Neonatal and maternal mortality in the workhouse of St. Martin-in-the-Fields, 1725-1824[1]

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Introduction

Today it is generally the case that urban dwellers enjoy higher life expectancy than their rural counterparts, globally. This urban advantage is partly attributable to the higher average incomes of urban dwellers, as well as superior access to public health services, including water supply and sewage disposal, and medical services. However this was not the historical norm. In the seventeenth and eighteenth centuries European cities operated as 'urban graveyards', with very high mortality rates, and required a net flow of in-migrants to maintain their population size. Wrigley has estimated that half the natural growth of the English population in this period (births in excess of deaths) was consumed by London's mortality regime. Kuznets argued that excessive urban mortality rates precluded modern economic growth, with its concomitant rapid urbanisation, because no population could produce a rural population surplus sufficient to maintain a very large urban component. However in the last quarter of the eighteenth century a dramatic change occurred in a large number of towns and cities in north-western Europe, and baptisms began routinely to exceed burials. Nevertheless although many cities became capable of natural growth in the late eighteenth century, an urban mortality penalty persisted across the nineteenth century, and cities only exceeded rural life expectancies in the twentieth century.

The transformation of cities and towns from demographic sinks to self-sustaining population centres in the late eighteenth century may also have coincided with the emergence of significant differences in mortality by social class. In England wealth seems to have conferred little advantage in life expectancy before the nineteenth century (Smith & Oeppen, 2006; Razzell & Spence, 2006; 2007). One possible explanation for the similarities in life expectancy amongst elite groups, such as peers and members of parliament, and the rest of the population is that wealthier individuals spent more time in cities and towns, where they were exposed to much more dangerous disease environments than rural dwellers. Unfortunately relatively little is known of mortality within different social groups in England in this period, and almost nothing about differences in mortality between sub-populations living in the same environment. Thus we don't really know whether wealth conferred any advantage *within* urban areas for instance, or whether the disease environment or dysfunctional behaviours overwhelmed advantages such as better housing, heating and food (Razzell & Spence, 2006).

By the late nineteenth century infant mortality exhibited a gradient by social class, but much of this gradient could be explained by the geographical distribution of different classes (Garrett et al., 2001). Wealthier social groups could buy their way into lower density areas with better facilities, a process which contributed significantly to the

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surbanisation of cities and towns. Similarly, infants of agricultural labourers experienced some of the lowest mortality rates, despite very low relative household incomes, because they were exposed to the relatively benign disease conditions of rural areas. Therefore much of the variation in infant mortality in late nineteenth-century England could be attributed to environmental factors determined by place of residence rather than to characteristics of individuals or households. In London suburbanisation began much earlier, and the wealthy moved progressively westward away from the city centre throughout the eighteenth century. Thus an important question in the study of class differences in mortality is to what extent suburbanisation and the outward movement of wealthier citizens to the peripheries of urban centres explains the emergence of differences in mortality by wealth. Other potential explanatory factors include the extent to which wealthier groups may have practiced wet-nursing, artificial feeding of infants, young age at marriage and other behaviours that would have reduced survival amongst women and infants, and the progressive abandonment or modification of which would have enhanced their life expectancy in the late eighteenth and nineteenth centuries.

This paper addresses the eighteenth century transformation of urban mortality, a process that remains very poorly understood. Urban areas are particularly difficult to study, because there are few census-type data giving the age and sex structure, or even the size, of the population, and urban dwellers were usually highly mobile, and not very amenable to techniques of family reconstitution. On the plus side, cities often kept Bills of Mortality, which recorded burials by age and sex, and burials by cause. Few rural areas recorded this type of information before the late eighteenth century, and so cities can provide insights into epidemiological phenomena that can only be guessed at in more stable communities. In London the Bills of Mortality recorded burials under two years of age, and dividing these by the baptisms recorded each year gives a rough estimate of trends in infant mortality (mortality in the first year of life) (Figure 1). However these data are subject to under-recording of both baptisms and burials, and the trends in under-recording probably differ for each type of record. To circumvent these problems John Landers reconstituted several London Quaker chapters, and found that infant mortality amongst the Quakers appeared to follow trends and levels similar to those of the London Bills population. The Quakers were relatively affluent compared with the London Bills population, and the similarity in infant mortality rates suggested that wealth may have conferred little advantage in this period, at least in childhood (Figure 1). Alysa Levene's estimates of mortality of infants abandoned at the London Foundling Hospital also suggest a decline in mortality amongst some of the most disadvantaged children in London. Outside the period of the General Reception (1756-60), when rates of intake were extremely high and very young and often ill infants were accepted, rates of mortality amongst foundlings in the hospital compared favourably with London Quaker children (Levene,2005; 2007). This comparison is problematic however, because the foundlings were usually sent to nurse outside London, usually within a week of abandonment at the Hospital, and so their death rates refer mainly to non-metropolitan environments, whereas the Quaker children were exposed to London's mortality regime throughout. Razzell and Spence (2007) reported similar levels and trends in infant mortality between 'elite' and non-elite families in several London sources, but the numbers involved were small and the quality of the sources problematic. It remains

unclear whether wealth conferred any survival advantage to infants and children in this period.

To investigate the decline of infant mortality in London, we are using a number of sources for the well-documented parish of St. Martin-in-the-Fields. Our sources include the sextons' burial books, that recorded age, cause of death, address and burial fee; and baptism fee books, that recorded dates of baptism and birth, address and fee paid for baptism. We are in the process of reconstituting the infant population of St. Martin's using these records, and hope to estimate infant mortality rates according to the baptism fees paid, to measure whether there were any differences in infant mortality by social status in this period. This is a novel project, because we hope to estimate mortality rates across the social scale, whereas other comparisons of mortality rates by social group have been confined to specific groups, such as Peers and Quakers.

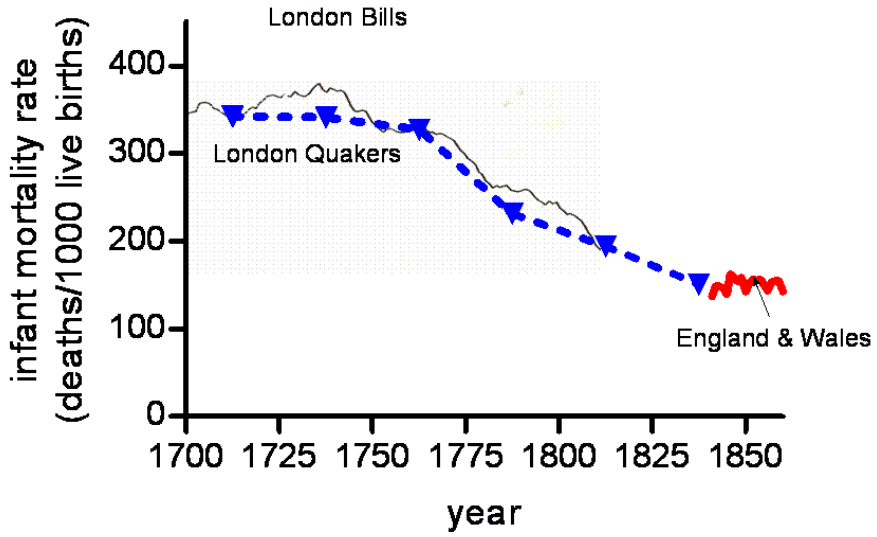

Figure 1. Infant mortality in London (estimated from London Bills of Mortality: black line) and amongst London Quakers (blue line).

