Inequality in infant morbidity: causes and consequences in England in the 1990s

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Abstract

***Study objective*—To examine the effect of deprivation, crowding, maternal smoking, and breast feeding on morbidity from wheeze and diarrhoea in the first six months after birth.**

***Design*—A geographically located population survey using maternal responses on self completion questionnaires.**

***Setting*—The three health districts of Bristol.**

***Subjects*—8501 infants from the Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) in which all women expecting a baby between April 1991 and December 1992 in Bristol were invited to participate.**

***Main outcome measures*—The prevalence and severity of wheeze at six months after birth. The prevalence of diarrhoea and the duration of the worst bout at six months after birth.**

***Results*—Logistic regression analyses using a conceptual hierarchical framework showed that wheeze was significantly more likely to be reported for infants if they lived in rented accommodation (OR=1.20, 95% CI = 1.04, 1.39), if they lived in crowded housing conditions (OR=1.26, 95% CI = 1.06, 1.49), if they were one of a number of siblings (OR=1.78, 95% CI = 1.52, 2.07), and if their mothers smoked (OR=1.38, 95% CI = 1.21, 1.58). They were significantly less likely to have wheeze if they were breast fed (OR=0.68, 95% CI = 0.59, 0.79). Each of these factors was independently related to the prevalence of wheeze. For infants with wheeze those who were breast fed for three or more months were significantly less likely to have three or more episodes in the first six months after birth (OR=0.76, 95% CI = 0.58, 0.99). A higher prevalence of diarrhoea in infancy was associated with living in rented accommodation (OR=1.25, 95% CI = 1.10, 1.41) and lower maternal education (OR=0.76, 95% CI = 0.69, 0.84) and a lower prevalence with breast feeding (OR=0.42, 95% CI = 0.37, 0.48). An episode of diarrhoea was significantly less likely to last for six or more days if an infant lived in mortgaged accommodation (OR=1.34 95% CI = 1.03, 1.75) and was breast fed for three or more months (OR=1.34 95% CI = 1.03, 1.75).**

***Conclusion*—Deprivation was associated with heightened morbidity from common conditions such as wheeze and diarrhoea for this geographical cohort of infants in England in the 1990s. Results supported evidence suggesting that breast feeding is protective against such conditions and is particularly associated with reduced severity and duration. Implications for future research and policy are discussed.**

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Patterns of mortality in 20th century Britain have seen a considerable decline in poverty related premature death in the first year after birth. This trend is conventionally attributed to improved sanitation, housing conditions, and nutrition,[1 2] but it could also be the consequence of a reduction in family size,[3] so lessening the possibility of overcrowded living conditions and of exposure to infection. Infant mortality is now so low that it no longer bears a systematic relation to standards of living for large population aggregates such as the British regions[4]; social class differentials, while still in evidence, have also narrowed over the past 10 years.[5] While absolute poverty and its devastating effects on survival in infancy seem now to have been virtually eliminated in Britain, it is not known if the impact of social disadvantage has simply shifted from mortality to morbidity at this time in a child's life. Improvements in standards of living combined with reductions in family size would suggest that this should not, as a matter of course, be the case. Rather maternal behaviours such as smoking and artificial infant feeding, now more common for mothers with lower social status, could be the predominant reason for heightened levels of morbidity in infancy.[6 7] Testing this proposition is however problematic using data collected nationally. What is known about health in the first year of life has often been based on rates of GP consultation for children aged 0–4 years, rather than the prevalence of morbidity in the population of children under 1.[8] Such data are not necessarily a good proxy for morbidity; rates of consultation do not always represent a true picture of prevalence, accounting for only the tip of the "iceberg of illness" in the community.[9] In such circumstances consulting the doctor is likely to be dependent on characteristics such as the duration or the severity of symptoms rather than their presence or absence.[10 11] Neither do patterns of consultation necessarily reflect social variations in prevalence, as the decision to seek help from a doctor is dependent on access to health care[12] and on health behaviour[13] as well as "need". Nor has it been possible to directly measure the competing influences of deprivation, overcrowded living conditions, and maternal behaviours on morbidity in the first year of life, as

no routinely collected national data sets combine information on all these factors for those infants born in the 1990s.[14]

Data on the prevalence of morbidity for specific conditions and the social and behavioural factors outlined above are however available for a large geographically defined population of mothers and their children born in the early 1990s and followed up since then, the Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC). Using these data the study reported in this paper aimed to examine the competing influences of relative deprivation, of crowded living conditions and of maternal behaviours such as smoking and feeding practice on morbidity in the first six months after birth. Two of the most common illnesses in early childhood were compared, wheezing and diarrhoea. Lower respiratory conditions such as bronchitis and pneumonia, so closely associated with infant mortality in the earlier part of this century, have consistently decreased both as a cause of death and as a reason for hospital admission for children under 5 years of age since the 1960s; in contrast the prevalence of wheeze has increased over this time period and asthma is now the most common reason for hospital admission for respiratory conditions.[6 15] An independent relation between the prevalence of wheeze and socioeconomic status in early childhood has not been consistently established and for school age children it is more severe symptoms rather than prevalence that have been associated with lower socioeconomic status.[16–18] Crowding, in terms of the number of other children in the household has been consistently associated with a higher prevalence of wheeze,[19–21] as has maternal smoking.[22 23] In some studies, but not in others, breast feeding is associated with a lower prevalence of wheeze.[24–26] Diarrhoea has in the past in Britain been closely associated with absolute poverty and particularly with overcrowded living conditions.[27] Mortality from this cause in infancy has sharply declined, but it is one of the conditions most commonly reported to the doctor in early childhood.[8] A higher prevalence of diarrhoea in developed countries is most commonly found in the first six months after birth for bottle fed babies.[28–30]

