

viewing neonatal jaundice as being physiological to seeing it as a mild disease that has to be monitored by bilirubin assessments and whose course should be managed by precautionary and therapeutic procedures.

Being in a hospital has thus become a factor in its own right and determines the frequency of medical interventions. In this case it concerned phototherapy, but it might also apply to the frequency with which many obstetric procedures are carried out, which is at present widely criticised.

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## For Debate . . .

# Inequalities in health in Britain: specific explanations in three Lancashire towns

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## Abstract

The reasons why mortality is higher in the poorer areas of Britain are largely unknown. Thus how to reduce inequalities in health is a matter of conjecture. In three neighbouring towns in northern England the rates of death from all causes differ greatly. Socioeconomic conditions in the towns are similar though below average for England and Wales. The pattern of disease specific rates was analysed and related to past differences in infant mortality.

It is suggested that past differences in maternal health and physique and in the postnatal environment, particularly infant feeding, housing, and overcrowding, may be determinants of current differences in adult mortality.

## Introduction

The geographical and social class differences in mortality in Britain reflect differences in death rates from several chronic diseases. They correlate with variations in a range of socioeconomic indexes, with rates being higher in poorer places and groups.<sup>1,2</sup> How specific socioeconomic influences determine variations in mortality from chronic diseases is, however, largely unknown, and therefore how inequalities in mortality can be reduced is a matter of conjecture.<sup>3</sup>

During 1968-78 variations in ischaemic heart disease, chronic bronchitis, and stroke accounted for 93% of the total variance in mortality from all causes between the 212 local authority groupings in England and Wales—that is, the county boroughs (large towns), London boroughs, urban areas within counties, and rural areas. We

have shown that these three diseases have a close geographical relation with certain causes of infant mortality during the early years of the century.<sup>4,5</sup> We interpret this as evidence that events in prenatal life and early childhood are important in the aetiology of these diseases. Specifically, the physique and health of the mother and the prenatal and postnatal growth and development of the infant may be determinants of ischaemic heart disease and stroke, and respiratory infection in early childhood may be a determinant of chronic bronchitis.

It follows that differences in maternal characteristics and in the postnatal environment may be determinants of the current differences in adult mortality. Census data from the past give some insight into the childhood environment. Indexes of crowded housing and of family income were geographically correlated with infant mortality.<sup>6</sup> The value of such indexes, however, is limited because they do not, for example, describe nutrition.

In 1914, after a national survey,<sup>7</sup> the Local Government Board published a report on infant mortality in Lancashire.<sup>8</sup> The report focused on the three neighbouring towns of Burnley, Colne, and Nelson, situated side by side on the western slopes of the Pennine Hills (figure). Each had developed as a cotton weaving town, and for the six miles from the centre of Burnley through Nelson to Colne there was hardly a break in the line of houses. Yet the infant mortality rates differed greatly. In 1911-3 there were 177 deaths per 1000 births in Burnley, 130 in Colne, and 87 in Nelson.

The current mortality in the towns differs also. During 1968-78 mortality at all ages and from all causes was 21% above the national average in Burnley, 10% above in Colne, and 4% above in Nelson.<sup>9</sup> The detailed description of the towns in the 1914 report gives an insight into the way in which past environmental differences that affected the health and development of infants might have determined the current differences in mortality among adults.

## Methods

Data on past conditions in the three towns were taken from the 1911 census<sup>10</sup> and from two Local Government Board reports, the first (1913) covering all 241 urban areas of England and Wales<sup>11</sup> and the second (1914)

