Environment, Housing, and Infant Mortality: Udine, 1807–1815

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Abstract

Much research on differentials of mortality focuses on the links to social class and socio-economic status. However, these links can be influenced by the location and spatial distribution of a population in a given area. This effect is particularly evident when considering areas that differ greatly in terms of climate and resources, but less so if the analysis is narrowed to a more limited context, such as individual towns. In many urban settings, the distribution of inhabitants follows a logical pattern because different functions are associated with certain areas. This process creates distinctive districts or sub-areas where the population appears relatively socially and economically homogenous. This means we have to look for associations between mortality and environmental and socio-economic factors. However, the geographical distribution of the population in some urban contexts is less clearly differentiated by the socio-economic status of the family. This analysis of Udine, a small town in north-east Italy, makes use of an integrated database derived from information taken from four sources: a) Napoleonic civil birth registers; b) Napoleonic civil death registers; c) a Napoleonic census with information on housing; and d) a detailed map of Udine. All four sources report the number of people registered for each house, making it possible to geo-reference demographic events while at the same time, controlling for the quality of the housing. This study has three aims: 1) to examine the possible socio-economic factors that affected infant and child mortality levels in the early 19th century; 2) to investigate whether these were affected by the housing quality; and 3) to determine if the spatial distribution of this mortality can be interpreted in the light of social and environmental differentials.

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Introduction

Much research on differentials of mortality focuses on the links to social class and socio-economic status, but these links can also be influenced by the location and spatial distribution of a population in a given area. This effect is particularly evident when referring to areas that differ greatly in terms of climate and resources, but less so if the analysis is narrowed to more limited context, such as individual towns.

In many urban settings, the distribution of inhabitants follows a logical pattern because different functions are associated with certain areas. This process creates distinctive districts or sub-areas where the population appears relatively socially and economically homogenous. This means we need to look for associations between mortality and environmental and socio-economic factors. However, in some urban settings, the geographical distribution of the population is not so clearly differentiated by the socio-economic status of the family.

This analysis of Udine, a small town in north-east Italy, aims to examine the socio-economic factors that affected infant and child mortality levels in the early 19th century; investigate whether these levels were affected by environmental factors, such as housing quality; and determine if the spatial distribution of this mortality can be interpreted in the light of social and environmental factors.

Background

Research on the links between mortality differentials and socioeconomic status shows that upper SES groups generally had a higher than average life-expectancy (Vedrenne-Villeneuve 1961; Perrenoud 1975; Blum, Houdaille and Lamouche 1990; Bengtsson and van Poppel 2011), but there is evidence that these differences were largely determined during childhood and early adulthood. Perrenoud (1975) estimates a 17 year difference in infant mortality between the poor and wealthy in 17th century Geneva, and Hollingsworth (1977) shows that the 7 year gap in life-expectancy between the English peerage and general population was largely determined in childhood.

Studies on rural populations, where social difference is less pronounced than in urban contexts, also show the same tendency. Families in the highest tax bracket had the lowest IMR in Weir's (1995) study of Rosny-Sous-Bois, and we see the same situation

in Italian rural communities, where SES is based on household head's occupation (Breschi *et al.* 2004). Comparisons between rural and urban populations show that IMR differentials by SES are more pronounced in the latter (van Poppel and Mandemakers 1997).

Although housing is associated to mortality and health, very few studies address this issue for pre-transitional populations, due partly to the lack of reliable data. This study makes use of sources with information on the characteristics and quality of individual houses, making it possible to evaluate their impact on infant mortality.

Most studies examine urban settings and reveal the correlation between overcrowding and infant mortality, as in Glasgow and Edinburgh in the 19th century (Cage 1994; Cage and Foster 2002). The reason given for this relationship is a direct and positive association between overcrowding and poverty. Although there is a clear connection between housing quality and mortality, it is not always easy to demonstrate the causal link (Burnett 1991). The Healthy Cities Project, launched in the eighties by The World Health Organization (WHO), investigated the determinants, including housing, of mortality and health status of present-day, urban populations (Ashton *et al.* 1986).