However for the poorest section of the parochial population, we have records that allow us to calculate very robust mortality rates, albeit under rather peculiar circumstances. This is the workhouse population. The workhouse registers recorded dates of admission and discharge or death, and age and various other details of workhouse inmates. Births and deaths were recorded, rather than baptisms and burials, and the records of entry and discharge make it possible to calculate the number of person-years at risk, and to convert deaths in the workhouse into mortality rates. Twenty percent of burials in the parish were attributed to the workhouse, and this proportion remained remarkably stable throughout the period 1750-1824 (the evidence for the parish as a whole covers the period 1750-1824, while the workhouse records span the years 1725-1824). On the face of it therefore the workhouse should reveal a great deal about health and mortality amongst paupers. In addition, in the context of urban mortality decline, we can ask whether declines in

mortality within the workhouse reflected changes in health of the wider metropolitan population, or rather were the result of changes specific to the workhouse, such as changes in the composition of the workhouse population, or improvements in workhouse conditions.

The drawbacks of the workhouse evidence are described below, after a brief description of the workhouse itself.

The workhouse of St. Martin-in-the-Fields

Under the English 'old' Poor Law, parishes were required by law to provide various types of economic and medical support for those poor who qualified as members of the parish. In most cases economic relief was provided in cash or goods, and medical support could take the form of payments for nursing, and medical treatments including attendance of a doctor and hospitalisation where this was available. Residential workhouses were introduced in some parishes from the early eighteenth century, although outside urban areas most were established only after the reform of the Poor Law in the 1830s. Workhouses were designed to recoup some of the cost to the parish of poor relief, by putting able-bodied paupers to work within the confines of an institution. Where residence in the workhouse was a condition of the welfare provision, workhouses were also intended to act as a deterrent to those seeking relief. However the extent to which workhouses replaced 'outdoor' relief (to paupers in their own homes) is unclear. Hitchcock has argued that the intention to deter and to recoup costs was never realised in the eighteenth century, and instead urban workhouses found themselves overwhelmed with sick paupers seeking medical aid, and were forced to assume a major medical function (Sienna, 2004).

London parishes were precocious in the establishment of workhouses, many opening in the 1720s. St. Martin's workhouse opened in 1725 and was the third largest of London's workhouses by 1803. It stood opposite the parish church of St. Martin-in-the-Fields, and enclosed a parochial burial ground. It was enlarged in 1772, raising its capacity from perhaps 400 to around 700 inmates. Like St. Luke's Chelsea, St. Margaret's (Westminster) and St. Sepulchre (London), described by Tim Hitchcock and Kevin Sienna, the St. Martin's workhouse quickly assumed an important medical function for the poor of the parish, and this aspect complicates analysis of mortality in the workhouse. Although St. Martin's workhouse was established, as Hitchcock argues was the norm, with the intention of putting the indigent poor to work, and initially lacked an infirmary, it seems to have developed a major medical function by the 1730s (Boulton & Schwarz, in press). Boulton has documented a progressive increase in provision of in-house services over the eighteenth century, and a concomitant reduction in the use of hospital services to treat parish invalids.

Unfortunately the St. Martin's admissions registers record a reason for admission in only a small minority of cases, so we cannot separate out those seeking medical treatment from applicants seeking other types of support. However the medical function of the workhouse is clearly evident in the extraordinary mortality patterns in the workhouse

(Figure 2). Most deaths occurred in the first week and month after admission, and mortality rates fell dramatically with duration of stay in the workhouse. This was the case at all ages (although in childhood the fall in mortality with duration of stay partially reflects the reduction in risk with rising age that occurs in childhood). Therefore the longer one stayed in the workhouse, the lower the risk of death. While this could be viewed as a Darwinian process of survival of only those most inured to conditions in the workhouse, it should be borne in mind that there was a constant outflow of the more able-bodied in search of employment, so long-term residents of the workhouse hardly constituted a selected group of robust survivors. Rather the pattern is likely to indicate that a significant proportion of inmates resorted to the workhouse in a state of acute illness, and many died shortly after entry.

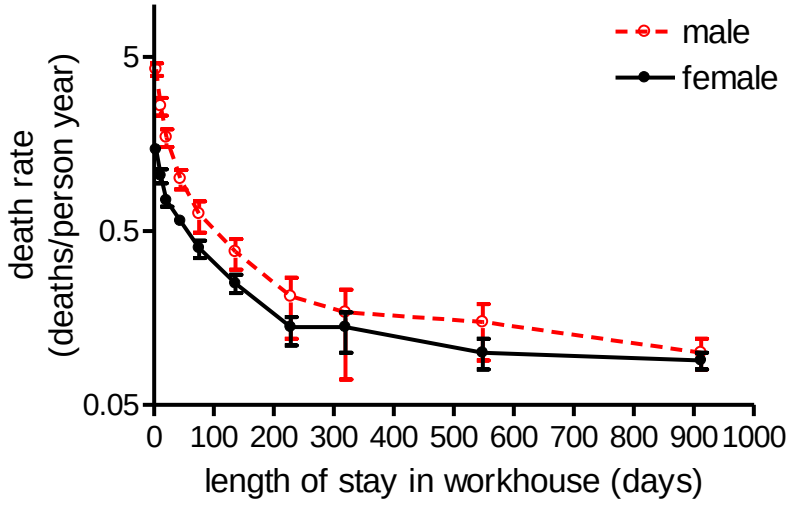

Figure 2. Mortality rates at different durations after admission to the workhouse, for males and females aged 20-49 (1725-1824). Note the log scale on the y-axis.

The apparent hospital-style function of the workhouse produced horrific mortality rates. Mortality was highest in the first quarter century after the workhouse opened, and improved markedly at all ages over the century 1725-1824. Figure 3 shows mortality rates by broad age groups over the century 1725-1824, by quarter century. In a crude attempt to separate the acutely ill from those entering the workhouse for other reasons, rates are presented as mortality 6-24 months after admission, when rates were much lower and more stable at most ages. Amongst long-stay inmates, survival improved only amongst children. However when rates are considered at all durations of stay, there were clear improvements at all ages (not shown). Therefore improvement in adult mortality in the workhouse was a function of reductions in mortality in the first weeks after admission, with little improvement in survival amongst long-stayers. One could speculate that this might reflect a reduction in acute infectious diseases (such as smallpox) amongst adults, that would provoke admission to the workhouse and elevate mortality in the first weeks

after admission (Davenport et al., 2011). Alternatively, it may reflect a shift in the balance of admissions between acutely ill and other types of inmates, as parish policy turned against outdoor relief (Boulton, 2011) and as the capacity of the workhouse was expanded in the 1770s and 1780s. These issues are addressed in a separate paper. Notably, mortality improved in both the first weeks and at longer durations of stay for children. This trend is consistent with a reduction in infectious diseases, which were the main causes of death amongst children and probably dominated child mortality at any duration of stay in the workhouse.

