Death on a strange isle: the mortality of the stone workers of Purbeck in the nineteenth century

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Abstract

This paper analyses the mortality of a group of rural workers in an extractive industry, the stone quarriers of the Isle of Purbeck in the southern English county of Dorset. The analysis uses a database created by nominal record linkage of the census enumerators' books and the Church of England baptism and burial registers to estimate age-specific death rates at all ages for males and females, and hence statistics such as the expectation of life at birth. The results are compared with mortality statistics published by the Registrar General of England and Wales (on the basis of the civil registers of deaths) for the registration district of Wareham, in which Purbeck is situated. The stone quarriers had heavier mortality levels than the rest of the population of Purbeck. Closer inspection, however, reveals that their high mortality was confined to males, and was almost entirely due to especially high mortality among boys aged less than five years. In contrast to the experience of coal and other metal miners, adult male mortality among stone workers was no higher than that among the general population. The final section of the paper considers possible explanations for these results, and suggests that excess mortality among boys in Purbeck from diseases of the lungs might have been responsible.

Acknowledgements

Introduction

Interest in mortality differentials by occupation in nineteenth-century England was

intense among contemporaries. Indeed it was a major focus of the work of the early

statisticians and administrators of the vital registration system.[1] It was believed that

the mortality experienced by persons with a given occupation (and their families) was

primarily the result of the particular environment in which they lived and worked.

The civil registration system collected a wealth of data on occupational mortality and

substantial variations were discovered in the mortality of both adults and children: in

the case of adults (especially adult males), these were largely explained by differing

occupational hazards, and in the case of infants and children, by living conditions.[2]

One group of occupations which experienced high mortality consisted of

miners, both coal miners and miners of metallic ore. Explanations of their high

mortality followed the pattern described above. Adult males suffered particularly

from lung diseases brought on by long exposure to dusty working environments.[3] The

infant children of miners and their wives were brought up in poor, overcrowded and

insanitary housing. Moreover, coal miners had the highest fertility of any major

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[1] See J. Eyler, *Victorian social medicine* (Baltimore, 1979); R. Woods, *The demography of Victorian England and Wales* (Cambridge, 2000), 203-46; and E. Higgs, *Life, death and statistics: civil registration, censuses and the work of the General Register Office, 1836-1952* (Hatfield, 2004).
[2] The most comprehensive discussion of these is to be found in Woods, *Demography*, 203-46 and 310-59; see also R. Woods and N. Shelton, *An atlas of Victorian mortality* (Liverpool, 1997).
[3] N. Woodward, 'Why did South Wales miners have high mortality? Evidence from the mid-twentieth century,' *Welsh History Review*, 20 (2000), 116-42.

occupational group, so that their children suffered more than others from the well-known hazards associated with short birth intervals.[4]

Most previous research on the mortality of those working in extractive industries has been concerned with coal miners and certain other large groups, for example the tin miners of Cornwall.[5] Yet there were many other, smaller, groups of similar workers in England and Wales, including lead miners, copper miners, and stone quarriers. This paper looks at the mortality of one such group, the stone workers in the Isle of Purbeck in the county of Dorset in southern England (Figure 1). These stone workers shared many of the occupational hazards of miners, because their 'quarries' were, in fact, more like mines, consisting of shafts and tunnels rather than holes in the ground. Like many other groups of miners, they formed a tightly-knit society, suspicious of outsiders, and adhering to customs and ways of living which were different from those of others living in the same locality.[6] The question we wish to ask in this paper is whether the mortality patterns typically found among coal miners and other groups of miners can be observed among this group of workers as well.

The next section of the paper describes the history of the stone workers in the Isle of Purbeck and their distinctive cultural and demographic profile. Following that we describe the method by which we have estimated age-specific death rates for stone workers, their wives and children. The method uses a database of individual life

[4] Woods, *Demography*, 295-305.
[5] R. Burt and S. Kippen, 'Rational choice and a lifetime in metal mining: employment decisions by nineteenth-century Cornish miners', *International Review of Social History*, 46 (2001), 45-75.
[6] M. Edgar and A. Hinde, 'The stone workers of Purbeck', *Rural History*, 10(1999), 75-90.

histories based on census and ecclesiastical registration data and involves the

estimation of death rates by age. From these rates, we construct and compare life

tables for the stone workers and for other occupational groups within the same

locality. The results are discussed first in the context of general levels of mortality

prevailing in the area surrounding the Isle of Purbeck, and then by focussing on

differences between the mortality of stone workers and that of other occupational

groups living in the same parishes. They reveal that the mortality of the stone workers

of Purbeck does not show the same characteristics as that of other groups of miners.

The final section of the paper discusses some possible explanations of the mortality

pattern we do observe.