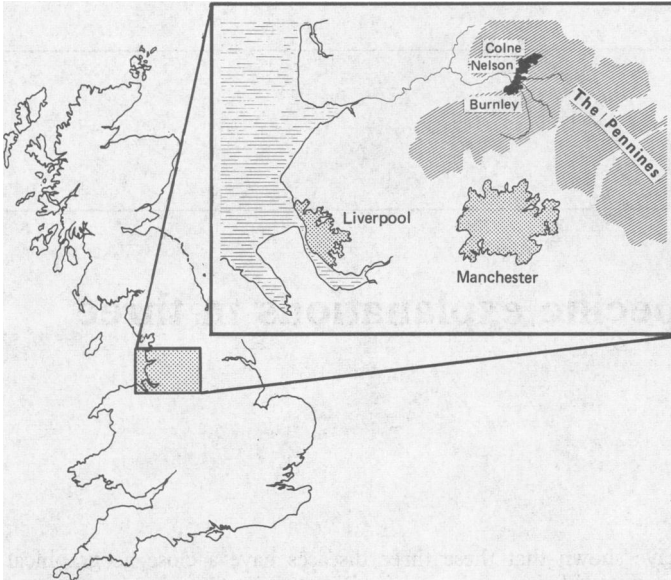
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covering Lancashire.<sup>8</sup> Published data from the 1971 census allowed current occupation, housing, and other socioeconomic indexes to be compared.<sup>12</sup> Additional data on infant mortality in 1921-5 came from the Registrar General's statistical reviews.<sup>13</sup>

The Office of Population Censuses and Surveys made available to us extracts from all death certificates in England and Wales during 1968-78, the period covered by the eighth revision of the International Classification of Diseases. Mortality rates for each sex for each local authority area were calculated from 1971 census data, grouped according to local authority boundaries before 1974.<sup>9,14</sup> Death rates were expressed as standardised mortality ratios.



Map of England and Wales to show location of Nelson, Colne, and Burnley.

## Results

### INFANT MORTALITY RATES

Table I shows infant mortality rates in the towns for four periods from 1896 to 1925.<sup>8,11</sup> Throughout this time there was a gradient in the rates from Nelson to Colne to Burnley. Rates in Burnley were much above the average for England and Wales, being consistently among the highest of any town. National rates fell from 155 per 1000 in 1896-8 to 76 in 1921-5.

Data for 1911-3 show that there were gradients from Nelson to Colne to Burnley for both neonatal and postneonatal deaths (table I) and for deaths

TABLE I—Nelson, Colne, and Burnley: infant mortality rates per 1000 births from 1896 to 1925 and infant mortality by period and cause, child mortality, and birth rate 1911 to 1913

	Nelson	Colne	Burnley	England and Wales
<i>Infant mortality per 1000 births, 1896-1925:</i>				
1896-8	154	170	197	155
1907-10	107	130	171	113
1911-3	87	130	177	111
1921-5	79	109	114	76
<i>Rates from 1911-3:</i>				
<i>Infant mortality per 1000 births:</i>				
Neonatal	38	37	49	
Postneonatal	49	93	128	
<i>Cause:</i>				
Group of five diseases*	35	33	53	
Bronchitis and pneumonia	17	25	26	
Diarrhoea	16	30	48	
Mortality at age 1-5 years per 1000 survivors at age 1	58	85	96	
Birth rate per 1000 population	18	21	23	

\*Premature birth, congenital defects, birth injury, want of breast milk, and atrophy, debility, and marasmus.

from the three main groups of causes—that is, the so called “group of five” diseases (premature birth, congenital defects, birth injury, want of breast milk, and atrophy, debility, and marasmus), bronchitis and pneumonia, and diarrhoea. Most deaths in this first group were recorded as being due to premature birth or congenital defects. The gradient in neonatal deaths, however, and in the group of five diseases which is their main cause, was less steep than for postneonatal deaths. Differences in mortality between the towns persisted through early childhood to 5 years.

Data from the 1913 report allow rates for the earlier period 1907-10 to be compared with those in all 241 urban areas in England and Wales. Neonatal death rates and those for the “group of five” diseases in Burnley during 1907-10 were 13% and 18% above the urban average; rates for bronchitis and pneumonia were 73% above and for diarrhoea 105% above. Rates in Nelson were mostly below the average, those for diarrhoea being 55% below.