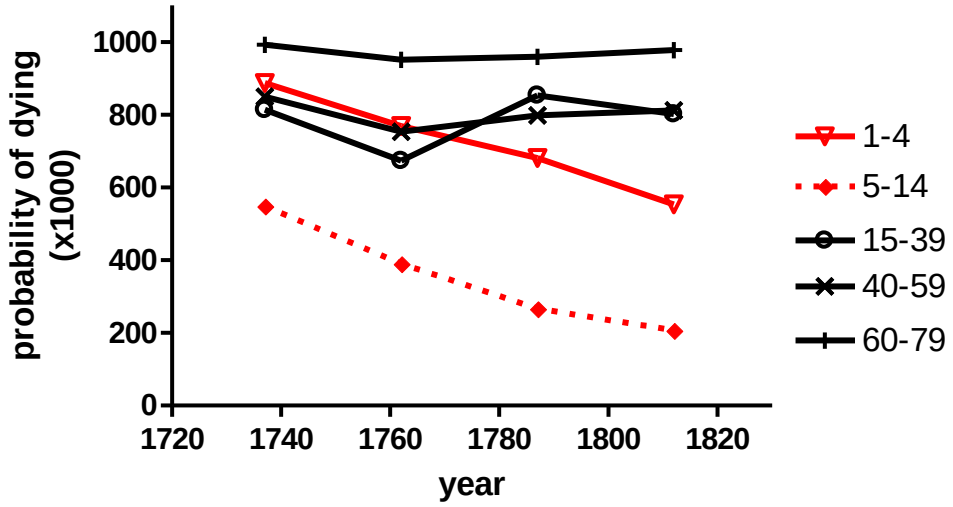

Figure 3. Risk of dying within each age interval, by quarter century, given mortality rates in months 6-23 after admission to the workhouse.

In this paper we focus on infants born in the workhouse, and their mothers. This focus is for several reasons. First, these groups experienced the most dramatic improvements in mortality within the workhouse over the eighteenth century. Neonatal mortality also fell markedly in the national population during the eighteenth and early nineteenth centuries, and accounted for almost all the reduction in infant mortality in this period (Wrigley et al., 1997). Maternal mortality also declined over the same period in the national population, and this improvement seems to have reflected more general gains in adult health, since reductions in maternal mortality were matched by improvements in survival of spouses, who presumably did not benefit from specific improvements in obstetric care (Wrigley et al., 1997). Comparison of neonatal and maternal mortality in the workhouse with wider trends may throw light on the so-far obscure sources of these improvements. Finally, these are the groups for which we can calculate mortality rates most reliably both inside and outside the workhouse, affording some comparison between the workhouse and the wider parochial population.

Infant mortality in the workhouse

Figure 4 shows the risk of dying within each age interval in the first year of life, by quarter centuries. Any infant unwise enough to spend the whole of its first year in the

workhouse had a very slim chance indeed of surviving (0.4 % in the second quarter of the eighteenth century, improving to only 39% by the early nineteenth century). However the majority of infant inmates spent only a fraction of their first year in the workhouse, and most survivors were discharged with their mothers or families. A few were sent out of London to nurse, but these were only a small proportion of infants born or brought into the workhouse, except in the 1750s and 1760s. It also evident from Figure 4 that mortality rates did reduce dramatically over time. Improvement was most marked in the earliest days of life, where for instance the chances of dying between day 7 and day 28 after birth fell 100-fold, from 40% to 4%. These improvements mirror in exaggerated form the declines in endogenous and neonatal mortality evident amongst both London Quaker infants and infants in the national reconstitution sample. However there was also considerable improvement in the survival of older infants in the workhouse, consistent with reductions in mortality of older London Quaker infants, but at odds with the unchanging levels of mortality at ages 6-24 months in the wider population (Landers, 1993; Wrigley et al., 1997). Therefore Figure 4 conveys the impression both of excessive mortality of infants in the workhouse, and of remarkable improvements over time.

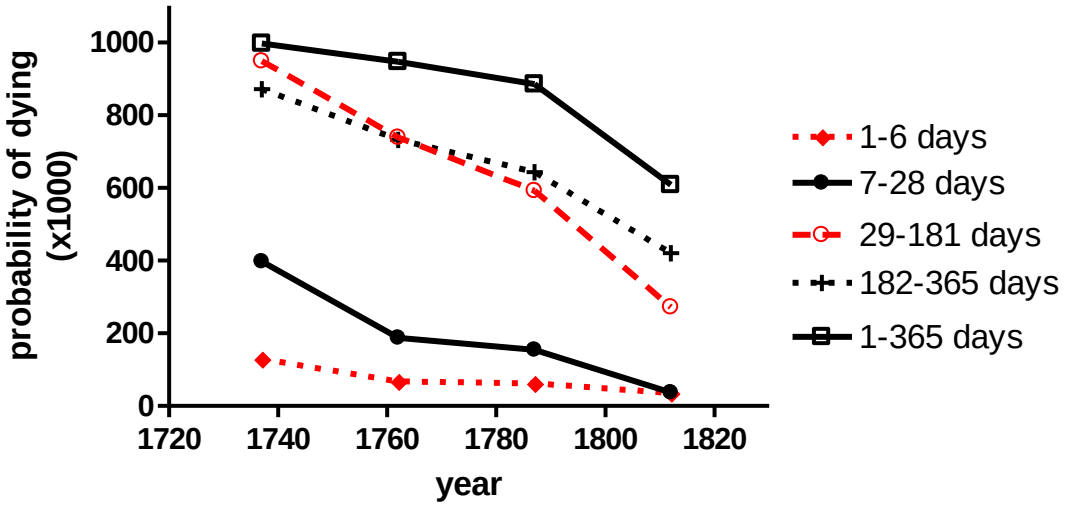

Figure 4. Risk of dying in each age interval, by quarter century, for workhouse infants.

The mortality rates for workhouse infants shown in Figure 4 are calculated for all infants in the workhouse, both those born in the workhouse and those brought in later in the first year of life, including foundlings and probably infants brought in on account of illness. As with other age groups in the workhouse, the infant intake was therefore very heterogeneous, with characteristics that probably varied over time. Thus foundlings, who suffered extremely high mortality rates in the workhouse, rarely appear after 1770, and their disappearance would have served to reduce infant mortality rates in infancy. Conversely, the practice of sending young children to be nursed outside London only becomes evident from 1752, and waned again after the 1770s. Many of these nurse children died, but their burials do not appear in the sextons' burial books, and their deaths

were not always reported in the workhouse records. Their deaths are not included in the calculations of infant mortality in Figure 4, which reflects only mortality *within* the workhouse, but the removal of significant numbers of infants from the workhouse who might otherwise have remained at risk there could lead to an underestimation of mortality if the infants selected for nursing were those with on average a higher risk of mortality than those remaining (for instance foundlings, orphans, or sickly infants). Therefore the following analysis focuses on the first month of life of infants born in the workhouse.

Neonatal mortality in the workhouse

The workhouse clearly functioned partly as a lying-in ward, with many women admitted 'In Labour'. It accounted for about 3-7% of all baptisms in the parish, depending on the year (Figure 5). The number of births in the workhouse rose sharply after the extension of the workhouse in 1772, but fell back to earlier levels in the 1790s. The workhouse accounted for 10% of all infant burials recorded in the period 1747-1824[5], but the workhouse proportion of infant burials fell sharply in 1783, and this coincided with the opening of a new labour ward, as will be discussed below. The apparent step change in infant deaths in the workhouse in 1783 provides a remarkable opportunity to investigate the factors influencing infant mortality in the workhouse.