The stone workers of Purbeck

The Isle of Purbeck is situated in central southern England. It is not an island in the

usual sense of that word, but rather a peninsula of some 60 square miles which forms

the south-eastern corner of the county of Dorset (Figure 1). Its description as an 'isle'

stems from its boundaries being largely delimited by water: to the north are the river

Frome and the southern shore of Poole Harbour; and to the east and south lies the

English Channel (Figure 2). Purbeck has historically been isolated from the rest of

southern England. A turnpike road link between Corfe Castle and the town of

Wareham to the north was built in the eighteenth century, but the first through road

from Corfe Castle to the town of Swanage was only constructed in 1862, and the

railway did not reach Swanage until 1885.[7] Before this, communications with the rest of southern England were most commonly made by sea.

Stone has been quarried in Purbeck since Roman times, but the industry rose to national prominence in the Middle Ages when huge quantities of Purbeck stone were used to build churches and cathedrals throughout England.[8] At that time, the industry was based south of the ancient town of Corfe Castle (Figure 2). During the fifteenth century the demand for stone for ecclesiastical building subsided and the industry seems to have become largely moribund. It was not until the second half of the seventeenth century that a revival occurred, and when it did the geographical focus of the industry shifted southwards into the parishes of Swanage, Langton Matravers and Worth Matravers (Figure 2).

The revived industry produced freestone for general building purposes, especially paving. Purbeck stone was used to rebuild the city of London after the Great Fire of 1666, and during the eighteenth century it was used to construct Ramsgate Harbour in the county of Kent.[9] Population growth and urbanisation ensured that the demand for paving stone, especially in London, continued into the nineteenth century. The Victorian passion for church restoration also stimulated a small revival in the demand for Purbeck marble. The quarried stone was transported from the Isle of Purbeck to London and elsewhere by sea.

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[7] R.Legg, *Old Swanage: quarry port to seaside spa* (Sherborne, 1983), 25; J. Hutchins, *History and antiquities of the county of Dorset*, 3rd ed. (eds W. Shipp and J.W. Hodson) (Westminster, 1861-1870), 462, 466.
[8] G.D. Drury, 'The use of Purbeck marble in Medieval times', *Proceedings of the Dorset Natural History and Archaeological Society*, 70 (1948), 79.
[9] Hutchins, *History and antiquities*, 464; E.O. Cockburn, *The stone quarries of Dorset* (Dorchester, 1971), 25.

The eighteenth and nineteenth century quarries were more akin to stone mines. The best beds of stone lay deep underground and were accessed by means of inclined shafts anything up to 125 feet deep. The quarriers then tunnelled horizontally along the seams of stone, cutting it out in blocks which were hauled to the surface on trolleys with the aid of a capstan.[10] The quarries were almost all family concerns, typically employing between six and 12 men.[11] Most of them were operated by sole proprietors who preferred, where possible, to employ their sons, only hiring other workers when their immediate family could not provide sufficient labour. In the 1850s and 1860s it was common for children to be put to work around the quarries at eight or nine years of age. If a man's sons were numerous enough he might work his quarry with their labour alone.[12] Sometimes two or more quarriers (generally closely related) would combine to work a quarry.

In addition to the quarriers, the stone trade also included two other types of worker: stone masons and stone merchants. Masons worked on the surface to cut and dress the quarried stone to the required size and shape. Quarriers and masons, however, were not separate groups. The quarriers were all skilled to some degree as

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[10] Letter XXVII 'The stone quarries of Swanage', in P.E. Razzell and R.W. Wainwright, eds, *The Victorian working class: selections from letters to the Morning Chronicle* (London, 1973), 43-4.

[11] Letter XXVII 'The stone quarries of Swanage', 43.

[12] We have yet to analyse the fertility of the Purbeck stone workers, so we cannot say whether they shared the high fertility of coal miners in the Victorian period (see D. Friedlander, 'Demographic patterns and socio-economic characteristics of the coal mining population in England and Wales in the nineteenth century', *Economic Development and Cultural Change*, 22 (1973), 39-51; and M.R. Haines, *Fertility and occupation: population patterns in industrialization* (New York, 1979)). The organisation of the Purbeck stone industry would, though, seem to offer a rationale for high fertility, or at least for having several sons.

masons and many men would switch between the two activities.[13] On the other hand, the third group, the stone merchants, was distinct. The merchants were a small group of men (no more than six at any one time) who purchased every ton of stone quarried in Purbeck and sold it on to customers throughout England and Wales. This meant that they effectively controlled the entire trade.

The familial element in the stone trade was very strong with many quarries being handed down from father to son.[14] All quarriers, masons and merchants were members of an organisation called the Company of Purbeck Marblers and Stone Cutters. This Company ruled that employment in the industry should be reserved to freemen of the Company and their apprentices. Apprenticeships lasted seven years, during which time the apprentice was required to lodge in a freeman's home. In 1697 apprenticeship was restricted to the sons and relatives of freemen, and this rule was still adhered to in the nineteenth century. Analysis of the marriage registers for the parish of Langton Matravers for the period 1813-1891 provides no evidence of anyone other than the son of a stone worker entering the stone trade.[15] The effect of this was that the stone workers of Purbeck in the second half of the nineteenth century

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[13] Legg, *Old Swanage*, 22, quotes C. Le Neve Foster, inspector of mines for the west of England, who reported in 1878 that 'if men can find work as masons they abandon their quarries for a time and do not return to them until other work is slack'.