There was a gradient in birth rates from 18 per 1000 population in Nelson up to 23 in Burnley (table I).

### CONDITIONS IN THE TOWNS<sup>8</sup>

Most of Burnley is in the valley where the rivers Brun and Calder meet. Nelson and Colne lie above it on the western slopes of the Pennines. The climate is cold and damp, and rainfall is above average, particularly in Nelson. Low lying areas of Burnley were persistently damp, especially those below the high embankment that carries the Leeds-Liverpool canal through the town. During the early 1800s there was extensive house building on land near Burnley town centre that was so marshy that it was unfit for farming.

In all three towns the level of employment was high, and wages were relatively good. The staple industry was cotton weaving (table II). The

TABLE II—Distribution (%) of men and women aged 10 years and over by occupation and percentage of married women employed, 1911

Occupation	Nelson	Colne	Burnley
<i>Men:</i>			
Textiles	59.4	47.0	36.0
Coal and shale mine workers	0.7	0.5	8.7
Building and construction	4.9	6.2	5.2
General engineering	1.9	6.0	5.7
All other occupations	24.0	30.7	33.7
Retired or unoccupied	9.1	9.6	10.7
<i>Women:</i>			
Textiles	45.0	39.0	43.6
All other occupations	9.7	11.5	12.7
Retired or unoccupied	45.3	49.5	43.7
Percentage of married women employed	37.1	32.2	41.4

textile industry employed roughly 40% of all the women aged 10 years and over. In Burnley a small percentage (8.7%) of the men worked in coal and shale mines. Otherwise the distribution of occupations among men and women in the three towns was similar.

Many of the women who worked in the weaving mills of Burnley and Colne were from the second or third generation of Lancashire industrial workers. Nelson, however, had developed more recently and had an eightfold increase in population between 1871 and 1911. Most of the people were immigrants from adjacent areas, especially from parts of Yorkshire. “This fact has an important bearing on the question of infantile mortality, owing to the general good health and the habits of cleanliness and thrift characteristic of these immigrants from rural districts.” The women were described as “sturdier and healthier” than those in Burnley.

There were no crèches at the mills. Usually the return of the mothers to work was soon followed by complete weaning and the infant, together with other children in the family below school age, was placed in the care of an untrained “minder” who was paid by the mother. “In view of the fact that so many mothers are anxious, for the sake of the wages, to get back to employment in the mills as soon as possible after childbirth, a large proportion of children born in Burnley are deprived of the advantages of breast feeding after the first few weeks of life. . . . In Colne and still more in Nelson breast feeding is usually continued longer than in Burnley.” An inquiry in Burnley showed that at the end of six months 36% of infants were breast fed, 34% had mixed breast and artificial feeding, and 27% had artificial feeding alone.

Most houses in the towns were similarly built of stone. In Nelson, however, houses were newer and tended to be more spacious (table III). Mean family size in the towns was similar. The worst houses were the back to back houses in the oldest parts of Burnley and Colne. These were small,

had no means of ventilation to the outside air, and lacked facilities for the storage of food and milk. Infant mortality was much higher in such houses—248 per 1000 in the back to back houses of Colne, for example, during 1912 compared with 80 in the so called "through" houses. Much of the excess mortality was due to diarrhoea. Resettlement of families from back to back houses to "through" houses was accompanied by a fall in infant mortality to around the average for "through" houses, showing that high mortality was a consequence of the structure of back to back houses rather than of the habits of those who occupied them. There were 2371 of these houses in Burnley and 1000 in Colne but only 52 in Nelson (table III).