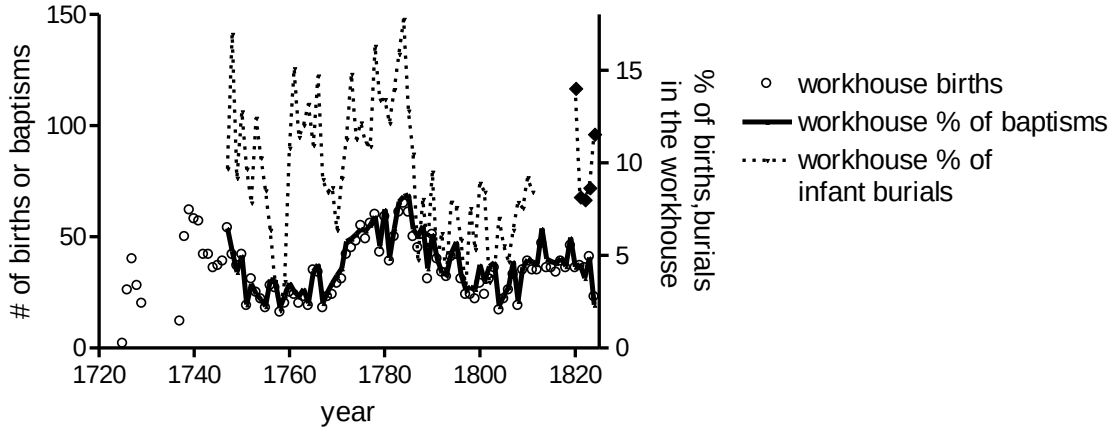

Figure 5. Annual numbers of workhouse births (from workhouse admissions register), workhouse births as a proportion of parochial baptisms (workhouse births from admissions register, parochial baptisms from baptism register), and infant burials from the workhouse as a proportion of all infant burials in the sextons' burial books.

After birth most surviving infants and mothers spent at least three weeks in the workhouse before being discharged. With the exception of the 1750s, when unusually high proportions of infants was sent to nurse or to the Foundling Hospital, the timing of discharges was remarkably stable, with a notable lengthening of stay occurring only after the peak period of births, from the 1790s onwards. By the end of the first month roughly a quarter of surviving infants had left the workhouse, and so the analysis of mortality

[5] Excluding periods of poor age recording in the sextons' burial books, and 1813-18, where only workhouse burials are available.

amongst those born in the workhouse is restricted to the first month of life, when most infants remained in observation. The first month of life (the neonatal period) is the most dangerous, and also the age where the greatest improvements in infant mortality occurred (in the St. Martin's workhouse, amongst London Quakers, and nationally).

Figure 6 shows risk of death in the first week (the early neonatal period), and weeks 2-4 (the late neonatal period), for infants born in the workhouse compared with the non-workhouse population of St. Martin's, and the Cambridge Group's national sample derived from family reconstitution. Although the trends are broadly similar in each population, the levels are very different. On the face of it the workhouse was an extremely lethal environment to be born in. However at least some of this excess mortality may have been a consequence of the types of births which occurred in the workhouse, rather conditions in the workhouse itself. The workhouse catered for most of the illegitimate births in the parish, and may also have dealt with the more difficult obstetric cases amongst the poor, both factors which should have inflated infant mortality regardless of workhouse conditions. In addition, the workhouse itself may have contributed to disastrous infant mortality rates through a tendency to unnecessary birth interventions such as forceps or cutting, through cross-infection from birth attendants, and via high levels of disease exposure as a function of crowding or poor hygiene (to the extent that these might have differed from the mother's home environment).

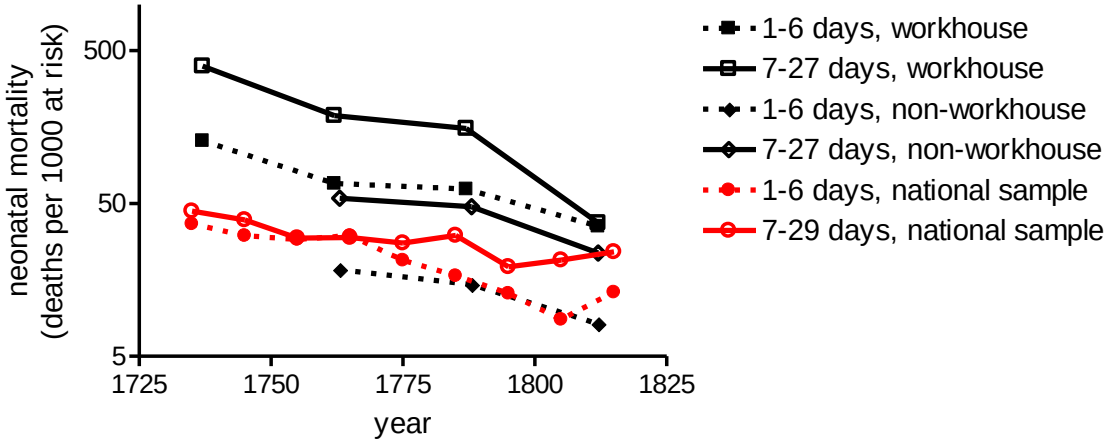

Figure 6. Neonatal mortality by period in the workhouse and non-workhouse populations of St. Martin-in-the-Fields, and in the Cambridge Group reconstitution parishes. Note the log scale on the y-axis.

The aim of the paper is to investigate the causes of improvements in mortality of infants born in the workhouse and their mothers, and to explore whether these improvements reflect changes in the composition of the workhouse population, changes in workhouse conditions, or are indicative of broader improvements in maternal and foetal health within the metropolitan population. To this end we first discuss the characteristics of the workhouse population at risk over the century 1725-1824, and then the evidence for changes in workhouse conditions, and the impact of these changes, over time. The

contributions of these different factors to mortality levels and to mortality change in the workhouse are considered both separately, and in interaction with each other, using Cox regression models. Results are reported in Tables 1, 3 and 4, and the full model, including all variables, is discussed after discussion of the individual variables. For the first quarter century we have only the workhouse admissions registers, but after 1750 we have linked workhouse inmates both to the sextons' burial books of the parish, which recorded cause of death, and to the baptism records that provide details of parentage.[6] This means that we have no real evidence of maternal mortality in the workhouse before 1750 (when 'Childbed' burials attributed to the workhouse appear in the sextons' books), because pregnant women often died without their pregnancy or any birth being recorded in the workhouse records. We have not linked mothers to births within the workhouse records, except in the case of maternal deaths.[7] Therefore we also have very little evidence of legitimacy rates before 1750, because the workhouse registers did not usually distinguish between legitimate and illegitimate births, and in most cases we can only obtain this information by linking infants to their baptisms records, in cases where infants survived long enough to be baptised. Stillbirths were frequently recorded in the workhouse, but their definition changed over time (as discussed elsewhere: Davenport, 2012). Stillbirths are discussed below in the context of maternal mortality, but the impact of changing definitions of stillbirths (from a category including many live births to one approximating 'dead-born') was reduced by exclusion of all stillborns and first day deaths from the following analysis.[8]

Characteristics of the workhouse population.

Legitimacy

Illegitimacy was clearly a key reason for birth in the workhouse. Of over 43,000 baptisms recorded in the parochial baptismal fee books 1751-1810, 3% were illegitimate (lacking a father of the same surname as the mother), and 84% of these were attributed to the workhouse.[9] Illegitimacy was associated with a severe mortality penalty in this period, with infant mortality rates as much as double those of legitimate infants. Therefore the

[6] The sextons' burial books recorded cause of death for workhouse inmates in the period 1750-1805. After 1805 workhouse burials were removed to a burial ground in Camden, and although the Camden registers have been combined with the sexton's books for the parish, they lack cause of death information.

[7] Linking mothers to infants would provide the age of mothers, and occasionally other characteristics such as marital status and reason for admission. However the workhouse records rarely recorded a reason for entry, and so most mothers were not described as pregnant or in labour, at least in the first 50 years of records, which complicates record linkage.

[8] Thus 'early neonatal mortality' refers to infants aged 1-6 days. Late neonatal mortality refers to infants aged 7-27 days.