[14] Letter XXVII 'The stone quarries of Swanage', 38.

[15] Langton Matravers marriage registers: Dorset Record Office, PE/LAM: RE/3/4-5. The marriage registers give information about the occupations of the bride and groom, and the occupations of their respective fathers. Edgar and Hinde, 'Stone workers', 79, divided the reported occupations into two categories: 'stone workers' and 'others'. They then analysed a 2 x 2 contingency table of the occupational categories of grooms against their fathers and found an almost perfect association between the two.

were descended down the male line over many generations from a small number of individuals.

In contrast to the 'recruitment by descent' among adult males which rendered the male population of stone workers largely closed, the female stone working population was much more open to movement in and out, such movement typically being associated with marriage. The marriage partners of stone workers were not drawn exclusively, or even largely, from within their own occupational community. In the nineteenth century, stone workers in the parish of Langton Matravers were no more likely than any other occupational group in Purbeck to marry the daughters of stone workers.[16]

By 1850 stone working was concentrated mainly in the parishes of Swanage and Langton Matravers (with a smaller number of quarries in the neighbouring parish of Worth Matravers). Swanage was a small coastal town with a population of 2,139 in 1851 rising to 2,674 by 1891, the rise being largely due to the successful promotion of a rather genteel type of tourism.[17] Langton Matravers had a population of 762 in 1851. During the next 40 years its population rose and fell with the fortunes of the stone trade and by 1891 it was 773, almost the same as it had been in 1851. Worth Matravers was a smaller parish, and predominantly agricultural. In common with other agricultural parishes its population fell during the second half of the nineteenth century from 396 in 1851 to 229 in 1891. The occupational structure of the three

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[16] Edgar and Hinde, 'Stone workers', 84-5, analysed a 2 x 2 contingency table of the occupational categories of grooms against those of their brides' fathers for the parish of Langton Matravers, and could not reject the null hypothesis of no association between the two.

[17] Legg, *Old Swanage*.

parishes in 1851 (Table 1) reveals that in Swanage and Langton Matravers stone

workers accounted for more than one in three of all occupied adult males, and in

Worth Matravers about one in five. In Swanage the most common other occupational

group was 'trades and crafts' reflecting its status as a small town. Langton Matravers

and Worth Matravers were both agricultural villages as well as stone parishes, and in

Worth Matravers 'farm workers' formed the largest single occupational group.

Data and methods

The aim of the analysis is to calculate age-specific death rates (ASDRs) for the stone-

working population and for other occupational groups in Purbeck. For reasons

outlined in the introduction, our interest focuses in particular on mortality rates

among infants and children, and among adult males. The young children of stone

workers can be identified easily from the information about occupation and

relationship within the family given in the individual-level census enumerators'

books (CEBs) for the decennial censuses, and adult male stone workers can be

similarly identified from the occupational data.[18] Fortunately, because of the

restrictive practices of the stone trade, occupational mobility between the stone trade

and other occupations was rare.

Data. The estimation of ASDRs requires information about deaths, classified by the

age at death, and about the population exposed to the risk of dying. Because access to

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[18] The census enumerators' books for Langton Matravers and Swanage for the censuses from 1851 to 1891 are available from The National Archives at the following references: 1851 – HO107/1856, 1861 – RG9/1343, 1871 – RG10/1992, 1881 – RG11/2098, and 1891 – RG12/1641.

civil registers of deaths is restricted in England and Wales, for data on deaths we have

to rely on the Church of England registers of burials.[19] The accuracy of the ASDRs

we estimate will depend on the completeness of death registration in these registers.

Unfortunately, apart from the civil registers there is no benchmark against which to

assess this for the Isle of Purbeck. The only studies we have come across which were

able to cross-check ecclesiastical burial registration with civil death registration relate

to a parish in mid-Wales and the city of Sheffield, both of which lie many miles from

the Isle of Purbeck.[20] The results of the Welsh study suggested that the burial

registers of the established Church were substantially more complete as a record of

deaths than the baptism registers were as a record of births. This provides an indirect

way of assessing the completeness of burial registration, for there *is* a benchmark

against which to measure the completeness of baptism registration. Since the

decennial population censuses provide data on age and place of birth, it is possible to

use the CEBs to identify the persons born in a particular parish, and their dates of

birth. The baptism register can then be searched to see what proportion of persons

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[19] Langton Matravers burial registers, Dorset Record Office (hereafter DRO): PE/LAM: RE/4/1-2; Swanage burial registers, DRO: PE/SW: RE 4/2-3. Access to individual death certificates is permitted, but the names of the deceased must be specified in advance and a fee paid for each certificate examined. This renders it impossible to gain access to large numbers of death records classified on the basis of, say, place and period of death.