TABLE III—Housing conditions, mean family size, and total population, 1911

	Nelson	Colne	Burnley	England and Wales
Percentage of population in dwellings of less than four rooms	5.6	15.1	13.6	19.4
Percentage of population living more than two persons to a room	3.7	6.6	9.5	9.1
Percentage (No) of dwellings back to back or single room	0.6 (52)	17.0 (1000)	9.9 (2371)	—
Mean family size	4.3	4.3	4.4	4.4
Total population	39 479	25 689	106 322	

Sanitary conditions in Nelson were better than those in the other two towns. In Nelson the women kept the streets outside their houses clean, "more water being said to be used for this purpose in Nelson than in any other town in Lancashire." In Nelson communal pits, used for disposal of household refuse, were small and covered and were "in striking contrast" to the large open pits in Burnley and Colne, which favoured the breeding of flies. Refuse collected from the pits and bins in Nelson and Colne was destroyed, whereas in Burnley around half was put on to "tips," which were sites for breeding flies. In Nelson, and to a lesser extent Colne, the manure pits around stables and cowsheds were disinfected in summer to prevent flies breeding. Sanitary regulations that were related to the production and sale of milk were more strictly enforced in Nelson.

#### CURRENT MORTALITY

Table IV shows standardised mortality ratios for 1968-78 at ages 55-74 years. Most people who died at these ages belong to the generation to whose childhood environment the 1914 report relates.<sup>8</sup> Analysis of all deaths in the towns during 1969-72 shows that 85% of people aged 55-74 years who died in Burnley were born in Lancashire. The corresponding figures for Nelson and Colne are 80% and 79%. More details are available for Burnley, where 65% of the people were born in the town itself. Analysis of a sample of 471 death certificates for people aged 55-74 years who died in the towns in 1973 showed that 79% who died in Burnley were born within a 12 mile radius of the Nelson town centre. Corresponding figures for Nelson and Colne are 75% and 73%. The percentages of people who were born and died in the same town are 68 in Burnley, 36 in Nelson, and 50 in Colne.

TABLE IV—Standardised mortality ratios for causes of death at ages 55-74 years in 1968-78, both sexes (figures in parentheses are numbers of deaths)

Cause of death	International Classification of Diseases No (8th revision)	Nelson			Colne			Burnley		
All causes	001-999	100	109	121	(2258)	(1468)	(5646)			
Ischaemic heart disease	410-414	106	119	120	(707)	(473)	(1662)			
Bronchitis	490-492	134	132	188	(175)	(102)	(503)			
Pneumonia	480-486	108	125	174	(120)	(82)	(392)			
Stroke	431-438	101	121	120	(242)	(171)	(582)			
Lung cancer	162	81	83	100	(160)	(99)	(415)			
Stomach cancer	151	106	127	132	(66)	(47)	(170)			
Other cancers	140-209 less 151, 162	87	102	96	(310)	(219)	(720)			
Other causes	Codes 001-999 not used above	97	93	117	(478)	(275)	(1202)			

The gradient in standardised mortality ratios from all causes from Nelson to Colne to Burnley was shown by both sexes. Ratios for men were 99 in Nelson, 110 in Colne, and 120 in Burnley; the corresponding ratios for women were 105, 112, and 125. For both sexes combined mortality in Nelson (standardised mortality ratio 100) was exactly the national average. The gradient in standardised mortality ratios for all causes is reflected in gradients for ischaemic heart disease, bronchitis, pneumonia, and stroke.

Standardised mortality ratios for lung cancer were low, although there was a trend between the towns. Ratios for all cancers other than stomach or lung were also around 100, with no trend.

Of the 971 deaths in Burnley that were in excess of those expected from national rates, 63% were caused by ischaemic heart disease (280 deaths), bronchitis (235), or stroke (97). A further 17% were certified as due to bronchopneumonia (167 deaths).