[9] The level of illegitimacy reported here is an underestimate of the illegitimacy rate in the parish because workhouse baptisms, the majority of which were illegitimate, were omitted from the baptism register and fee books in certain periods. In addition, illegitimate infants were probably at higher risk of early neonatal death, and many may have died before baptism (resulting in their exclusion from baptismal records). This latter effect may have been countered to a large extent by the high proportion of illegitimate births that took place in the workhouse, where baptism took place much more rapidly after birth than was the case in the parish generally. In the period 1752-1810 pauper baptisms accounted for 16% of all baptisms in St. Martin-in-the-Fields, and a quarter of these were attributed to the workhouse.

high proportion of illegitimate births in the workhouse would be expected to inflate mortality rates in the workhouse compared to the parish as a whole.[10]

Although illegitimate infants constituted the majority of births, a significant minority of births in the workhouse were legitimate. Unfortunately, the workhouse records contained enough information, such as 'bastard of' or 'son of Joseph and Mary', to attribute legitimacy status in only a small percentage of entries. Eden reported in 1797 that 'each married lying-in woman [was allowed] one pot of porter for caudle the first 9 days and a pint for 7 days after; others half that quantity", but did not give the numbers of women in either category (Eden, 1797: 443). To determine the legitimacy status of workhouse births we linked births in the workhouse registers to the baptism fee books and registers for the parish. We were able to link nearly 80 % of workhouse births to an entry in the baptism records. Linkage was incomplete because in some periods workhouse baptisms were clearly not incorporated into the parochial registers, and also because very early infant deaths in the workhouse sometimes escaped baptism, although baptism was much more rapid in the workhouse than in the parish as a whole, and usually occurred with 0-3 days of birth. Of workhouse births where marital status if the mother could be determined (from 1752, when the baptism fee books were available), 28.3% were legitimate.

The ratio of legitimate to illegitimate births was fairly constant over the period when it could be measured (1750-1824), and therefore changes in the proportion of legitimate births could not have contributed to mortality decline amongst infants born in the workhouse. To establish whether illegitimacy did in fact confer a disadvantage within the workhouse we compared mortality amongst illegitimate and legitimate infants, and infants whose legitimacy status was unknown, for the early neonatal (week 1) and late neonatal (weeks 2-4) age groups, using Cox regression.[11] Legitimacy was associated with a lower risk of mortality in the first week of life, but the difference was statistically insignificant, over the whole period (Table 1[12]) and considered separately by quarter century (for the period 1751-1824: data not shown). By contrast, illegitimacy carried a severe penalty in the late neonatal period, with legitimate infants experiencing mortality rates only around 60% of the risk of illegitimate infants (Table 1). Legitimate and illegitimate births shared similar patterns of seasonality, and there was no evidence that unmarried paupers were assigned to different wards from married women to give birth (the issue of wards is discussed further later), so inclusion of these variables did not affect results. Notably, infants for whom no legitimacy status could be determined suffered

[10] In the later nineteenth century the excess mortality of illegitimate infants was a function of higher mortality in the later months of infancy, with little difference in mortality in the first month of life. In this case any excess mortality of illegitimate infants might not appear in our analysis of neonatal mortality. However Kitson (unpubl. Ph.D. thesis, Cambridge 2004: 230-236) reported endogenous infant mortality rates for illegitimate infants 30-80% higher those of legitimate first-born children in Banbury and Gainsborough in the eighteenth century. It is possible that the similarities in neonatal mortality of legitimate and illegitimate infants in the nineteenth century may have arisen as consequence of the large changes in neonatal mortality that occurred over the eighteenth and early nineteenth centuries.

[11] Cox regression measures the relative risk (hazard) of different categories in time-varying data (in this case mortality by age), on the assumption that the differences between categories are constant with age. In fact the influences of legitimacy, seasonality and other variables were different in the first week of life compared with later weeks, and so early neonatal and late neonatal risks were estimated separately.

[12] Note that Tables 1, 3 and 4 appear at the end of the text.

significantly higher mortality than other infants in the early neonatal period, and this reflects the fact that legitimacy status could not be confirmed for many infants who died very early and were not baptised. In the late neonatal period this group was small (since most infants in the workhouse were baptised within a few days), and did not differ in mortality from illegitimate infants.

Difficult labours in the workhouse

The emergence of a mortality disadvantage of illegitimacy only after the first week of birth is interesting. One possible explanation is that married women were more likely to seek to give birth in the workhouse in cases where they anticipated, or experienced the beginnings of, a difficult labour and birth (a logical extension of the more general hospital function of the workhouse for the poor). This would elevate the mortality of legitimate infants as a group in the period surrounding birth, when most deaths as a consequence of labour difficulties or low viability might be expected to occur, but would have less impact after the first week of life.

We attempted to address this question in several ways. First, difficult births would be expected to be attended by higher maternal mortality. Before the 1790s (when there was a radical improvement in maternal mortality rates in the workhouse), maternal mortality was much higher in the workhouse than in the parish outside the workhouse, or in London more generally (see section on maternal mortality below). The workhouse accounted for only a quarter of all pauper baptisms, but over half of all pauper 'Childbed' burials. To test whether married paupers were more likely than unmarried to die as a result of a pregnancy proved difficult, because the workhouse registers rarely described the marital status of pregnant women entering the workhouse, and very few births that could be linked to mothers that died in childbed survived to be baptised. Indeed before the late 1770s very few deaths in childbed could be linked to a corresponding birth at all, and the few that could were all described as 'stillborn'. This failure to identify infants associated with maternal deaths suggests that, in the period when true stillborns were probably rarely recorded (before 1783), most maternal deaths were associated with stillbirths or very early neonatal deaths that escaped registration in the workhouse records. This provides very tentative support for the importance of stillbirth to maternal mortality, and the possible significance of a decline in stillbirth rates for maternal survival (Woods, 2009), but the evidence is unfortunately very slight.

After 1775 most childbed deaths were associated with a live birth described in the admissions registers (although all the infants involved died within two months of birth). Of eight that survived to be baptised, four were legitimate, but although this proportion is higher than the proportion of legitimate births in the workhouse (50% of maternal deaths, compared with 30% of births), the numbers involved are too small to be interpreted.

We also tested whether multiple births were more common in the workhouse, since multiple births are associated with a much higher risk to both mother and infants, and could therefore serve as indicators of possible resort to the workhouse in cases of difficult births. However multiple births were not in excess of the numbers expected (2.75% of all births including those reported as stillborn, and 2.46 % of those reported live born,

compared with 2.7% of live births the Cambridge Group national reconstitution sample: Wrigley et al.,1997: 243). Twins born in the workhouse were more likely than singleton births to be legitimate, but the difference was not significant (3.04% compared with 2.34% of illegitimate, P=0.6).[13] Therefore there was little evidence to suggest that the workhouse catered especially for difficult births (legitimate or illegitimate), that might have raised neonatal (and maternal) mortality within the workhouse. However multiple births served only as an indicator of other types of high risk pregnancies, that we couldn't measure, and we can't rule out the possibility that the workhouse catered for a population at relatively high obstetric risk. Certainly the high proportion of illegitimate births suggests that a high proportion of births were first births, which carry a higher risk than subsequent births. Conversely, high rates of illegitimacy were probably associated with a relatively young maternal age structure (borne out by the younger age distribution of maternal deaths in the workhouse compared with the non-workhouse population of St. Martin's), and younger women are generally at lower risk of obstetric complications, and have lower rates of multiple births.

