Childhood Exposure to Disease and Old Age Mortality:

Migrants and Natives in Nineteenth-century Cities

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Abstract:
Recent studies suggest that poor conditions in early childhood may have long-term effects on adult and old age mortality. We make use of a natural experiment resulting from rural to urban migration in the mid-nineteenth century. Mortality was much higher in urban areas, especially in rapidly growing industrial cities. Migrants usually came from healthier rural origins as young adults. Data for this study is available from 19th-century Belgian population registers describing two sites: a rapidly growing industrial city; a small town that became an industrial suburb. We find evidence of three processes that lead to differences between the mortality of migrants and natives. First, recent migrants have lower mortality than natives, because they are self-selected for good health when they arrive. This advantage decreases with time spent in the destination. Second, migrants from rural backgrounds had a disadvantage in epidemic years, because they had less experience with these diseases. Third, migrants from rural areas had lower mortality at older (but not younger) ages, even if they had migrated more than ten years earlier. We interpret this as a long-run consequence of less exposure to disease in childhood.

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Introduction

Recent studies have paid increasing attention to the effects of conditions in early life on mortality at older ages. Experiences *in utero* and in early childhood have been linked to a variety of general and specific conditions appearing many years later (Elo and Preston 1992). In this paper we compare migrants and natives in two nineteenth-century cities to look for long-term consequences of childhood environments. Before 1900 rural people who moved into cities were introduced to more than just the latest technologies and fashions. They also entered a more diverse and much more deadly epidemiological environment. Public health measures, water purification, and sanitary sewers did not bring urban death rates down to rural levels until the end of the nineteenth century (Preston and van de Walle 1978). If differences in exposure to disease in childhood had long-run consequences, migrants from rural areas should have carried this advantage with them when they moved to cities. The analysis in this paper is designed to separate this effect from other explanations of mortality differences between rural migrants and urban natives.

We have three reasons to expect important differences in mortality between migrants and natives. First, migrants are a self-selected group who are usually healthy at the time they move (Williamson 1988; Abraido-Lanza, Dohrenwend et al. 1999; Khlat and Darmon 2003). Since most migrants are looking for more rewarding employment, people with poor health or disabilities are less likely to undertake the journey. This "healthy migrant" hypothesis has been used to explain the lower mortality rates of migrants in North America and Europe. Since it depends upon selection at the individual level, migrants will be healthier than natives in the destination even if aggregate mortality and morbidity are higher in the origin than in the destination. Migrants in nineteenth-century industrial cities often had lower mortality than urban natives (Alter, Bourdelais et al. 1999), and we have observed that migrants who left a poor rural area often came from families with more surviving sons (Oris and Alter 2001). A related mechanism lowering the mortality of migrants is called the "salmon-bias effect." If migrants return to their origins when they become sick, their deaths will not be recorded in the destination area (Razum, Zeeb et al. 1998; Abraido-Lanza, Dohrenwend et al. 1999).

Second, migrants may lack defenses against diseases that are more common at their destination than in their places of origin. Recent migrants are less likely to have either the biological immunities or social skills and social networks developed by natives to resist such diseases. This will result in high mortality shortly after arrival, but those who remain in the destination will acquire the "seasoning" that they need (Oris 2001). Allan Sharlin (1978) used this reasoning to argue that migrants in early modern cities had much higher mortality rates than urban natives. Smallpox, for example, was an epidemic disease in most of Europe but it was endemic in some large cities. Since survivors of smallpox acquire permanent immunity, the disease disappears without a constant flow of new victims. Smallpox epidemics in market towns tended to be five years apart, because it took that long to add enough vulnerable children to the population to sustain a new epidemic (Dobson 1997). In large cities the disease never completely died out, and migrants from rural areas often contracted smallpox when they arrived in the city (Landers 1987).

Third, although migrants may have lacked immunities to specific diseases, there could be long run advantages for those who suffered fewer diseases in childhood. Some childhood diseases, such as measles, can permanently compromise the immune system (Lunn 1991). Others, such as typhoid fever, may be contracted in childhood but cause sickness and death at older ages (Bengtsson and Lindström 2000; Troesken 2004). Diseases in early childhood may also compromise a child's nutrition and development (Martorell and Habicht 1986), which could have consequences much later. In addition, repeated episodes of disease may have cumulative effects that appear at older ages. Finch and Crimmins (2004) argue that episodes of sickness early in life result in inflammatory responses, which increase the likelihood of chronic diseases at older ages. (See also Riley (1989) on "insult accumulation.") Thus, migrants from less stressful environments may have been less prone to degenerative diseases, like heart diseases.