Some of the findings from this project are also relevant to historical populations. For example, the relationship between asthma and dampness in homes (Jaakkola *et al.* 2011); infants exposed to high levels of fungi spores are more likely to develop asthma and suffer from respiratory problems (Gent *et al.* 2002). Another risk factor is indoor smoke from burning coal or wood (Desai *et al.* 2011). Studies in developing countries reveal a relationship between biomass fuel use and low birth-weight, stillbirth, perinatal death and acute lower respiratory infection (Desai *et al.* 2004).

Other findings show a correlation between temperature and old-age mortality (Rudge 2011; Wilkinson *et al.* 2004). We also see an increased risk in winter, especially in warmer rather than colder climates, known as the "paradox of excess winter mortality". This issue is well-known in historical demography (Healy 2003; Barnett *et al.* 2005) and many studies of the preindustrial period show that low winter temperatures in rigid climates also affected infant mortality from respiratory disease (Derosas 2009; Dalla Zuanna and Rosina 2011; Breschi *et al.*, 2000). Another element to emerge, supported by studies from the early 19th century, is the link between death from tuberculosis and overcrowding (Baker *et al.* 2011; Stein 1950). A similar connection is

found between measles and infant and child mortality in Stockholm between the 19th and 20th centuries (Burström *et al.* 1999).

Sources

Housing Registers

House numbering was introduced in many Italian towns at the turn of the 19th century. Udine had its first numeration in 1801, which just referred to houses within the town walls (Mansutti 1984), and a later integration in 1809. One of the aims was to compile accommodation lists for passing military troops.

The 1809 register is the most detailed of the two (Breschi and Serio 1999), listing a total of 2100 numbered houses, although some were uninhabited, others made up more than one residence, and a few, even if identifiable, remained numberless (e.g. the town-wall towers). This source contains valuable information such as the number of residences for each number, the property owner and families that lived there, the profession of the household head, presence of domestic staff, and indication of the number and military rank of soldiers who could be accommodated. There is also separate documentation on male and female occupants. In addition to demographic information, this source also records the number of rooms, fireplaces and kitchens on each floor of every house, and the presence of outhouses or stables.

Despite this wealth of information, some gaps do remain that currently impede analysis. While the numeration system does include the majority of the town's buildings, it only regards private residences, so lacks information on the residents of all public and religious buildings such as prisons, military barracks, monasteries, convents and rectories. The same is true of people with no fixed abode, or beggars, who had a strong presence in urban settings.

These lists were in no way intended for the drafting of a town map, which was done decades later by the engineer Antonio Lavagnolo (1842-50). *While there is no connection between the lists and this map,* we can note that the total number of street numbers and their position of remained unchanged, which means we can pin point them with precision.

The Napoleonic Civil Registers

The creation of the Kingdom of Italy in 1806 saw the introduction of the Napoleonic Civil Code across the country, which initiated the keeping of civil registers on all births, deaths and marriages. This study uses the birth and death registers for Udine, which span from January 1st, 1807 to December 31st, 1815. These record not only the name and surname of each newborn and deceased, but also socio-economic information, such as the profession of individual, parents and spouse (in the case of deaths), and the date, time and house number of the event. This means we can give a precise location to each of the 5,956 births and 6,572 deaths recorded between 1807 and 1815. Like all main Italian towns at the time, Udine had a hospital which also functioned as a place to leave foundlings. The number of children abandoned in this period results as 1,477, which is around a quarter of all births. These children were often left with documentation of their baptism including the parish where the ceremony took place. The majority originated from other, at times quite distant, locations. Of the 696 foundlings we have birthplace records for, only 28 were baptised in Udine. The deaths recorded at the hospital also show a concentration of 'outsiders', which account for almost all most of the 162 beggars, those with no fixed abode and the 978 foundlings.