#### CURRENT SOCIOECONOMIC CONDITIONS

Data from the 1971 census (table V) show that compared with England and Wales the three towns have a higher percentage of men in social classes III manual, IV, and V. This excess is greatest in Nelson. For housing,

TABLE V—Socioeconomic indexes in 1971 and infant mortality 1968-72

	Nelson	Colne	Burnley	England and Wales
Employed men in social classes (%):				
I	2	3	3	5
II	13	14	13	18
IIIN	8	10	10	12
IIIM	48	47	45	38
IV	18	16	20	18
V	11	11	10	9
Households with exclusive use all amenities (%)*	67	72	63	82
People living more than one person per room (%)	14	10	14	12
Households in dwellings of less than five rooms (%)	55	44	51	36
Households owning a car (%)	40	36	34	52
Infant mortality 1968-72	20	19	22	18
Total population	31 249	18 940	76 513	

\*Hot water, fixed bath, inside lavatory.

overcrowding, car ownership, and other socioeconomic indexes the towns are also worse than the average for England and Wales, with the exception of domestic overcrowding in Colne. Only in the percentage of households owning a car, which is an indicator of income, is there a worsening gradient from Nelson to Colne to Burnley. The outstanding feature of the industry in the towns has been the decline in cotton weaving, less than 20% of the workforce in any of the towns being employed in the cotton industry in 1971. New industries include light engineering and the manufacture of aerospace equipment. The pattern of employment in the towns is similar.

#### Discussion

In three industrial towns in northern England that are situated side by side there are large differences in current death rates. In Burnley (famous through its association with Sir James MacKenzie, who practised medicine there from 1879 to 1907) adult mortality at ages 55-74 years is one of the highest in any of the large towns in England and Wales. In Colne mortality is only 9% above average, whereas in Nelson, which is situated between the others, mortality is average (table IV). Eighty per cent of the excess mortality in Burnley is certified as due to ischaemic heart disease, chronic bronchitis, stroke, or bronchopneumonia. The last of these is given as the underlying cause of death from several types of chronic disease. Excluding cancer of the stomach, cancer mortality is around the national average. Mortality from lung cancer, which is an index of cigarette smoking, is average or below average.

The close proximity of the towns precludes explaining the large differences in mortality in terms of environmental variables such as rainfall. Nor is it likely that there are important differences in

medical care. The hospital services for the towns are centred on Burnley. Rather the effect of socioeconomic factors is suggested. Recent census data show all three towns to be among the poorer towns in England and Wales as indicated by the high percentage of manual workers, by type of housing, and by income. Differences between Nelson and Burnley, however, are small and less than the differences from the national average. Interestingly, Nelson has the greatest excess of manual workers but nevertheless has a mortality rate from all causes that is equal to the national average.

The present similarity of the towns belies the large differences that formerly existed and led to large differences in mortality among infants and young children. These differences included the health and physique of mothers, infant feeding practices, housing, and sanitation but not income or occupation.

Nelson is newer than the other two towns. The people were recent migrants from nearby rural areas rather than second or third generation industrial workers. More of the women—described as “sturdier and healthier” than those in Burnley—breast fed their infants and they did so for longer. The birth rate in Nelson was the lowest of the three towns. The housing was more spacious, and domestic overcrowding, measured by the percentage of the population living more than two persons to a room, was less. There were fewer back to back houses and single room dwellings than in the other towns. The effects of poor housing in Burnley may have been compounded by unusually damp soil. Nelson had better sanitation than the other two towns as a result of better refuse disposal and street cleaning and more vigorous action against fly breeding.

We have shown that within the 212 local authority groupings in England and Wales there is a close geographical relation between neonatal mortality during 1921-5 and ischaemic heart disease and stroke mortality in 1968-78.<sup>4</sup> We interpret this as evidence that poor maternal health and physique and impaired prenatal and postnatal growth and development of the infant are major risk factors for the two diseases. In addition, ischaemic heart disease is related to postneonatal mortality. Thus giving artificial feeds to infants, early weaning, and frequent respiratory or enteric infection in infancy may also be risk factors for the disease. We suggest that past variations in prenatal and early postnatal influences determined the current geographical distribution of ischaemic heart disease and stroke in England and Wales. The gradient in neonatal mortality and the “group of five” diseases during 1911-3 from Nelson up to Burnley, the description of better maternal physique and health in Nelson, and the lower birth rate accord with the current lower rates of ischaemic heart disease and stroke in the town.