Each of these hypotheses suggests contrasts between migrants and natives that can be examined empirically. We expect the "healthy migrant" effect to be strong immediately after migration but to diminish as time in the destination increases (Frisbie, Cho et al. 2001; Harding 2003; Cho, Frisbie et al. 2004; Harding 2004). While current health is a good predictor of mortality in the near future, it is not a guarantee against sickness or death. This pattern is familiar from life and health insurance. Insurees are selected for good health, and they have lower mortality and morbidity rates immediately after the purchase of a policy. Actuaries regularly adjust for this period of positive selection, but they usually assume that this effect is trivial after ten years.

The seasoning hypothesis also implies that differences between migrants and natives should decrease over time, but it predicts higher rather than lower mortality among more recent migrants. In addition, migrants from places with less disease should face greater disadvantages in years with epidemic diseases, which may not have reached less populated areas. In our study area, nineteenth-century Eastern Belgium, the difference in life expectancy between rural areas and booming industrial towns sometimes exceeded 12 years (Neven 1997). This implies that we should distinguish between migrants from rural areas with relatively low mortality and migrants from other urban areas, who should have had the same experiences as natives. In this respect the effect of seasoning will be different from the healthy-migrant effect, which should apply equally to all migrants regardless of origin.

The early-life-conditions hypothesis differs from the other two hypotheses in three respects. First, it should not be related to time spent in the destination. Second, migrants from rural areas should have an advantage but those from other urban areas should not. Again, we assume that individuals raised in rural areas were exposed to fewer diseases and had fewer episodes of sickness as children. Third, early life conditions should be more strongly associated with mortality from chronic diseases than infectious diseases. This implies that we should see lower mortality at older ages among migrants from rural areas regardless of the time that they spent in the destination.[1]

Sources and Methods

Data for this study is drawn from the population registers of Limbourg and Verviers, two cities in eastern Belgium. Verviers, which had developed into an important

[1] Some recent studies of industrialized countries also consider a fourth hypothesis to explain persistent low mortality of immigrants. The acculturation hypothesis suggests that immigrants are protected from higher mortality by behaviors that they learned in their home countries. As immigrants and their children adopt the attitudes and behaviors of their new societies, like smoking and less healthy diets, their mortality becomes more like the average in their destination. This hypothesis is not appropriate for the population studied here. Most of the migrants in our sample moved short distances (less than 20 kilometers), and they joined urban societies that had been formed by earlier migrants from the same origins.
Abraido-Lanza, A. F., B. P. Dohrenwend, et al. (1999). "The Latino mortality paradox: A test of the "salmon bias" and healthy migrant hypotheses." American Journal Of Public Health **89**(10): 1543-1548, Razum, O. and D. Twardella (2002). "Viewpoint: Time travel with Oliver Twist - Towards an explanation for a paradoxically low mortality among recent immigrants." Tropical Medicine & International Health **7**(1): 4-10.

center for woolen textiles production during the eighteenth century, became the first location on the continent to develop mechanical spinning. The city grew rapidly in the first half of the nineteenth century, growing from about 10,000 inhabitants in 1800 to 24,053 in 1846, and 52,438 in 1899. This growth did nothing to improve public health, and life expectancy at birth in Verviers was about 32 years in 1846(Alter 1988). Death rates remained high until the 1870s, when water from a new reservoir began to be distributed in the city.

Limbourg was a former stronghold of the Dukes of Limbourg, which retained an urban atmosphere in spite of its small size (Capron 1996). Limbourg stagnated in the early nineteenth century as mechanized textile production in Verviers took the place of the artisanal methods used in the smaller city, but factories began to spread from Verviers to Limbourg around mid-century. Limbourg's populatin fell from 1,945 in 1806 to 1,763 in 1846, but it grew to 4,627 in 1899. Expectation of life at birth in Limbourg was around 40 years at mid-century (Capron 1998). This was better than Verviers, but still five to ten years below the life expectancies in surrounding rural areas. The gap between urban and rural areas was particularly large during cholera epidemics.

