAY A. (2003), *Migration and Health: A review of the international literature*, MRC Social & Public Health Sciences Unit, Occasional paper 12.

MEY W. (2002), "Regionale Unterschiede der Sterblichkeit im Süden der Neuen Bundesländer", in CROMM J., SCHOLZ R.D. (eds.), *Regionale Sterblichkeit in Deutschland*, Augsburg and Göttingen: WiSoMed, Cromm, 117-127.

NAIR C., NARGUNDKAR M., JOHANSEN H., STRACHAN J. (1990), "Canadian cardiovascular disease mortality: first generation immigrants versus Canadian born", *Health Reports*, 2(3):203-228.

NOLTE E., SHKOLNIKOV V., MCKEE M. (2000a), "Changing mortality patterns in East and West Germany and Poland. I: Long-term trends", *Journal of Epidemiology and Community Health,* 54:890-899.

NOLTE E., SHKOLNIKOV V., MCKEE M. (2000b), "Changing mortality patterns in East and West Germany and Poland. II: Short-term trends during transition and in the 1990s", *Journal of Epidemiology and Community Health,* 54:899-906.

PALLONI A., ARIAS E. (2003), *A re-examination of the Hispanic mortality paradox*, CDE Working Paper 2003-01.

PALLONI A., ARIAS E. (2004), "Paradox lost: explaining the Hispanic adult mortality advantage", *Demography,* 41(3):385-415.

PAUL C. (1992), "Sterblichkeit im regionalen Vergleich. Allgemeine Sterbetafeln der elf alten Bundesländer", *Wirtschaft und Statistik,* 82-87.

PRESTON S.H., HEUVELINE P., GUILLOT M. (2001), *Demography. Measuring and modeling population processes*, Oxford, Blackwell.

RAFTERY J., JONES D.R., ROSATO M. (1990), "The mortality of first and second generation Irish immigrants in the U.K.", *Social Science and Medicine,* 31(5):577-584.

RAZUM O., ZEEB H., GERHARDUS A. (1998a), "Cardiovascular mortality of Turkish nationals residing in West Germany", *Annals of Epidemiology,* 8(5):334-341.

RAZUM O., ZEEB H., AKGÜN H.S., YILMAZ S. (1998b), "Low overall mortality of Turkish residents in Germany persists and extends into a second generation: merely a healthy migrant effect?", *Tropical Medicine and International Health,* 3(4):297-303.

ROLOFF J. (2000), *Die demographische Entwicklung in den Bundesländern Deutschlands,* Materialien zur Bevölkerungswissenschaft 100, Wiesbaden: Bundesinstitut für Bevölkertungsforschung.

SCHOLZ R.D., THOELKE H. (2002), "Lebenserwartung in Berlin 1986 bis 1996 – Trends und regionale Unterschiede", in CROMM J., SCHOLZ R.D. (eds.), *Regionale Sterblichkeit in Deutschland,* Augsburg and Göttingen, WiSoMed, Cromm, 65-83.

SHAI D., ROSENWAIKE E. (1987), "Mortality among Hispanics in metropolitan Chicago: an examination based on vital statistics data", *Journal of Chronic Diseases,* 40(5):445-451.

SHARMA R.D., MICHALOWSKI M., VERMA R.B.P. (1990), "Mortality differentials among immigrant populations in Canada", *International Migration,* 28(4):443-450.

SINGH G.K., SIAHPUSH M. (2001), "All-cause and cause-specific mortality of immigrants and native born in the United States", *American Journal of Public Health,* 91(3):392-399.

SOMMER B. (1998), "Die Sterblichkeit in Deutschland im regionalen und europäischen Vergleich", *Wirtschaft und Statistik*, 960-970.

SOMMER B. (2002), "Die Sterblichkeit in der Bunderepublik Deutschland in der Regionalisierung der Länder", in CROMM J., SCHOLZ R.D. (eds.), *Regionale Sterblichkeit in Deutschland*, Augsburg, Göttingen: WiSoMed, 18-32.

STRACHAN D.P., LEON D.A., DODGEON B. (1995), "Mortality from cardiovascular disease among interregional migrants in England and Wales [see comments]", *British Medical Journal (Clinical Research Ed.)*, 310(6977):423-427.

TONIOLO P., PROTTA F., CAPPA A.P.M. (1989), "Risk of breast cancer, diet and internal migration in Northern Italy", *Tumori*, 75(5):406-409.

TSUGANE S., GOTLIEB S.L., LAURENTI R., SOUZA J.M.P., WATANABE S. (1989), "Mortality and cause of death among first-generation Japanese in Sao Paulo, Brazil", *International Journal of Epidemiology*, 18(3):647-651.

VALKONEN T., BRANCKER A., REIJO M. (1992), "Mortality differentials between three populations – residents of Scandinavia, Scandinavian immigrants to Canada and Canadian-born residents of Canada, 1979-1985", *Health Reports*, 4(2):137-159.

VAN STEENBERGEN J.E., SCHULPEN T.W.J., HOOGENBOEZEM J., VAN DRIEL H.F., BIJLSMA F. (1999), "Ethnicity and childhood mortality in the Netherlands", *European Journal of Public Health*, 9(3):205-210.

VAUPEL J.W. (2002), "Life expectancy at current rates vs. current conditions. A reflexion stimulated by Bongaarts and Feeney's 'how long do we live?'", *Demographic Research*, 7:365-377.

VAUPEL J.W., CAREY J.R,; CHRISTENSEN K. (2003), "It's never too late", *Science*, 301:1679-1681.

VIGOTTI M.A., CISLAGHI C., BALZI D., GIORGI D., LA VECCHIA C., MARCHI M., DECARLI A., ZANETTI R. (1988), "Cancer mortality in migrant populations within Italy", *Tumori*, 74(2):107-128.

WEI M., VALDEZ R.A., MITCHELL B.D., HAFFNER S.M., STERN M.P., HAZUDA H.P. (1996), "Migration status, socioeconomic status, and mortality rates in Mexican Americans and non-Hispanic whites: the San Antonio Heart Study", *Annals of Epidemiology*, 6(4):307-313.

WILD S., MCKEIGUE P. (1997), "Cross sectional analysis of mortality by country of birth in England and Wales, 1970-92", *British Medical Journal*, 314(7082):705-710.

WITTWER-BACKOFEN U. (1999), *Disparitäten der Alterssterblichkeit im regionalen Vergleich – Biologische versus sozioökonomische Determinanten. Regionale Studie für den Raum Hessen*, Materialen zur Bevölkerungswissenschaft 95, Wiesbaden, BiB.