Workhouse conditions

Infants and their mothers suffered excessive mortality in the workhouse, and it seems probable that at least some of this excess mortality could be laid at the door of the workhouse itself, rather than the characteristics of its inmates. In particular, the abrupt drop in infant mortality in the mid-1780s (see Figure 5), in a period of high birth rates in the workhouse, and in the absence of any sudden changes in the composition of the women using the workhouse, suggests some abrupt change in the environment in which workhouse births took place. After a major rebuilding in 1772 the workhouse was expanded further in 1783, when the roof was raised to provide space for a charity school and extra wards. We can explore the consequences of this to a limited extent, because the admissions registers indicate the ward each infant was born in, and it is possible from the age and sex structure of the ward inmates, and occasionally their reasons for admission, to determine the type of ward.

The workhouse introduced a labour ward in the 1730s, and an increasing proportion of infants were subsequently born into labour wards (apparently regardless of legitimacy status). The workhouse expanded its birth services significantly from 1772, but only from 1783 did all births take place in a labour ward. From mid-1783 all recorded births took place in the same ward, ward 4, which did not appear in earlier records (it may have been a new ward, but renumbering of an old ward is also a possibility). This ward was clearly a labour ward, inhabited only by women of reproductive age and infants. Being born in a labour ward significantly reduced neonatal risk compared with being born in other types of ward, and this effect was particularly dramatic in the case of the new labour ward used from 1783 (Table 1). It is clear that there was a major reorganisation of labour arrangements around this point, and this coincided with a remarkable reduction in infant

[13] The statistical insignificance of the difference may reflect the small numbers of multiple births involved. However mother of legitimate and illegitimate infants may have differed in other characteristics, such as age, that may have affected twinning rates (mothers of legitimate infants may have been older on average, and multiple births are more common at higher ages).

mortality. This is clearest when mortality rates are calculated by day of life in the first month (Figure 7). Mortality is usually highest on the first day of life, and declines with age throughout the first week. The workhouse pattern is aberrant in two respects, before 1783. Firstly, the first day rate was very low, because many deaths of live-born infants seem to have been classified as stillborn (Davenport, 2012). Second, mortality appears to rise after the first week. In the first period, 1725-49, mortality was excessive in the second and third weeks of life. In the period 1750-1782 this excess mortality became concentrated in the second week of life, in a pattern very typical of neonatal tetanus, also called 'eight day sickness' or 'nine day fits'.[14] After 1783 this mortality peak disappeared abruptly. Neonatal tetanus is usually caused by infection of the umbilical stump due to contamination during cutting, or by application of infected ointments. It is still a significant cause of neonatal mortality in developing country populations with low levels of skilled attendance at birth (Roper et al., 2007).

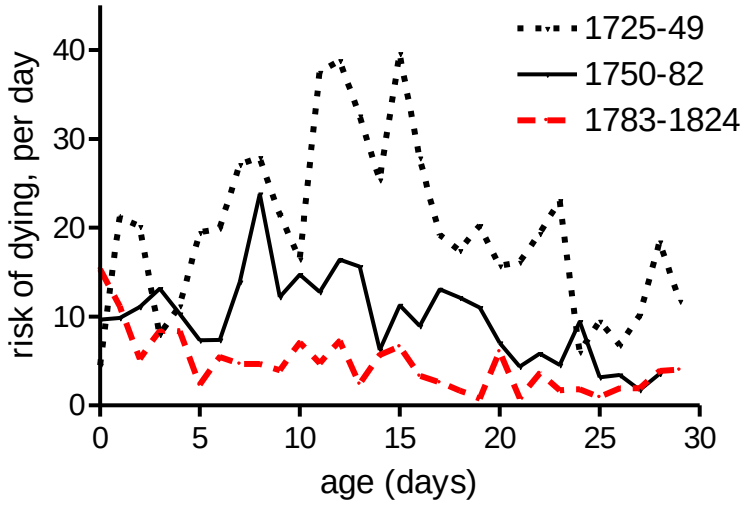

Figure 7. Daily mortality rates in the first month of life amongst infants born in St. Martin-in-the-Fields workhouse.

The extension of the workhouse in 1772 was accompanied by a large hike in births within the workhouse, but no improvement in neonatal survival. The doubling of the number of births in the workhouse probably increased infant mortality in the parish as a whole, since more infants were exposed to the risk of neonatal tetanus. An important question is whether a similar peak of mortality occurred amongst neonates in the parish, or whether neonatal tetanus was largely a workhouse phenomenon. Unfortunately this is difficult to determine, because the evidence for the rest of the parish consists of age at death information, which although usually reported in days or weeks for young infants, nevertheless shows significant heaping especially on ages such as 'one week', 'ten days'

[14] It is possible that some of these deaths are attributable to 'foul disease' (venereal diseases), but this cause of death did not decline amongst inmates in this period, so could not account for the disappearance of the anomalous mortality pattern in the 1780s.

and 'two weeks'. This produces artifactual peaks that obscure underlying patterns in daily rates. The workhouse reported day of birth and death, rather than age of neonatal deaths, and so heaping on particular ages is not a problem. Nevertheless the age pattern of mortality in the parish does not suggest excessive mortality in the second week of life that would be consistent with high levels of mortality from tetanus.[15] It seems likely instead that practices within the workhouse were responsible for very high rates of infection with neonatal tetanus, and this made a very significant contribution to excessive neonatal mortality within the workhouse.

The reorganisation of the wards in 1783 and the sudden disappearance of the mortality peak in the second week of life coincided with several other changes. First, 1783 marked a change in the recording of stillbirths in the workhouse. Before 1772 stillbirths were recorded frequently, and this practice coincided with a pronounced deficit in deaths of very young neonates. After 1772 no stillborns were recorded until 1783, when there was a sudden leap in both stillborns and first day deaths, suggesting a reformation of the rules surrounding registration of births, and the adoption of a more stringent definition of live-born. The evidence points to some overhaul of policies towards labour and birth, but unfortunately the workhouse records don't indicate the motive for these changes, nor how they were enacted. In a tantalising coincidence, a similar fall in neonatal tetanus rates was reported in the Dublin Lying-in Hospital in 1784. Dr Joseph Clarke, who took over management of the hospital in 1783, reported in 1789 that rates of early neonatal mortality in the hospital had been excessive, and were attributable to nine day fits (Clarke, 1789). Through improved ventilation he reported that he was able to cut dramatically the incidence of nine day fits and neonatal mortality. The coincidence in timing is very striking. It is quite likely that Clarke discussed his results with other medical practitioners before 1790 (for instance, he was in communication with Price in England in 1786), but the coincidence in timing seems too close for an improvement in Dublin to have driven changes in St Martin's, and in any case Clarke's remedy was unlikely to prevent neonatal tetanus.