Limbourg and Verviers have been chosen for study because they have long series of population registers that can be supplemented by registers of births, deaths, and marriages. All municipalities in eastern Belgium were required to make lists of inhabitants in 1806, when the area was part of the Napoleonic Empire. Some places renewed these lists in the following decades. We have lists of inhabitants for Verviers in every year between 1806 and 1846, except for 1807. Lists for Limbourg survive from 1808, 1829, 1837, and 1841, and there are some lists of in-migrants during this period. In

1846 all municipalities in Belgium copied the census of that year into bound volumes, which were subsequently updated with births, deaths, marriages, and migration. Similar volumes were opened after censuses in 1856, 1866, 1880, 1890, and 1900, and this system eventually turned into Belgium's current population register. This means that we have individual-level information about population movements, including migration, for almost the entire nineteenth century in both Limbourg and Verviers.[2]

In this study we use data for individuals aged 20 and older who were born before 1850. In Verviers we follow individuals, including migrants who entered the city, from 1850 until 1899. The data for Limbourg begins in 1850 and ends in 1889. The population registers of both communities report places of birth for each individual. We also identify the dates that migrants entered Limbourg or Verviers. In most cases a date of entry is explicitly reported. When a date of entry is not available, we use the opening date of the first register in which the individual was recorded in Limbourg or Verviers. Data from Limbourg and Verviers have been pooled after experiments suggested that results were similar in both communities.

We use the Cox (1972) semi-parametric regression model to study factors associated with mortality. This model assumes that hazard rates vary along some "baseline" time dimension, which is not measured explicitly in the model. Covariates have proportional effects on the probability at all durations of time. We use age as the baseline time dimension, which means that the regression models presented below implicitly control for age.

[2] The sources used for Limbourg are Archives de l'état à Liège, *Registres de population*, 1806, 1808, 1829, 1836, 1846, 1856, 1866, 1880, 1890; *Declarations des transferts de domicile: entrées*, 1818-1913; *Declarations des transferts de domicile: sorties*, 1813-1914. The sources for Verviers are Archives communales de Verviers, *Registres de population*, 1846, 1849, 1856, 1866, 1880, 1890; *Relevés des habitants*, 1806-1846.

Table 1 presents distributions of the explanatory variables used in the analysis, and examples of complete models are in Table 2. Our focus will be on the first two covariates, time since arrival and origin, which are discussed in detail below. We control for city, sex, social class (occupation of head of household), year of birth, and year. We see in Table 2 that the relative risk of dying was 13 percent higher in Verviers than in Limbourg. Females faced risks that were 15 percent lower than males, and mortality varied substantially by social class.

The years included in the analysis have been divided into five groups: 1850-1865, 1866-1867, 1868-1882, 1883, and 1884-1899. This classification serves two purposes. First, it is intended to detect trends in mortality. We noted above that mortality in Verviers began to decrease after water from a new dam was piped to the city. This development does not appear in the data presented here, except perhaps in the absence of cholera epidemics after 1866. Second, 1866-67 and 1883 have been separated, because they were years of unusually high mortality in the sub-population studied here.[3] The first epidemic was clearly cholera, which was widespread in Europe in 1866. The cause of high mortality in 1883 is less clear, however. City-wide crude death rates were actually higher in 1881 than in 1883, when smallpox was reported in Verviers. Mortality in 1881 was not particularly severe in the subpopulation studied here, however, and they had not been strongly affected by the smallpox epidemic in 1871 either.[4] We believe that typhoid

[3] The cholera epidemic occurred in 1866. There were actually fewer deaths than normal in 1867, because so many vulnerable people had died in the epidemic.
[4] Smallpox probably had a weak impact in our sample, because they were older than the general population. Smallpox tends to strike younger people who lack immunities acquired from inoculation or previous contact with the disease.

fever was the main contributor to the peak in deaths in 1883, but it is also possible that influenza was present in that year.[5]

Results

The first event history model in Table 2 shows a clear link between migration and health. The most recent migrants had the lowest risks of dying, but migrants' advantage over natives decreased as time since their arrival increased. Figure 1 shows the effects of time since arrival on the relative risk of dying from the event history models in Table 2. All comparisons are to persons born in Limbourg or Verviers. The pattern in all years is quite clear, but there are important differences between years with and without epidemics. When epidemic years are excluded, the relationship between mortality and time since arrival becomes even more pronounced. Migrants who had arrived less than five years earlier were 31 percent less likely to die than natives, and those who had arrived five to ten years faced risks 25 percent below those of natives. As their time in Limbourg or Verviers increased, migrants became more like natives. The estimated risk for migrants who had twenty to twenty-nine years is 7 percent below the risk of dying for natives, but it is not statistically significant. Migrants who had arrived more than 30 years in the past seem to have been more likely to die than natives. This is exactly the pattern that we expect the healthy-migrant effect to produce.