Udine at the start of the 19th century

Although Udine was a relatively small town in the early 19th century, with around 13,000 inhabitants within the walls, it was the only urban centre in Friuli – the region that formed the eastern part of the Napoleonic Kingdom of Italy. It had many craft stores and shops which drew in clientele from all over Friuli to stock up on provisions, and was also the region's main market place for grain, even after trade was liberalised in 1806. There were numerous mills along the two canals that ran through the town that also functioned as iron workshops and tanneries. Textiles was one of the town's most productive sectors, which led to a large number of resident spinners and weavers.

Udine had a small but relatively varied population, with Friuli's most important families and landowners and modest farming families who cultivated the area within the

town walls for small-scale market gardening and more extensive farming. Udine also had a strong presence of religious institutions with nine parishes and numerous monasteries and convents, and was also the seat of the Bishop, with all the economic benefits this entailed.

Udine was also an important administrative centre. This period saw an increase in central state bureaucracy, and much effort was given to collecting the many taxes needed to fuel the Emperor's war machine. There was also the first modern cadastre of north-east Italy, which created demand for professional surveyors and qualified estimators, and led to many white-collar workers migrating to Friuli from other areas.

Although Udine was the most socio-economically diverse location in all Friuli, there is a lack of historical documentation on housing quality since the local authorities appear to have been concerned with the aesthetics of facades rather than health and hygiene (Mansutti 1984). Nevertheless, we can assume that the living conditions in the majority of town houses in the early 19th century were similar to the poor state depicted in an 1877 report (Baldissera 1877).

Territorial diffusion and socio-economic characteristics of infant mortality

Although we have information on occupation, this data is at times poor and incomplete; the House register indicates the SES of household heads only, and the Birth register records that of fathers. The best depiction of the socioeconomic characteristics of the inhabitants of Udine is given by the Death register, due to its detailed spatial coverage and the universality of this event.

The socio-professional classification adopted here has a traditional scheme; as well as the usual productive sectors, such as agriculture, handicraft and trade, we also consider white-collar workers, domestic staff and the upper classes (namely proprietors and professionals). Clergymen are considered separately, and beggars and people with no recorded occupation are counted as a residual group.

Table 1 presents a preliminary account of Udine's occupational structure, taken from records of 4,221 deaths. This analysis does not take account of the deaths outside the town, the 1,733 in hospital, the 41 in other public institutions and the 21 lacking indication.

Table 1. Occupational structure in Udine at the beginning of the XIX century.

	Registers of deaths	
Occupation	Deaths	% deaths
Agriculture	567	13.4
Handicraft	1,595	37.8
Trade	648	15.4
White collar workers	217	5.1
Domestics & servants	494	11.7
Upper class	462	10.9
Clergymen	102	2.4
Other	136	3.2
Total	4,221	100.0

Source: Napoleonic civil registers, Registers of deaths 1807-18**15.**

Table 2 shows infant mortality rates in relation to gender and occupation at the individual level. The denominator is the total number of births within the town walls between 1807 and 1814 (N = 3,870), and the numerator, infant deaths (0 years) from the same sample (N = 999). We can see the typically high levels of infant mortality in an urban context, with significant SES differentials (the upper class presenting the lowest, and the categories 'other', which includes beggars, and 'handicraft' the highest), consistent with previous literature. The high levels of infant mortality for children of white-collar workers, and low levels for agricultural workers are, however, fairly surprising, and notably, male mortality exceeds female in all SES categories, except the upper class.

Table 2. Infant mortality rates by occupation and gender, Udine generations 1807-1814