[20] H.R. Davies, 'Nominal record linkage of historical data : procedure and applications in a North Wales parish' (unpublished PhD thesis, University of Southampton, 1993); N. Williams, 'Death in its season: class, environment and the mortality of infants in nineteenth-century Sheffield', *Social History of Medicine*, 5 (1992), 77-9. Davies's study used the civil death registers, to which he obtained access through good fortune; Williams used copies of the civil death registers which were made in Sheffield for a purpose specific to that city, and which are not available for other places.

thus identified was recorded.[21] We have carried out this exercise for the parishes of

Langton Matravers and Swanage for each of the decades 1841-1851 to 1881-1891,

searching in the baptism registers for all those stated in the census at the end of each

decade to have been aged ten years or under and born in one of the two parishes.[22]

For Langton Matravers the proportion successfully matched to entries in the baptism

register ranges from 80 per cent in the decade 1861-1871 to 59 per cent in the decade

1881-1891. For Swanage the proportions are lower, ranging from 57 per cent in 1851-

1861 to only 33 per cent in 1871-1881. The Welsh evidence suggests that the burial

registers are likely to have substantially higher coverage than the baptism registers.

We conclude therefore, that the Church of England burial registers for Langton

Matravers probably provide a fairly complete record of deaths, but that those of

Swanage probably omit a proportion of deaths. Of course, the comparison of the

mortality of stone workers in a parish with that of other occupational groups will not

be affected by the under-registration of deaths provided that the proportion of deaths

omitted did not vary by occupation, and we have no reason to suppose that this was

the case.

To assist with estimating the correct population exposed to risk, we have

individual-level census data from the CEBs. In our analysis, we use the CEBs for the

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[21] This kind of analysis was developed by Peter Razzell (see P.E. Razzell, 'The evaluation of baptism as a form of birth registration by cross-matching census and parish register data', *Population Studies*, 26 (1972), 123-34); later applications include E.A. Wrigley, 'Baptism coverage in early nineteenth-century England: the Colyton area', *Population Studies*, 29 (1975), 303-13 and M. Yasumoto, 'How accurate was the Methley baptismal registration?' *Local Population Studies*, 35 (1985), 19-24.

[22] Langton Matravers baptism registers, Dorset Record Office (hereafter DRO): PE/LAM: RE/2/1-3; Swanage baptism registers, DRO: PE/SW: RE/2/2-4.

five censuses of 1851, 1861, 1871, 1881 and 1891.[23] We also have information about births drawn from the Church of England baptism registers, supplemented by birth dates inferred from the data in the CEBs about age and place of birth. The baptism registers provide data on the occupation of the father of the child being baptised. Most baptisms in late nineteenth century England took place within three months of birth, and the baptism registers normally stated the age of the child being baptised if the child was not an infant.[24]

Estimation of age-specific death rates. In order to analyse mortality, the population is divided into convenient age groups, and age-specific death rates (ASDRs) estimated separately for each age group. We then use these ASDRs to calculate, for each age group, the probability that a person who survives to the youngest age of that age group will die within that age group.

We conducted separate investigations for each intercensal decade from 1851 to 1891. For each decade, we used record linkage to match persons in the first census to either the burial register (for those who died within the decade) or the subsequent census (for those who survived). Those who could not be matched to either the census or the burial register were assumed to have out-migrated during the decade and before their death. We also matched babies born during the decade to either the burial register or the next census, again assuming that those who could be matched to

[23] The CEBs are also available for 1841, but the information on occupation is less detailed, and there is no information on relationship within the family. They are also now available for 1901, but because of the 100-year closure rule the 1901 census enumerators' books were not available when we began this research.

[24] See S. Dewhurst and A. Hinde, 'Age at baptism in rural Hampshire in the second half of the nineteenth century', *Local Population Studies*, 57 (1996), 72-5.

neither of these sources had out-migrated before the next census and before their

death. The matching exercise produced data from which we could derive a period of

observation during each decade for each person which began either with birth or with

the initial census, and ended either with death, or the subsequent census, or with the

assumed date of out-migration. For the census to census linkage, the date of out-

migration was assumed to be three years after the date of the initial census.[25] For the

birth to census linkage, the date of out-migration was assumed to be half-way

between the date of birth and the date of the subsequent census. This period of

observation was then subdivided into shorter spells, each corresponding to time spent

in one of the age groups used in the investigation, which were: under 1 year, 1-4 years

last birthday, 5-9 years last birthday, five-year age groups up to 85-89 years last

birthday, and 90 years and over. To illustrate this, consider a baby born on 1 January

1856, who was enumerated in the 1861 census (taken on 7 April). During the decade

1851-1861 this child will contribute 12 months exposure in the age group 'under 1

year' (the period from 1 January 1856 until 1 January 1857), four years of exposure in

the age-group '1-4 years last birthday' (from 1 January 1857 until 1 January 1861)

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[25] We used three years after the date of the initial census rather than five years (half
way between the two censuses) for two reasons. First, those whose observation is
terminated by out-migration rather than death are known to have out-migrated before
their death, which means that their true dates of out-migration will tend to be shifted
to an earlier period within the decade. Second, the assumption of a constant rate of
out-migration per unit of time among those enumerated at the initial census and still
living in the parish at any subsequent time leads to an expected duration until out-
migration of less than five years. Note that out-migration from the area was quite
common, even among stone workers, who tended to 'follow the tools' and move to
work in areas where Purbeck stone was being used in building (see Edgar and Hinde,
'Stone workers').

and about three months in the age group '5-9 years last birthday' (from 1 January 1861 until 7 April 1861).