In contrast, migrants had no mortality advantage in years with epidemics. In epidemic years, there is no difference between the relative risks of dying of natives and of

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[5] Infectious diseases are reported in Commission Médicale Provinciale de Liège, *Rapport*, 1864-1899. No epidemic diseases are reported for Limbourg or Verviers in 1883, but typhoid fever was reported in Liège and several other communities. The outbreaks of typhoid fever in the early 1880s caused a scandal, because Belgian cities had made many improvements in the distribution of drinking water. Political and medical elites had hoped that the problem was solved, but there was no way to certify the safety of drinking water until Pasteur's discoveries were accepted.

migrants who had arrived less than twenty years earlier. Although migrants were generally in better health than natives, they were not more resistant to specific infectious diseases: cholera in 1866 and typhoid fever in 1883. This suggests that a "seasoning effect" was also at work, and we now turn to comparisons among migrants to test this hypothesis.

In Table 3 and Figure 2 migrants are divided by both time since arrival and origin. We split the first dimension into four groups: natives, migrants who arrived less than ten years earlier, migrants who arrived more than ten years earlier, and migrants who arrived before age 15. Migrants who arrived as children are in a separate category, because their experiences should be more similar to natives. We use place of birth as an indicator of origin, which we divide into three groups: rural, urban, and other. Places of birth were classified on the basis of their population in 1900. Municipalities with less than five thousand inhabitants in 1900 are considered rural, and places with more than ten thousand are considered urban. The "other" group consists of places that fell between five and ten thousand in 1900 as well as places of birth outside of Belgium that we could not clearly identify as cities. Any categorization of this kind is bound to be arbitrary and imperfect. For example, some places in our "rural" group were actually industrial villages with close economic and epidemiological ties to neighboring cities. Furthermore, we do not have complete migration histories, and some people born in rural areas may have spent their childhood in other cities before arriving in Limbourg and Verviers. Since these problems would tend to reduce rather than increase the differences between categories, they should not affect the interpretation of comparisons between the rural and urban groups. Figure 2 focuses on this rural/urban comparison.

Figure 2 shows that the pattern in the previous figure was primarily due to migrants from rural areas. In non-epidemic years, migrants from rural areas had lower risks of dying than migrants from urban areas. During the two epidemic periods, rural migrants had the same or higher mortality than natives, while migrants from urban areas experienced mortality that was the same or lower than natives. A selection effect is also apparent among urban migrants who had been in Limbourg or Verviers less than ten years, but it is not as strong as the effect for rural migrants with similar migration histories. Figure 2 tempts us to conclude that urban migrants had acquired greater immunity to epidemic diseases than natives of Limbourg and Verviers, but those results are not statistically significant. Overall, Figure 2 suggests that both the healthy-migrant and seasoning effects were present.

We next divide the sample by age and sex to examine the early-life-conditions hypothesis. Table 4 and Figure 3 compare risks of death by rural/urban origins among younger adults (ages 20 to 59) in non-epidemic years. In this age group, both female and male migrants born in rural areas had lower relative risks of dying than natives if they had arrived less than ten years earlier. After ten years of residence in Limbourg or Verviers, however, there is no difference in mortality between rural migrants and natives. Again, the results for migrants from urban areas lack statistical significance, but it seems most likely that they had a smaller advantage than rural migrants.

Non-epidemic mortality over age 60 is examined in Table 5 and Figure 4. At this age we find lower mortality only among recent male migrants born in rural areas, but we can explain the absence of a selection effect among female migrants in a way that is consistent with the "healthy migrant" hypothesis. In a previous study, Alter (1999) found that older women who migrated into Verviers were often widows moving from rural areas to join the households of their married children. Older men, however, rarely joined their children's households even if they were widowers (Neven 2003). This implies that migration of older women was not selectively based on better health. Indeed, older female migrants may have been joining the households of their married children precisely because their health had worsened.[6]

Finally, migrants from rural areas who had arrived more than ten years earlier also had lower mortality than natives, and in this case the effect is statistically significant for females but not for males.[7] We interpret these results as evidence in favor of the early-life-conditions hypothesis. Migrants from urban areas had either higher (females) or slightly lower (males) mortality than natives, but the results lack statistical significance.