Maternal mortality in the workhouse

The apparently dramatic improvement in birthing conditions in the workhouse after 1783 did not coincide with a similarly sudden reduction in maternal mortality, but the actual numbers of maternal deaths were low (55 in total) so it was not possible to pinpoint changes in timing with the same precision that could be applied to infant mortality. Maternal mortality was estimated from 'Childbed' burials reported in the sextons' books 1750-1805. These burials were converted to rates per 1000 births using the births recorded in the workhouse admissions registers (including stillborn births). This will overestimate maternal mortality, because many stillbirths went un-recorded, as well as pregnancies without issue, and so the number of birth events is under-estimated. In addition, definitions of maternal mortality include deaths attributable to pregnancy within some period after birth, usually 40-60 days. Childbed burials on the other hand may have

[15] A crude check, devised by Boerma & Stroh (Demography, 1993) uses the ratio of deaths at ages 4-14 and 15-27. A ratio near unity suggests the absence of neonatal tetanus, and this was the case in the non-workhouse population of St. Martin's.

excluded deaths caused by the pregnancy but occurring some time after parturition. However it is clear from the workhouse records that in cases where we can compare the date of birth with the date of death of the mother, the term Childbed was used to refer not only to deaths occurring within days of giving birth, but also to maternal deaths that followed at least a month after the birth. Maternal mortality rates per decade are shown in Table 2 (per thousand births), together with rates for the parish excluding workhouse deaths. Rates in the workhouse were high but also variable, both due to the small numbers of deaths involved, and to the epidemic quality of maternal mortality in the workhouse. Nearly half of all maternal deaths in the workhouse (26) occurred in the three years 1766-68. This suggests an infectious epidemic, possibly puerperal fever, although the absence of births associated with these maternal deaths in the workhouse records also suggests some more complex interaction between foetal survival and workhouse birthing practices. It is possible for instance that excessive interference in deliveries of stillborn or distressed infants led to high rates of maternal mortality, through haemorrhaging or infection.

period	Workhouse	Non-workhouse	Workhouse births	Non-workhouse births
1750-59	12.1	8.4	248	7817
1760-69	122.5	7.6	245	7503
1770-79	26.2	10.4	458	7383
1780-89	13.7	10.4	512	7315
1790-1805	2.9	8.2	500	12431
1806-24	-	5.5		15191

Table 2. Maternal mortality rates in the workhouse and non-workhouse populations of St. Martin-in-the-Fields. Rates were calculated as Childbed burials per 1000 births. Births were calculated from live and stillbirths reported in the workhouse register, or from baptisms plus stillborns reported in the sextons' burial books (for the non-workhouse population)

Maternal mortality in the workhouse was excessive compared with the parish outside the workhouse, and with estimates derived from the Bills of Mortality. However there was also a marked reduction in maternal mortality towards the end of the period, with no maternal deaths occurring after 1790 (until cause of death data cease for the workhouse in 1806). The absence of Childbed burials from the workhouse after 1790 was probably not an artifact of under-recording of mortality in the sextons' books, because comparison with deaths recorded in the workhouse registers themselves indicated that only two deaths were recorded for women admitted as pregnant in this period, of 491 women at risk and staying less than 2 months, indicating a rather low risk of pregnancy-associated death in this group, given the relatively high levels of mortality from other causes. Although the small numbers and volatility of workhouse maternal mortality rates make it impossible to be confident, it is tempting to speculate that improvements in birthing conditions associated with the establishment of the new labour ward in 1783 that reduced neonatal tetanus rates could also have improved the survival of mothers.

Other factors influencing neonatal mortality in the workhouse

Seasonality

Seasonality of mortality can often provide clues to the causes of mortality, and may be used with caution to infer breastfeeding practices. Neonatal mortality is often considered to be relatively aseasonal, or to peak in winter months, possibly as a function of cold or exposure to respiratory infections. Season of birth did not significantly influence mortality amongst workhouse-born infants, except in the first week of life when summer births were at significantly lower risk of mortality (Table 1). This summer advantage was in stark contrast to the pattern outside the workhouse, where neonatal burials peaked in the summer months (Figure 8). A similar pattern of excess summer mortality prevailed amongst London Quaker neonates (Landers, 1993). Landers attributed this to very early weaning or absence of breastfeeding amongst the Quakers, which exposed infants to particular risk of diarrhoeal diseases in summer when foods and liquids were most liable to contamination. Strikingly, in both St. Martin's and amongst London Quaker neonates, this seasonal pattern of high summer risk persisted, despite large falls in neonatal mortality. Landers suggested that such a pattern reflected the increasing concentration of mortality amongst a diminishing proportion of families where hand feeding persisted. Alternatively, improvements in neonatal mortality may not have been a function of changes in feeding practices. Interestingly, infants brought into (not born in) the workhouse in the first month of life did show a summer excess of mortality, but this pattern was almost entirely attributable to the inclusion of foundlings in this group, who were presumably hand-fed not wet-nursed. Infants brought in with their mothers showed a seasonal pattern of risk similar to the workhouse-born infants. The healthiness of summer amongst workhouse infants compared to the parochial population suggests high rates of breastfeeding in this pauper population, and suggests one pathway that may have diminished differences in infant mortality by social status. The lack of a pronounced winter penalty is surprising in view of the evidence for higher neonatal mortality in winter in the nineteenth and twentieth centuries, and the persistent penalty of winter birth amongst foundlings (Levene, 2007), but accords with the relative absence of seasonality of endogenous mortality in the Cambridge Group reconstitution parishes, where birth intervals suggest prolonged breastfeeding was the norm (Wrigley et al., 1997: 336).

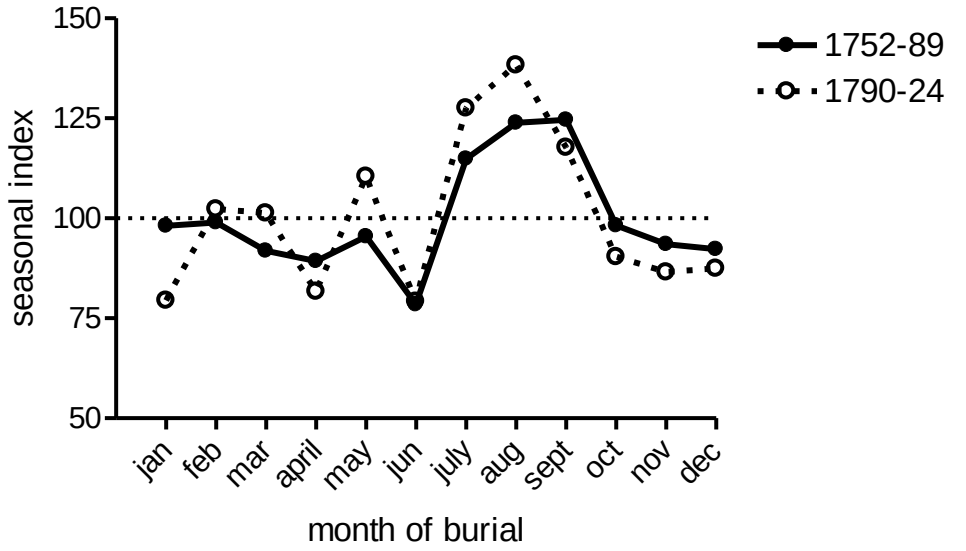

Figure 8. Seasonality of neonatal mortality (days 0-29) in St. Martin-in-the-Fields (corrected for seasonality of births).

Modelling change over time in infant survival in the workhouse

The richness of the sources for St. Martin's workhouse made it possible to examine some of the characteristics of mother giving birth in the workhouse (marital status and risk of multiple births), and to estimate some of the effects of changes in workhouse conditions, using ward type as an indicator of quality of birthing practices. The analysis of these variables indicated that maternal characteristics may have contributed to high neonatal mortality rates, via whatever mechanisms illegitimacy operated to elevate infant mortality. However there was no evidence that the composition of women giving birth in the workhouse changed over time in a manner that would account for the large reductions in neonatal mortality in the period 1725-1824. However workhouse conditions, as assessed by the impact of ward type, appear to have shown marked improvement over the century. Analysis of seasonality effects indicated that breastfeeding was very prevalent in the workhouse, and there may have been little room for improvement in this area, at least in the neonatal period. The question remains whether the improvements in neonatal mortality in the workhouse were primarily a function of improvements in workhouse conditions, or were related to wider changes in the parochial and metropolitan populations. This question can't be answered satisfactorily, because we have only very limited information regarding changes in the workhouse, and because any improvements that the workhouse shared with the rest of the population can be estimated only as a residual. Nevertheless, we can estimate the extent to which the variables we *can* measure affected trends over time.