The record linkage, and hence the calculation of the periods of observation for each person, were carried out separately for each decade. In order to increase the number of person-years exposed to risk in each age group, the resulting data were pooled across the four decades from 1851-1891. This effectively produces, for each person who lived in the parish during the 40-year period between 1851 and 1891, a series of spells of observation classified by age, and corresponding to the periods he or she spent in the parish. It does, however, miss certain spells of observation. Persons who in-migrated are not observed until the first census after their in-migration. It follows that those who in-migrated and then died before the next census are not observed at all; neither are the unknown number of persons who in-migrated and then out-migrated before the next census. Each of these omissions will impart some bias to the estimates of the ASDRs, though the biases will probably be small, and will cancel out to some extent.[26] A more comprehensive record linkage exercise which considered the whole 40-year period at the same time could in principle allow the incorporation of some of the omitted spells, though at a considerable cost in time and effort.

Once the length of time each person in the data set was exposed to risk in each age group has been calculated, these figures are summed to give the total exposed to

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[26] The omission of the period exposed to risk among in-migrants before the census after their date of in-migration will result in the ASDRs being over-estimated, because none of the relevant persons can have died during the omitted exposed to risk period. On the other hand, the omission of the exposed to risk period for those who in-migrated and died before the subsequent census will result in the ASDRs being under-estimated.

risk for the relevant age group. The ASDRs are then estimated by dividing the observed number of deaths in each age group by the total exposed to risk in the corresponding age group. The record linkage exercise, and hence the estimation of the ASDRs, was carried out separately for the parishes of Langton Matravers and Swanage. Once the ASDRs were obtained for all age groups, they were used to estimate the expectation of life at birth by calculating a life table.[27]

Results

We begin the presentation of the results by comparing the estimated expectations of life at birth in the two parishes of Langton Matravers and Swanage with those calculated using aggregate civil registration data on deaths for the Wareham registration district in which the Isle of Purbeck is located. The registration district (RD) is the smallest geographical area for which aggregate data on deaths classified by age and sex are published, and hence for which expectations of life at birth can be estimated. Wareham RD included the whole of the Isle of Purbeck, together with an additional section of the county of Dorset to the north of Purbeck, surrounding the market town of Wareham. During the decades between 1851 and 1891, the expectation of life in the Wareham RD rose from 47 years to 53 years for the sexes combined and males lived on average for two or three years less than females (Table 2). The pooled results for the 40-year period between 1851 and 1891 for the parish of Langton Matravers are very close to the average expectation of life in Wareham RD for both males and females. For Swanage, by contrast, the estimated expectations of

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[27] The method used to estimate the life table is described in A. Hinde, *Demographic methods* (London, 1998), 30-4.

life at birth are higher than those in the Wareham RD. It seems unlikely that mortality

was lower in Swanage than in Langton Matravers. More probably, the less complete

registration of burials in Swanage has led to the omission of a proportion of deaths, a

downward bias in the estimated ASDRs, and hence an upward bias in the expectation

of life. In Langton Matravers, where we tentatively concluded that the burial register

probably contained an almost complete record of deaths, the congruence with the RD

figures is reassuring. The main conclusion to draw from these results for the

expectation of life at birth is that there is no evidence that overall mortality in the two

stone parishes was higher than that in the Wareham RD as a whole.

In Swanage, the population is large enough to make it possible to estimate life

tables separately for stone workers and others. We have chosen to compare stone

workers with those engaged in other manual occupations (that is, excluding 'middle

class' occupations). As expected, the expectation of life at birth for both stone

workers and those engaged in manual occupations was lower than that in the

population as a whole (Table 3). Stone workers also had slightly higher mortality than

other manual workers. However, the main difference between stone workers and

others was in the greater differential between males and females. The wives and

daughters of stone workers could expect to live an average of almost ten years longer

than males, whereas the sex differential in the expectation of life at birth was only 5.5

years for other manual workers. The main reason for the difference was the higher

mortality of male members of the stone working population, whose expectation of life

at birth was just under 48 years (Table 3).

Stone-working was certainly considered to be a dangerous occupation, and

there are several entries in the parish burial registers for both Swanage and Langton

Matravers indicating that individual deaths were the result of accidents in the stone 'mines'. So was this excess male mortality among the stone workers in Swanage the result of the hazardous nature of work in the stone quarries? To answer this question we used the occupation-specific life tables for Swanage to estimate the probability that a male alive at age 15 years would still be alive on his 50th birthday. If work in the stone quarries was especially hazardous, we should expect this probability to be lower for stone workers than for other occupations. It turns out that this is not the case. The chance of survival from age 15 to age 50 years for men was identical for stone workers and other manual workers at 79 per cent, and very similar to that for the population as a whole (78 per cent). Despite the contemporary perception that stone working was a dangerous occupation, therefore, adult male mortality among stone workers was no higher than that in the population as a whole.