In summary, we find that differences in mortality between migrants and natives are affected by time since arrival, epidemics, and places of origin. The most consistent result is that recent migrants from rural areas had lower mortality than natives in years without epidemics. The only exception to this pattern is among older women migrating from rural areas, and other evidence suggests that their migration was more likely to be due to poor than to good health. The advantage of rural migrants disappeared during the two epidemics recorded in our data, however. Since our results for migrants born in urban areas are more diverse and none are statistically significant, it is more difficult to be certain about them. Nevertheless, urban-to-urban migrants appear to have had smaller

[6] Alter, Cliggett, and Urbiel (1996) found that old people living in the households of married children had higher mortality than those living alone or with unmarried children. They argue that older people in Verviers preferred to maintain separate households, and they gave up their independence only when they were physically unable to live on their own. Alter, G., L. Cliggett, et al. (1996). Household Patterns of the Elderly and the Proximity of Children in a Nineteenth-Century City, Verviers, Belgium, 1831-1846. Aging and Generational Relations. T. Hareven. Berlin and New York, Walter de Gruyter: 30-52.

[7] The p-value for females over 60 is .052 for non-epidemic years, which are shown in Table 5 and Figure 4. When all years are included, the p-value is .011.

advantages than rural migrants in non-epidemic years and to have fared as well or better than natives in epidemic years. At older ages we see evidence that migrants from rural areas may have retained an advantage over natives even when they had arrived more than ten years earlier.

Conclusion

Differences in mortality between migrants and natives in nineteenth-century Limbourg and Verviers offer evidence in favor of all three hypotheses described above: selection, seasoning, and childhood environment. The most powerful of these mechanisms was selection. The risks of dying among recent migrants were as much as thirty percent lower than the risks faced by natives, but their advantage decreased as they spent more time at their destination. This implies that migrants were mostly in good health when they arrived. The main exception to this pattern provides further support for the selection hypothesis. Women from rural origins who migrated after the age of 60 had the same risk of dying as native women of the same age. Since these women were often widows joining the households of children who had migrated earlier, they were not selected for health in the same way as other migrants.

While migrants had lower mortality than natives in normal years, they had no advantage when epidemic diseases were present. This can be interpreted in two ways. On one hand, it may simply mean that good health was not a defense against virulent infectious diseases, like cholera. On the other hand, migrants may have been at a disadvantage during epidemics, because they had experienced a smaller number of pathogens than urban natives, i.e. less seasoning. Migrants also lacked social skills that urban natives had gained in previous epidemics. Access to healthy water was always a challenge in nineteenth-century towns (Goubert 1987), and it became a question of life and death in periods of rapid urban growth (Oris 1998). Our data suggest that migrants from urban origins, whose experiences would have been similar to urban natives, weathered epidemics better than migrants from rural backgrounds.

Finally, differences between migrants born in rural and urban areas suggest long term effects of childhood environments. Migrants from rural origins generally had lower mortality than those from urban origins, except when epidemic diseases were present. While this advantage was short-lived at younger adult ages, it was more persistent at older ages. Again the most interesting result is for female migrants from rural areas above the age of 60. Those who had migrated more than ten years earlier were almost twenty percent less likely to die than native women. Since the average time since arrival in this category is more than twenty five years, most of these women had arrived in Limbourg or Verviers as young adults. The absence of this effect among younger migrants suggests that a rural childhood was more important for the degenerative diseases of old age than for the infectious diseases faced by young adults.

Table 1. Distributions of Covariates Used in the Event History Analysis, Limbourg and Verviers, 1850-1899

	Ages 20-59	Ages 60 and older	Ages 20 and older
Time since arrival:			
Native	44.0	35.2	42.6
0- 4	15.1	7.4	13.9
5- 9	10.8	6.4	10.0
10-19	14.3	9.8	13.6
20-29	9.0	11.3	9.4
30+	6.8	29.9	10.6
Time since arrival and origin:			
Native	44.0	35.2	42.6
Rural <10	15.5	8.6	14.3
Urban <10	3.0	1.6	2.8
Other <10	6.9	3.6	6.3
Rural 10+	13.7	31.8	16.7
Urban 10+	2.1	4.5	2.5
Other 10+	4.6	8.6	5.3
Arrived ages 0-15	10.2	6.1	9.5
Occupation of head of household:			
No occupation	3.2	9.0	4.2
Laborer	11.0	13.4	11.4
Skilled	56.4	46.6	54.6
Manager	20.6	18.1	20.2
Proprietor/Professional	8.9	13.0	9.6
Year of birth:			
<1800	1.6	30.7	6.4
1800-1824	26.3	55.3	31.1
1825-1850	72.1	14.0	62.6
Years			
1850-1865	38.9	26.5	36.9
1866-1867	5.1	3.8	4.9
1868-1882	35.4	33.7	35.1
1883	2.2	2.6	2.2
1884-1899	18.5	33.3	20.9
Sex			
Male	50.3	45.0	49.4
Female	49.7	55.1	50.6