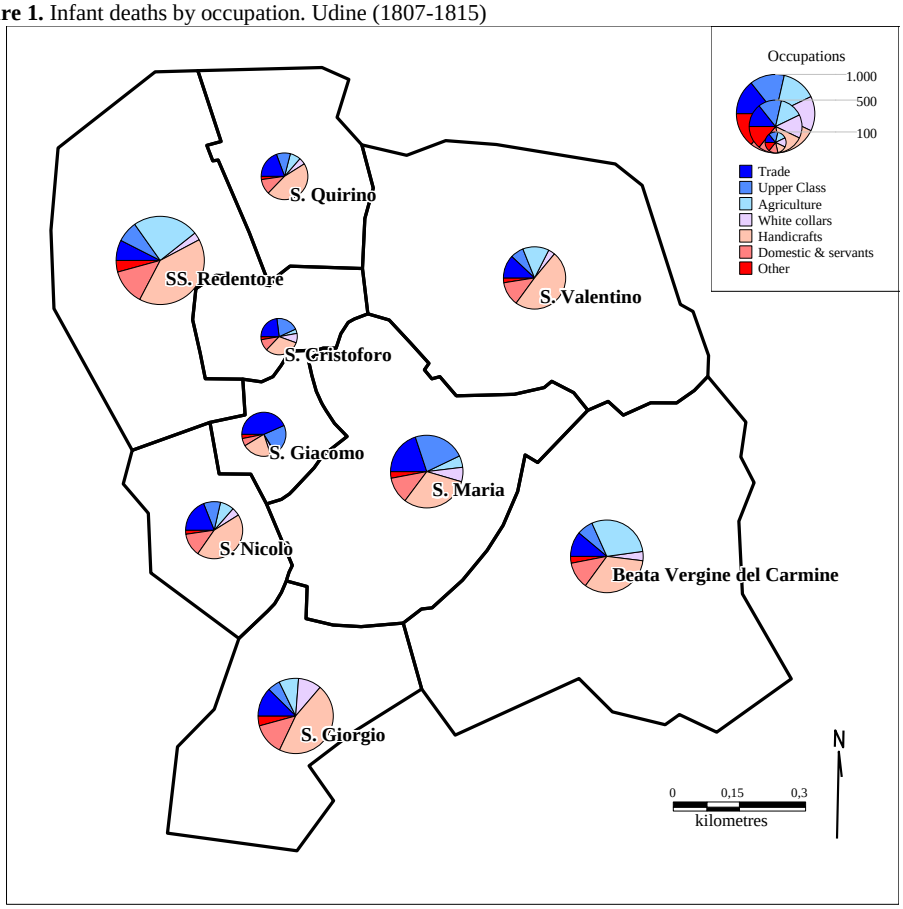
Occupation	F	M	Total	N deaths
Agriculture	234.1	257.9	247.3	113
Handicraft	267.3	288.5	279.0	395
Trade	206.7	239.4	222.6	183
White collars	218.0	298.5	258.4	69
Domestics & servants	271.0	301.7	287.3	131
Upper class	235.3	220.7	227.5	91
Other	181.8	433.3	326.9	17
Overall	242.0	272.4	258.1	999

Source: Napoleonic civil registers, Registers of births and deaths**.**

Figure 1 presents territorial data on occupation and infant deaths within Udine. The territory has been subdivided into parishes since this partition reflects the socio-

economic distribution of the population. Circle size is proportional to the number of infant deaths, and therefore, to some extent, population size. The coloured socio-professional categories clearly demonstrate the degree of occupational variety within each parish.

Figure 1. Infant deaths by occupation. Udine (1807-1815)



Source: Napoleonic civil registers, Registers of deaths.

The determinants of spatial distribution of infant mortality in Udine

Our findings show that the spatial distribution of infant mortality is linked to the geographic distribution of individuals and their related socio-economic status. This said, social difference only partly determined the population distribution in 19th century Udine. Occupation is only a rough indicator of the social status since one economic sector could include a wide range of social categories. The parish level is therefore insufficient to demonstrate the spatial relationship between SES and infant mortality.

We need to analyse data on a smaller-scale, namely on the level of the individual house.

It may be possible to infer the socio-economic status of an infant who died from the characteristics of their home, although it is not easy to define the characteristics of a ‘rich’ or ‘poor’ house. The number of rooms, for example, is not a good indicator without information on their condition. The 1809 housing list provides information on the characteristics and quality of each residence, and specifies the suitability of each for different military ranks of guest soldiers. This makes it possible to examine the likelihood of infant death in a given residence in relation to this qualitative datum.