We now turn to the analysis of infant and child mortality. Consider first infant mortality. In the Wareham RD between 1861 and 1891 just over one in ten children born failed to survive until their first birthday (Table 4). According to the results for the two stone parishes, infant mortality in Langton Matravers was rather higher than that in the Wareham RD and that in Swanage rather lower, but we must again interpret the Swanage figures with caution because of the likely omission of deaths from the burial register. The most striking finding emerges, however, when we estimate the infant mortality rate separately for the offspring of stone workers in Swanage. Infant mortality among all the children of stone workers is 129 per thousand, more than one third higher than that among the town's population as a

whole (Table 4).[28] This excess mortality, however, is concentrated entirely among males, where the infant mortality rate is 173 per thousand. For child mortality (that is, deaths at ages 1-5 years per 1,000 survivors to exact age 1 year), a rather similar pattern emerges. The death rate in this age group is lower in the two Purbeck parishes than in the Wareham RD as a whole (Table 5), but is once again higher in Langton Matravers than in Swanage. Among the children of stone workers in Swanage, rates are substantially higher than among the whole population of that parish, and notably the children of 'non-stone' manual workers. Male mortality is 50 per cent higher than that of females (69 per thousand compared with 46 per thousand). The reason for the excess mortality of male stone workers in Swanage seems to be clear: the sons of stone workers have much higher mortality in infancy and childhood than do boys in the population as a whole or, indeed, the daughters of stone workers.

The question arises as to whether the difference between the mortality of male children of stone workers and other male children is statistically significant. We can estimate 95 per cent confidence intervals around the estimates of infant and child mortality among stone workers' sons and the sons of 'non-stone' manual workers.[29]

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[28] This infant mortality rate is expressed in deaths per thousand births and is not the same as the age-specific death rate (ASDR) for those under one year which is estimated by dividing deaths by the total exposed to risk. In Swanage the ASDR for the children of stone workers was 0.138 and this is converted to an infant mortality rate (IMR) using the formula $IMR = 1 - \exp(-ASDR)$. Therefore in this case we have $IMR = 1 - \exp(-0.138) = 0.129$.

[29] The 95 per cent confidence intervals for the ASDRs are estimated by adding and subtracting 1.96 times the square root of the variance to the estimated age-specific death rate (ASDR). The variance may be estimated as the ASDR divided by the total exposed to risk. Thus, for example, in the age group under one year in Swanage, among the sons of stone workers there were 44 deaths and a total exposed to risk of 232.66 years. The estimated ASDR for boys was therefore equal to $44/232.66 = 0.189$. The variance of this estimate is equal to $0.189/232.66 = 0.000813$, and the 95

For infant mortality, these are 125 – 217 deaths per thousand births for the sons of

stone workers, and 37 – 114 for the sons of 'non-stone' manual workers. Since these

do not overlap, we conclude that the difference between the infant mortality of male

children between these two groups is statistically significant. The 95 per cent

confidence intervals for the number of deaths before exact age five years per

thousand survivors to exact age one year is 39 – 99 for the sons of stone workers and

4 – 39 for the sons of 'non-stone' manual workers: again, the lack of overlap suggests

a statistically significant difference.

Discussion and conclusion

In this paper we have shown that using nominative record linkage of data from the

nineteenth century census enumerators' books of England and Wales and the Church

of England baptism and burial registers, it is possible to derive estimates of

occupational mortality differentials for local areas. Record linkage is laborious, most

of the time being spent in gathering the data and performing the initial linkage

exercise. Once a linked data set is available, the task of calculating the correct

population exposed to risk and estimating the relevant age-specific death rates is

relatively quick.[30]

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per cent confidence interval therefore ranges from 189 – (1.96 x √0.000813) to 0.189
+ (1.96 x √0.000813). Evaluating these quantities gives a 95 per cent confidence
interval for the ASDR of 0.133 to 0.244. This then needs to be converted into a 95 per
cent confidence interval for the infant mortality rate (deaths per thousand births). An
ASDR of 0.133 produces an infant mortality rate of 1 – exp(–0.133) = 0.125, and an
ASDR of 0.244 an infant mortality rate of 1 – exp(–0.244) = 0.217, giving a 95 per
cent confidence interval for the infant mortality rate of 0.125 to 0.217 or 125-217
deaths per thousand births.
[30] We used the Statistical Package for the Social Sciences (SPSS) and an Excel
spreadsheet for the calculations.

The substantive results of our investigation are surprising and rather puzzling. Unlike miners elsewhere in England and Wales, the stone quarriers of Purbeck (and we should remember that the stone quarries were, to all intents and purposes, stone 'mines') did not apparently experience heavier mortality on account of occupational hazards. Instead, the outstanding feature of their mortality was the high death rate among male infants and young children.