Municipality:			
Limbourg	43.6	44.2	43.7
Verviers	56.5	55.9	56.4
Subjects	7814	2438	8547
Deaths	1196	1318	2517
Time at risk (years)	85065	19515	104580
Death rate	0.014	0.068	0.024

Table 2.
Effects of Covariates on the Relative Risk of Dying at Ages 20 and Older for Non-epidemic and Epidemic Years in Limbourg and Verviers, 1850-1899

	All years		Non-epidemic years		Epidemic years	
Covariates	Relative risk	p-value	Relative risk	p-value	Relative risk	p-value
Time since arrival:						
Native	1.00		1.00		1.00	
0- 4	0.76	0.00	0.69	0.00	1.01	0.97
5- 9	0.80	0.04	0.75	0.01	0.96	0.88
10-19	0.93	0.42	0.88	0.20	1.06	0.78
20-29	0.90	0.31	0.93	0.49	0.57	0.14
30+	1.26	0.02	1.22	0.06	1.41	0.19
Occupation of head of household:						
No occupation	1.80	0.00	1.74	0.00	2.23	0.03
Laborer	1.00		1.00		1.00	
Skilled	0.87	0.13	0.84	0.08	1.03	0.92
Manager	0.63	0.00	0.64	0.00	0.56	0.07
Proprietor/Professional	0.56	0.00	0.55	0.00	0.62	0.22
Year of birth:						
<1800	0.80	0.28	0.81	0.29		
1800-1824	1.00		1.00		1.00	
1825-1850	0.82	0.06	0.84	0.13	0.80	0.51
Year:						
1850-1865	1.00		1.00			
1866-1867	2.07	0.00			1.20	0.51
1868-1882	1.05	0.54				
1883	1.43	0.04	1.04	0.65	1.00	
1884-1899	1.10	0.48	1.10	0.51		
Female	0.74	0.00	0.76	0.00	0.66	0.01
Municipality:						
Limbourg	1.00		1.00		1.00	
Verviers	1.13	0.05	1.13	0.06	1.14	0.41
Subjects	7814		7710		4309	
Deaths	1196		1018		178	
Time at risk	85064.7		78047.7		7017.0	
Chi-squared	178.3		106.2		34.9	
Degrees of freedom	17		15		13	
p-value	0.00		0.00		0.00	

Table 3. Effects of Time Since Arrival and Origin on the Relative Risk of Dying at Ages 20 and Older in Limbourg and Verviers, 1850-1899

	All years		Non-epidemic years		Epidemic years	
Time since arrival and origin:	Relative risk	p-value	Relative risk	p-value	Relative risk	p-value
Native	1.00		1.00		1.00	
Rural <10	0.81	0.00	0.76	0.00	1.03	0.86
Urban <10	0.87	0.33	0.86	0.32	0.85	0.71
Other <10	0.80	0.03	0.76	0.01	0.97	0.92
Rural 10+	0.91	0.08	0.90	0.05	1.09	0.60
Urban 10+	0.96	0.69	1.00	1.00	0.50	0.17
Other 10+	0.91	0.26	0.89	0.17	1.12	0.67
Arrived ages 0-15	1.06	0.45	1.09	0.28	0.82	0.41

Note: Estimates are drawn from a model that also includes covariates for occupation of head of household, year of birth, year, sex, and municipality.

Table 4.
Effects of Time Since Arrival and Origin on the Relative Risk of Dying for Ages 20 to 59 in Non-epidemic Years, Limbourg and Verviers, 1812-1899

	Females		Males	
Time since arrival and origin:	Relative risk	p-value	Relative risk	p-value
Native	1.00		1.00	
Rural <10	0.70	0.02	0.72	0.02
Urban <10	0.59	0.13	0.83	0.48
Other <10	1.04	0.82	0.53	0.00
Rural 10+	1.02	0.88	0.97	0.81
Urban 10+	0.59	0.18	0.94	0.83
Other 10+	0.61	0.04	1.01	0.96
Arrived ages 0-15	1.00	0.99	1.19	0.20

Note: Estimates are drawn from a model that also includes covariates for occupation of head of household, year of birth, year, sex, and municipality.