We devised four different regression logistic models with the dependent variable of 1 for houses where an infant death occurred and 0 otherwise (Table 3). Model 1 uses two explanatory variables: the number of births; and number of residents in each house. The first aims to capture the risk of infant death since a greater number of births implies a higher probability of these deaths. The second aims to detect any effects associated to crowding.

Models 3 and 4 include the variable of room density, estimated from the number of inhabitants in each house. Models 2 and 4 include the variable regarding house “quality”, differentiating between lodgings deemed appropriate for officers and those for other military ranks. Variation in model fit was then estimated through a Likelihood Ratio test.

Table 3. Logistic regression. Risk of at least one infant death in the house. Udine 1807-1815

	Model 1			**Model 2**			**Model 3**			**Model 4**		
	Odds Ratio	**Std. Err.**	**P>z**	**Odds Ratio**	**Std. Err.**	**P>z**	**Odds Ratio**	**Std. Err.**	**P>z**	**Odds Ratio**	**Std. Err.**	**P>z**
N° of births	2.06	0.073	0.000	2.05	0.073	0.000	2.08	0.072	0.000	2.08	0.072	0.000
House inhabitants 1809 / Density per room	1.02	0.013	0.135	1.03	0.014	0.036	1.26	0.082	0.000	1.24	0.083	0.002
House assigned to officers (ref. All the other ranks)				0.68	0.114	0.022				0.85	0.141	0.335
Number of obs	2102			2102			2102			2102		
Log likelihood	-954.7			-952.0			-949.7			-949.2		
LR chi2(4)	772.5			777.9			782.5			783.4		
Prob > chi2	0.000			0.000			0.000			0.000		
Pseudo R2	0.288			0.290			0.292			0.292		
Likelihood-ratio test												
LR chi2(1)	5.4						0.9					
Prob > chi2	0.020						0.333					

The only significant variable in model 1 is number of births. The risk of infant death doubles for each new birth within a house. A positive but not statistically significant association emerges between infant mortality and number of residents, although with model fit this link does become significant, suggesting an increased risk of death for infants living in crowded conditions. This is because the mean number of inhabitants per house is higher among the wealthy than the poor (9.59 versus 5.93), whereas infant mortality is higher for the latter (0.251 versus 0.210). In model 2, house "quality" has a statistically significant impact, with a lower risk of infant death in higher "quality" housing.

In line with previous studies on other European towns, room density is significantly and positively associated to the risk of infant death (model 3). House "quality" does not have a statistically significant impact in model 4, but the sign is consistent with model 2.

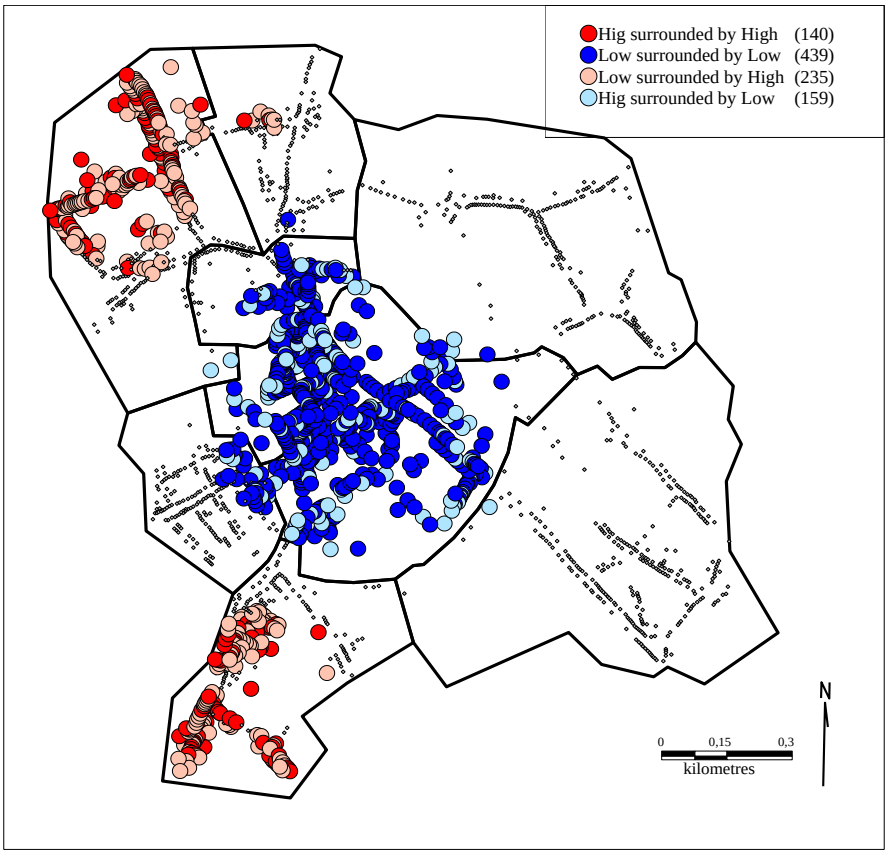
In short, a clear relationship emerges between crowding and infant mortality, and housing quality also appears to play a big role.