There are various possible explanations of this, but many of them can be ruled out quite simply. For example, demographers in areas of the developing world often refer to deliberate differences in the care and attention given to male and female children. Normally, this is related to a preference for sons over daughters, and is cited as an explanation of high female mortality relative to that of males. Among the stone workers of Purbeck, though, the opposite preference would be needed, as it is the death rate among boys which is excessive. There is, however, no reason to suppose that the stone workers preferred daughters to sons, and evidence of such differential treatment of male and female offspring in nineteenth century England is almost entirely lacking.[31]

There might have been selective under-registration of female child burials. If this was the case, though, it would seem that it was confined to the children of stone workers, as among the children of other working-class groups, reported female mortality was higher than that of males (Tables 4 and 5).

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[31] For a good summary of this issue see B. Harris, 'Gender, health and welfare in England and Wales during industrialisation', *Research in Economic History*, 21(2008), 157-204. The stone workers of Purbeck are likely to have preferred sons to daughters, if anything, because sons could work in the family stone quarry.

Another possibility is that genetic factors may have been responsible, since the stone workers were descended down the male line from a rather small number of individuals. However, most life-threatening genetic disorders which affect males (such as haemophilia) are passed to sons through their mothers and, as we have seen, the mothers of stone workers—at least in the parish of Langton Matravers—were not drawn from a closed population. It is possible that in the parish of Swanage, which is where the evidence for excess male infant and child mortality is clearest, there was a tendency for in-marriage within the stone working population, and we have not yet analysed the occupational information in the Swanage marriage register to test this.[32] Although the fathers of stone workers were descended through many generations from rather a small number of men, few genetic disorders are passed down through the male line (those few disorders which are caused by Y-chromosome defects, which clearly only affect males, are mainly related to male infertility, and as such are not life-threatening).

It is also possible that the ways in which infants and children were cared for had a differential impact on the well-being of boys and girls, perhaps if the wives of the stone workers were also working in the family business. However, the evidence we have from contemporary accounts of the lives of stone workers and their families suggests that stone quarrying was men's work, and that the wives of stone workers did not have unusual working patterns which might have led, for example, to the feeding of their infants being interrupted.

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[32] It would, however, be surprising if the behaviour of stone workers in Swanage was different from that in Langton Matravers, as there was a good deal of contact between the parishes and the stone industry was effectively a single organisation.

A final potential explanation is that baby boys were more susceptible to lung problems than were baby girls, and the environmental pollution associated with the stone quarries might have extended to the homes of the stone workers, most of which were located close to the quarries.[33] This possibility can be investigated in a little more detail. Data on the number of deaths by age, sex and cause were published by the Registar General of England and Wales for the 1850s and 1860s. The data are arranged on the basis of registration districts (RDs), of which there were more than 600 in the country. These data have been rendered machine readable by Robert Woods, and are available from the United Kingdom Data Archive at the University of Essex.[34]

As mentioned earlier, the Isle of Purbeck was located within the Wareham RD, and in this RD during the 1850s and 1860s there were 149 deaths from diseases of the lungs to boys aged under five years, compared with only 86 to girls of the same age, the number of male deaths being, therefore, 73 per cent greater than that of females.[35] In the neighbouring RD of Dorchester (which was in many respects environmentally similar to Wareham but did not have a stone industry) during the same two decades the numbers of deaths from lung diseases to boys and girls aged under five years were 293 and 232 respectively, a male excess of only 26 per cent.[36]

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[33] We should like to thank Alysa Levene for suggesting this possibility to us.

[34] R. Woods, *Causes of death in England and Wales, 1851-60 to 1891-1900: the decennial supplements* [computer file] (Colchester, UK Data Archive [distributor], 1997), SN 3552. This is available from the UK Data Archive at the University of Essex (www.data-archive.ac.uk).

[35] Woods, *Causes of death.* The same analysis cannot be carried out for the 1870s and 1880s because the Registrar General's age- and cause-specific data were not tabulated separately for males and females. The excess male mortality was concentrated mainly at ages under two years.

[36] Woods, *Causes of death*.

This Dorchester excess is very similar to that in the south west of England as a whole, where in the 1860s, the total number of male deaths at ages under five years from lung diseases was only 28 per cent greater than that of females.[37] If we confine our attention to infants, in Wareham RD the number of deaths from lung diseases among boys in the 1850s and 1860s was 133 per cent of that among girls, and the corresponding figure for Dorchester RD was 48 per cent. This compares with an excess in the 1860s in the south west of England as a whole of 44 per cent. Again, it is the Wareham RD that stands out as exceptional.[38] Although we cannot link the large excess mortality from lung diseases among males relative to females in the Wareham RD specifically to the children of Purbeck's stone workers, the evidence does suggest that there may have been something unusual about the sex ratio of deaths from lung diseases among infants and young children in the Purbeck area, and this could well have been linked to the stone industry.

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[37] Woods, *Causes of death*. The 'south west of England' here includes the counties of Wiltshire, Dorset, Devon, Cornwall and Somerset.