Table 5.
Effects of Time Since Arrival and Origin on the Relative Risk of Dying for Ages 60 and Older in Non-epidemic Years, Limbourg and Verviers, 1812-1899

	Females		Males	
Time since arrival and origin:	Relative risk	p-value	Relative risk	p-value
Native	1.00		1.00	
Rural <10	0.99	0.97	0.71	0.05
Urban <10	1.32	0.35	0.94	0.87
Other <10	0.77	0.31	0.74	0.26
Rural 10+	0.82	0.05	0.90	0.32
Urban 10+	1.27	0.20	0.91	0.66
Other 10+	0.94	0.67	0.90	0.53
Arrived ages 0-15	1.05	0.80	1.08	0.68

Note: Estimates are drawn from a model that also includes covariates for occupation of head of household, year of birth, year, sex, and municipality.

Figure 1. Effects of Time Since Arrival on the Relative Risk of Dying for Non-Epidemic and Epidemic Years, Ages 20 and older, Limbourg and Verviers, 1850-1899

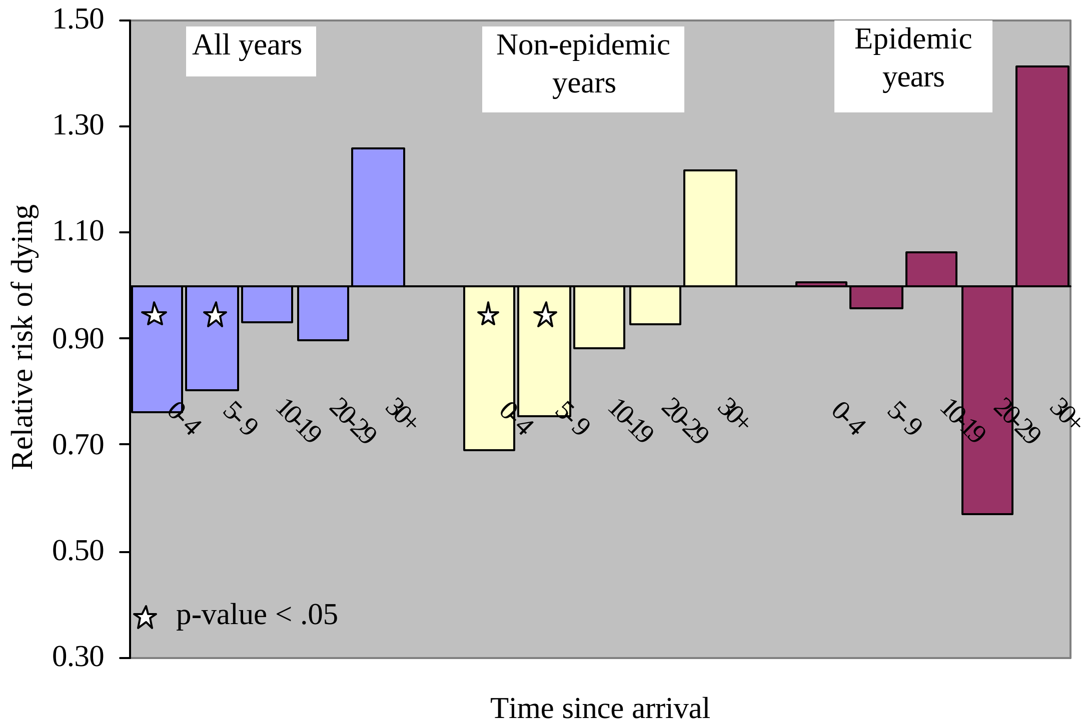


Figure 2. Effects of Time Since Arrival and Origin on the Relative Risk of Dying for Non-Epidemic and Epidemic Years, Ages 20 and older, Limbourg and Verviers, 1850-1899