Infant mortality clusters

To examine how far these observations for IMR tendencies can be attributed to territorial location, we can look at "local dependence" conditions or spatial heterogeneity, which refers to the particular conditions that distinguish one territory from all others (Voss *et al.* 2006; Anselin 1992). This analysis aims at seeing if there are groups of civic numbers – i.e. clusters of houses – where residents assume similar behaviour. Local dependence is calculated using the LISA index (Cliff and Ord 1973; Upton and Fingleton 1985; Anselin 1995), obtained using GeoDa, a valuable and powerful spatial data analysis software tool (Anselin *et al.* 2006). This index calculation takes account of the variable under analysis, and a series of territorial weights applied at the house level. The choice of weights represents a "hypothesis on the part of the researcher regarding the interdependence of the places where the phenomena is observed and the extent to which these interdependent relations influence the phenomena itself" (Badaloni and Vinci 1988). These methods are described in more detail else-

where (Zaccomer and Mason 2007; Anselin undated), but in short the analysis depends on the criteria for deciding the proximity threshold for two houses to be considered close. This can then be applied to every house in the analysis, resulting in the creation of a spatial weight matrix based on the distance between pairs. The proximity threshold used here is necessarily high, at 306 meters, so as to be greater than the distance between the two most distant houses (81 m) and account for the houses which resulted as having no infant deaths. The values from the LISA index are shown below (figure 2).

Figure 2. LISA Cluster map of the IMR figures of each house in Udine (1807-1815)



The coloured circles indicate where the LISA index has a significance of at least 0.05. Dark blue represents spatially clustered houses with low levels of IMR, and red corresponds to those with high levels of IMR. The other colours represent outlier houses; those with an opposite tendency to neighbouring residences. Pink is for houses with high IMR values surrounded by low ones, and light blue for those with low IMR values surrounded by high ones.

This map clearly reveals three distinct clusters. The town centre is dominated by houses with low IMR values, whilst the south-west parish of S. Nicolò and that of SS. Redentore in the north-west, are characterised by houses with high levels.

Conclusions

As seen in many other rural and urban contexts, there is a negative association between SES and IMR in Udine during the Napoleonic era. The link between poor socio-economic conditions and high infant mortality can be further explained when housing quality and overcrowding are taken into account.

Evaluation of the spatial distribution of infant mortality should also consider that some areas in a town are more prone than others, which is particularly important in cases like Udine, where there is no marked socio-economic distribution of the population.

In the case of Udine's central parishes, the greater presence of upper class families clearly did play a positive role, and the results from the LISA index reflect those from the descriptive analysis, but there is little correlation in the case of the outer parishes, and it remains unclear why two of them have a concentration of houses with high levels of IMR. It could be because S. Nicolò and SS. Redentore are the only parishes that have all-four of the following characteristics: 1) high density of artisans and craftsmen (linked to high infant mortality rates); 2) few trade workers (socio-professional group associated to low levels of infant mortality); 3) high number of overcrowded houses; 4) low number of high quality houses.

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