Table 1 shows the apparent effects of period of birth, considered singly. As expected from the patterns in Figure 6, there was a large drop in both early and late neonatal mortality between the first and second periods, a plateau of mortality in the second half of the eighteenth century, and further substantial improvement in the first quarter of the

nineteenth century. When we factor in the influences of ward type and seasonality (Table 3), the effects of both period of birth and ward type are diminished, especially for early neonates. However both the 1783+ ward and improvements in the second and last quarter of the period remain as robust effects, suggesting that while specific improvements in labour ward management played a key role in reducing neonatal mortality, there were other independent sources of improvement in the mid-eighteenth and early nineteenth century. Table 4 reports an alternative multivariate model that includes legitimacy, but is restricted to the period 1750-1824 on that account. Births with no legitimacy status were excluded, and this produced a poor model fit for early neonatal mortality, suggesting that much of the effects of seasonality, and improvements in mortality, arose from changes in mortality amongst the youngest infants, many of whom escaped registration. However the inclusion of illegitimacy did not reduce the strong effects of both period of birth and ward type on late neonatal mortality.

Multivariate analysis of the limited range of variables we have constructed for workhouse neonates indicates that changes in birthing conditions in the workhouse played a large role in reducing neonatal mortality (at least after 1783), but that the reorganisation of the labour ward in 1783 was not enough to account fully for the significant fall in infant mortality after this date. Other, unmeasured factors also played a key role in mortality decline, especially in the late neonatal age group.[16]

Conclusions.

The rich sources for the parish of St. Martin-in-the-Fields provide a great deal of insight into pauper mortality within the workhouse. Workhouse inmates clearly experienced extravagant levels of mortality, although much of this was a consequence of the use of the workhouse as a type of emergency ward. However the workhouse was especially lethal to infants born in the workhouse, and to their mothers. Part of this excessive mortality was attributable to the prevalence of illegitimate births in the workhouse, which carried a higher risk especially in the late neonatal period. However apart from marital status, there was little evidence that the workhouse attracted women in high risk categories, at least in terms of birth complications such as multiple foetuses. Rather the most obvious cause of the high mortality in the workhouse appeared to be the high incidence of neonatal tetanus amongst newborns, probably caused by contaminated instruments ointments used in severing the umbilical cord (or possibly contaminated instruments used in delivery).

The aim of this study was to assess the extent to which patterns of neonatal mortality in the workhouse were shared with the wider London population. Figure 6 indicated that neonatal mortality in the workhouse followed trends in the parochial population in exaggerated form. The greater falls in mortality within the workhouse compared with the parish probably reflect the impact of workhouse-specific factors, such as neonatal tetanus,

[16] One means of exploring these changes further would be to examine changes in causes of death in the neonatal period suing the sextons' burial books. However causes of death are particularly unhelpful in infancy, where the vast majority of infants in the parish were reported as dying from convulsions in this period.

which elevated mortality and the elimination of which caused a very precipitous fall in neonatal mortality. When the impact of neonatal tetanus is discounted, then patterns of mortality decline in the workhouse resemble the parish more closely, suggesting that mortality improvements in the pauper population may have been coupled to improvements in health of other status groups, at least in infancy. The question remains what these improvements may have been. Three possibilities are often suggested: an increase in the prevalence and/or duration of breastfeeding; improvements in delivery practices, and improvements in maternal health. With respect to breastfeeding, the differences in the seasonality of neonatal mortality between workhouse infants and the non-workhouse population, and the persistence of a strong summer penalty in the latter, suggested that breastfeeding was much more prevalent in the workhouse population than in the parish as a whole, and that this pattern did not alter substantially in the late eighteenth and early nineteenth centuries. Therefore changes in breastfeeding patterns seem unlikely to explain improvements in mortality amongst either pauper neonates (where breastfeeding was apparently very widespread) or non-workhouse infants (where there is no evidence for an increase in breastfeeding). On the other hand, we found some evidence of improved birthing practices in the workhouse, in the positive effects of the post-1783 labour ward on both neonatal and possibly maternal survival. Changes in management of births in the workhouse may have reflected, or driven, more widespread improvements in the practice of midwifery in London, that could have influenced maternal and neonatal survival across the social scale. Finally, the evidence for improvements in the survival of the poorest infants and their mothers indicates that any substantial changes in maternal health that might have driven these improvements must have been very widespread and relatively egalitarian in their effects. On balance, if one accepts that improvements in the health of infant paupers and their mothers kept pace with other income groups, then improvements of an epidemiological type (such as a reduction in smallpox incidence: Woods, 2009) seem more plausible than a rise in living standards.

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	Early neonatal (days 1-6)		Late neonatal (days 7-27)	
variable	mortality as % of base category	Statistical significance (P)	mortality as % of base category	Statistical significance (P)
Legitimacy				
illegitimate	100	-	100	-
legitimate	71	0.242	62	0.006
unknown	244	<0.001	222	<0.001
Ward type				
mixed	100	-	100	-
labour ward (pre-1783)	74	0.092	73	0.002
1783+ labour ward	42	<0.001	19	<0.001
Season of birth				
winter	100	-	100	-
spring	80	0.258	102	0.848
summer	56	0.014	96	0.750
autumn	93	0.716	103	0.800
Period				
1725-49	100	-	100	-
1750-74	56	0.007	45	<0.001
1775-99	59	0.004	35	<0.001
1800-24	29	<0.001	10	<0.001

Table 1. Relative hazards of legitimacy, ward type, season of birth and period in early and late neonatal periods, considered separately (univariate Cox regression analysis).

	Early neonatal (days 1-6)		Late neonatal (days 7-27)	
variable	mortality as % of base category	Statistical significance (P)	mortality as % of base category	Statistical significance (P)
Ward type				
mixed	100	-	100	-
labour ward (pre-1783)	80	0.289	98	0.858
1783+ labour ward	52	0.026	40	<0.001
Season of birth				
winter	100	-	100	-
spring	85	0.422	111	0.374
summer	56	0.016	97	0.801
autumn	93	0.700	101	0.914
Period				
1725-49	100	-	100	-
1750-74	61	0.026	46	<0.001
1775-99	88	0.602	54	<0.001
1800-24	54	0.098	22	<0.001

Table 3. Full multivariate Cox regression model, 1725-1824. Legitimacy was excluded as a variable, because legitimacy status was unknown for the period 1725-49.

	Early neonatal (days 1-6)		Late neonatal (days 7-27)	
variable	mortality as % of base category	Statistical significance (P)	mortality as % of base category	Statistical significance (P)
Legitimacy				
illegitimate	100	-	100	-
legitimate	73	0.287	61	0.005
Ward type				
mixed	100	-	100	-
labour ward (pre-1783)	97	0.092	83	0.303
1783+ labour ward	57	0.187	30	<0.001
Season of birth				
winter	100	-	100	-
spring	107	0.818	120	0.300
summer	91	0.791	89	0.558
autumn	97	0.921	93	0.738
Period				
1750-74	100	-	100	-
1775-99	139	0.296	119	0.282
1800-24	78	0.614	56	0.057

Table 4. Relative hazards of legitimacy, ward type, season of birth and period in early and late neonatal periods 1750-1824 (multivariate Cox regression analysis). Births for which no illegitimacy status could be defined were excluded.