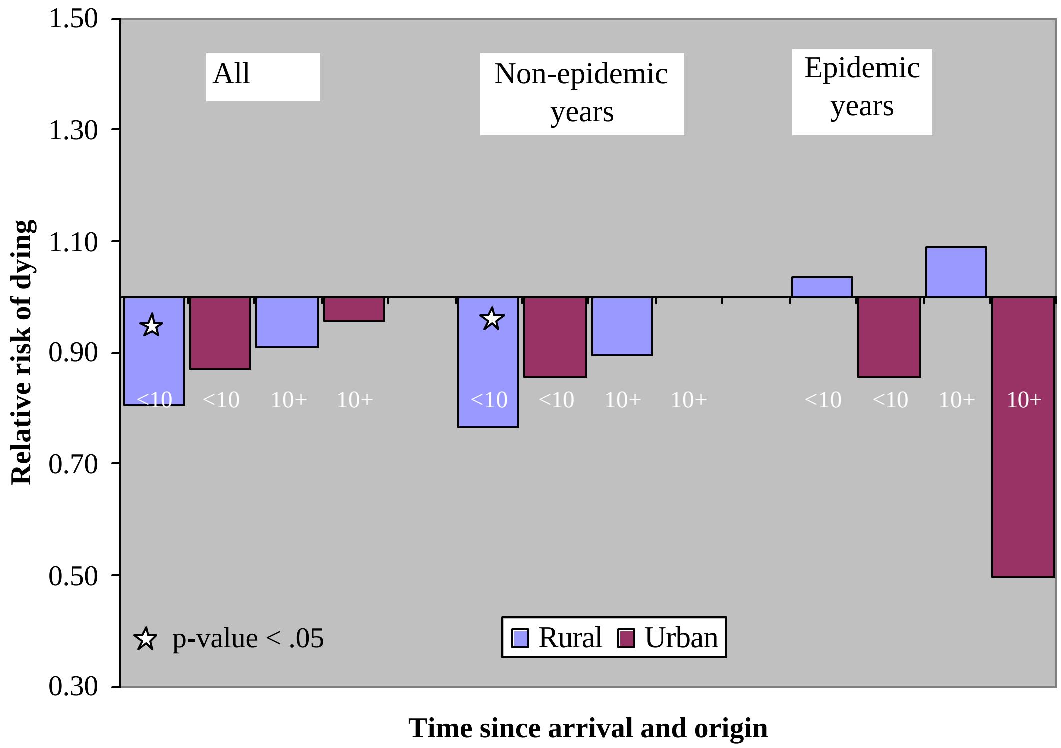
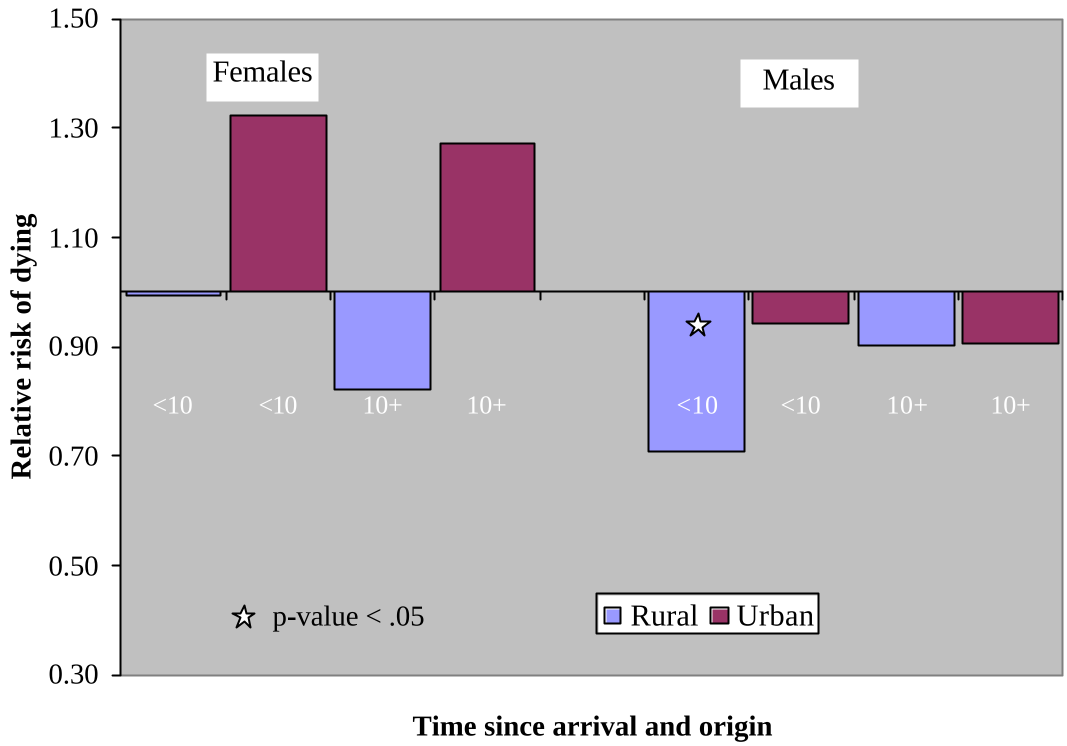


Figure 3. Effects of Time Since Arrival on the Relative Risk of Dying by Sex in Non-epidemic Years, Ages 20 to 59, Limbourg and Verviers, 1850-1899

Figure 4. Effects of Time Since Arrival on the Relative Risk of Dying by Sex in Non-epidemic Years, Ages 60 and older, Limbourg and Verviers, 1850-1899



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