[38] Note that the population sex ratio in the Wareham RD was not very different from that in Dorchester RD or in the south-western counties. During the 1850 and 1860s there were 99 boys for every 100 girls aged under five years in Wareham RD, and 104 boys for every 100 girls aged under five years in Dorchester RD (Woods, *Causes of death*). The differential between the two RDs in the sex ratio of the mortality *rates* from diseases of the lungs is, therefore, even greater than that in the sex ratio of numbers of deaths.

Table 1

Occupational structure of stone-working parishes in the Isle of Purbeck, 1851

Occupational group	Percentage of adult males stated to be employed		
	Swanage	Langton Matravers	Worth Matravers
Farmers	1	3	5
Farm workers	8	24	41
Trades and crafts	28	16	11
Maritime occupations	5	0	12
Professionals	5	3	3
Servants	10	10	6
Stone workers	36	42	22
Others	2	3	1
Total number employed	807	309	143
Employed as a percentage of whole population	39.6	40.8	36.7

Notes. 'Maritime occupations' include coast guards who were employed against smugglers. 'Professionals' include landowners and other wealthy or educated persons.

Source. Census enumerators' books, 1851, The National Archives HO107/1856.

Table 2

Expectations of life at birth in Wareham registration district (RD) compared with the parishes of Langton Matravers and Swanage

Decade	Expectation of life at birth		
	Wareham RD	Langton Matravers	Swanage
Both sexes			
1851–1861	47.1		
1861–1871	50.2	51.8	56.0
1871–1881	52.0		
1881–1891	52.9		
Males			
1851–1861	47.0		
1861–1871	49.1	49.8	53.9
1871–1881			
1881–1891	51.5		
Females			
1851–1861	47.3		
1861–1871	51.4	53.6	57.6
1871–1881			
1881–1891	54.3		

Note. For the decade 1871-1881, deaths were not tabulated separately for males and females for the Wareham registration district.

Source. Wareham RD figures calculated from data in the decennial *Supplements* to the Registrar General's *Annual reports*. See R. Woods, *Causes of death in England and Wales, 1851-60 to 1891-1900: the decennial supplements* [computer file] (Colchester, UK Data Archive [distributor], 1997), SN 3552. This is available from the UK Data Archive at the University of Essex (www.data-archive.ac.uk).

Table 3

Expectations of life at birth for stone workers and others in Swanage, 1851-1891

	Expectation of life at birth		
	Whole population	Stone workers	'Non-stone' manual workers
Both sexes	56.0	52.9	54.2
Males	53.9	47.9	51.3
Females	57.6	57.8	56.8

Note. 'Non-stone' manual workers included all other occupied persons except for professionals, farmers, those engaged in occupations requiring educational qualifications, and those in trades and crafts who were employers.

Table 4

Infant mortality (deaths under 1 year per 1,000 live births): Wareham registration district (RD) and the two stone parishes compared

Population and period	Infant mortality rate		
	Both sexes	Males	Females
Wareham RD			
1861–1871	106	122	89
1871–1881	102		
1881–1891	101	111	90
Langton Matravers			
1851–1891	116	120	112
Swanage 1851–1891	92	102	83
Children of stone workers in Swanage	129	173	85
Children of 'non-stone' manual workers in Swanage	89	76	102

Notes. For the decade 1851-1861 the mean population at ages under one year was not given in the Registrar Gemeral's data, so infant mortality rates could not be estimated. For the decade 1871-1881, deaths were not tabulated separately for males and females.

Source. Wareham RD figures calculated from data in the decennial *Supplements* to the Registrar General's *Annual reports*. See R. Woods, *Causes of death in England and Wales, 1851-60 to 1891-1900: the decennial supplements* [computer file] (Colchester, UK Data Archive [distributor], 1997), SN 3552. This is available from the UK Data Archive at the University of Essex (www.data-archive.ac.uk).

Table 5

Child mortality (deaths under 5 years per 1,000 survivors to exact age 1 year): Wareham registration district (RD) and the two stone parishes compared

Population and period	Child mortality rate		
	Both sexes	Males	Females
Wareham RD			
1861–1871	74	76	72
1871–1881			62
1881–1891	60	68	52
Langton Matravers			
1851–1891	52	59	45
Swanage 1851–1891	39	39	39
Children of stone workers in Swanage	57	69	46
Children of 'non-stone' manual workers in Swanage	33	21	47

Notes. For the decade 1851-1861 the mean population at ages 1-5 years was not given in the Registrar Gemeral's data, so death rates specific to this age group could not be estimated. For the decade 1871-1881, deaths were not tabulated separately for males and females.

Source. Wareham RD figures calculated from data in the decennial *Supplements* to the Registrar General's *Annual reports*. See R. Woods, *Causes of death in England and Wales, 1851-60 to 1891-1900: the decennial supplements* [computer file] (Colchester, UK Data Archive [distributor], 1997), SN 3552. This is available from the UK Data Archive at the University of Essex (www.data-archive.ac.uk).

Figure 1

Location of the Isle of Purbeck

Figure 2

Map of the Isle of Purbeck showing the area where stone quarrying took place in the nineteenth century