We have also shown a close geographical relation between past infant mortality from bronchitis and pneumonia and current mortality from chronic bronchitis and emphysema in England and Wales.<sup>5</sup> We interpret this as strong support for the hypothesis that pulmonary infection during infancy may have persisting effects and lead to chronic bronchitis in adult life. The gradient in postneonatal mortality, specifically mortality from bronchitis and pneumonia, from Nelson up to Burnley accords with the current lower rates of chronic bronchitis in Nelson. Aspects that are likely to have determined the lower infant mortality from respiratory disease in Nelson include better housing, lower level of domestic overcrowding, and greater frequency of breast feeding.

The findings presented in this paper allow interpretations of differences in adult mortality other than as a major effect of the prenatal and early postnatal environment. Although mortality from cancer, apart from lung and stomach cancer, is little different in Nelson and Burnley and below the national average in both, mortality from all causes other than ischaemic heart disease, stroke, bronchitis, pneumonia, and cancer is highest in Burnley. Diseases contributing to this excess include those with origins in early life—for example, chronic rheumatic heart disease—and others with more immediate origins, such as accidents, poisonings, and violence.

Our evidence for the importance of the prenatal and early postnatal environment rests on close geographical correlations that are remarkably consistent in both sexes, all age groups, and the different geographical areas throughout England and Wales.<sup>4,5</sup> The findings in Burnley, Colne, and Nelson add little to the evidence. They do, however, give a detailed insight into differences in

maternal characteristics and the postnatal environment which might have determined current differences in adult mortality.

The inability to find specific explanations for the geographical differences in mortality in Britain has led to a variety of hypotheses. The Black report concluded that “much, we feel, can only be understood in terms of the more diffuse consequences of the class structure.”<sup>6</sup> We suggest that specific explanations may be found in the environmental influences that determined past differences in child development. These explanations may allow a national strategy for reducing inequalities in health to be developed.

We thank Dr Peter Grime, district medical officer for Burnley, Pendle and Rossendale Health Authority, for help in obtaining information about the three towns; our colleagues in the MRC Environmental Epidemiology Unit, in particular Mr Paul Winter, who helped with the computing; and Mrs Bridget Wilde, who typed the manuscript.

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*What is the best treatment for the nausea and vomiting of pregnancy? Is vitamin K or vitamin C of any value?*

Nausea and vomiting of pregnancy may often be controlled by reassurance and instructing the patient to eat small, frequent meals of rather dry foods. Eating before getting up in the morning helps. Antiemetics such as promethazine hydrochloride may be prescribed if necessary. I cannot think of a logical reason why vitamin K or vitamin C should be of any value.—G J LEWIS, consultant obstetrician and gynaecologist, Stourbridge.

*Should a vegetarian who eats eggs and milk products require iron supplement?*

Several studies show that a vegetarian diet does not affect iron status.<sup>1</sup> It is, however, essential that the diet provides an adequate intake of energy. The iron in vegetable foods is, in general, less biologically available than that in animal foods. This is due to several factors. Firstly, the iron in plant foods is principally non-haeme iron and, secondly, the proportion of this that is bioavailable—that is, digested, absorbed, and used by the body—is greatly affected by other components of the diet.<sup>2</sup> For example, vitamin C, citric acid, and protein enhance its absorption whereas phytate, phosphates, and tannins inhibit absorption. So it is desirable to eat a good mixture of foods and to include fresh fruit and vegetables.<sup>3</sup> Preference should be given to high extraction cereal products that have been cooked because this reduces the phytate content. Many proprietary breakfast cereals and all foods made from white and brown (but not wholemeal) flour contain added iron.—D A T SOUTHGATE, head, nutrition and food quality research, AFRC Institute of Food Research, Norwich.

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