Sample selection

ALSPAC approached all pregnant women expecting a baby between April 1991 and December 1992 in the three health districts of Bristol to invite their participation. The number of pregnancies enrolled to the study, excluding miscarriages, late fetal and neonatal mortality was 13 995 mothers. The enrolment rate varied geographically, to between 80 and 90% of the eligible population. A comparison of the sample with a sample matched by area and maternal social and demographic characteristics from the 1991 census revealed that, in common with nationally based surveys, the ALSPAC sample under-represented those living in rented accommodation, those without use of a car, those who were lone parents, and those who were younger mothers, with differences in percentages with these characteristics of approximately 10%. The sample selected for the study reported here consisted of singletons and all mothers and their children for whom measures of morbidity were completed before the infant was 36 weeks old. The data required for this particular research project were extracted from four separate self completion questionnaires at 18 and 32 weeks gestation and at 6 and 8 months after birth; complete information for all the variables used in the analysis was available for 8501 cases. There were no significant socioeconomic and demographic differences between this sample and the whole ALSPAC sample, for which the census comparison was made.

Measures used

CONDITION SPECIFIC MORBIDITY

For wheeze, prevalence was estimated by maternal responses to the question "Has your baby ever had wheezing with whistling on his/her chest when he/she breathed?" Mother's estimate of the number of separate episodes of wheezing with whistling on the chest was used as the measure of severity; responses were categorised as 1–2 episodes or 3+ episodes. For diarrhoea prevalence was estimated by maternal responses to the question "Has your baby ever had diarrhoea or gastroenteritis?" and the persistence of a single episode was measured by maternal report of the duration of the worst bout, which was categorised as 1–5 days or 6+ days. Both questions were asked at six months after birth. The actual questions are displayed in the Appendix.

DEPRIVATION AND CROWDING

Housing tenure was used to measure material deprivation; living in rented accommodation is an important indicator of low income[31] and has been shown to be a better discriminator of relative deprivation in its association with health than social class.[32] Our own previous study of maternal health using ALSPAC data showed that housing tenure was closely related to other proxy measures of family income such as use of car and partner's employment status.[33] Using latent class analysis this study also showed that women who were more likely to live in mortgaged accommodation (and thus be relatively affluent) could be divided into two clusters, one with a low probability of having achieved educational qualifications higher than O levels, the other with a higher probability of having achieved such qualifications. Maternal educational level was therefore used as a means of identifying any relation between social status and health that was not accounted for by housing tenure. "Crowding" was measured, in common with other similar studies of infant health,[27 29] using the two variables number of persons per room and the parity of the mother, which was taken as indicative of the presence or absence of siblings in the household.

Parity was measured at 18 weeks gestation and maternal educational level at 32 weeks; housing tenure and number of persons per room were measured at 8 months after the birth.

Table 1 Characteristics of the sample of 8501 infants

		Number	*%*
Deprivation variables			
Housing tenure	Mortgaged/owned	6808	80.1
	Rented/other	1693	19.9
Mother's highest educational qualification	O level or lower	5168	60.8
	Higher than O level	3333	39.2
Housing variables			
Ratio of persons per room	≤1 person per room	7503	88.3
	>1 person per room	998	11.7
Parity	1	3833	45.1
	2	3045	35.8
	3+	1623	19.1
Behavioural variables			
Mother smoked at 8 months postpartum	No	6668	78.4
	Yes	1833	21.6
Duration of breast feeding	Never	1930	22.7
	<3 months	2712	31.9
	3 or more months	3859	45.4
Symptoms			
Wheezing	No	6885	81.0
	Yes	1565	18.4
	Missing	51	0.6
Number of incidents of wheeze	1 or 2	669	42.7
	3 or more	439	28.1
	Missing/unknown	457	29.2
Diarrhoea	No	6248	73.5
	Yes	2240	26.3
	Missing	13	0.2
Number of days of worst bout	1 to 5 days	1837	82.0
	6 or more days	327	14.6
	Missing	76	3.4

MATERNAL BEHAVIOURS

Breast feeding was measured using responses to questions at 6 months after birth about whether the infant was breast fed and, if so, how long breast feeding was continued. Answers to these questions were categorised according to whether breast feeding was the choice of feeding method and, if so, the length of time that the baby had been breast fed. Smoking behaviour was measured by responses to a question asked when the infant was 8 months old about how many cigarettes were smoked daily.

Analysis

The variables housing tenure, overcrowding, parity, mother's educational level, breast feeding and its duration, and maternal smoking were used in a series of logistic regression analyses to assess their association with the prevalence of wheeze. Similar analyses were performed in relation to the prevalence of diarrhoea, this time excluding maternal smoking, as there was no a priori aetiological explanation for an association between maternal smoking and diarrhoea in infancy. Analyses were repeated using the severity of wheeze and the duration of the worst episode of diarrhoea as the outcome measures. In these analyses only a measure of the duration of breast feeding was used, as it is the continuance of breast feeding, rather than having breast fed or not, that is most likely to have a protective effect. Two different approaches were used in the logistic regression analyses that acted as a check for one another. The first (regression analysis I) was based on the assumption that each of the explanatory variables included in the analysis had a direct effect on the outcome under consideration and that this effect was not mediated through any other variables in the model. All the variables were thus entered into the model together and each was considered to be a possible confounder for all the others; individual factors were therefore adjusted for all the other factors in the model when considering their relation to the outcome measure. However, while a confounder should be associated with the exposure under study and also be predictive of disease occurrence, it should not be a mediating factor, that is a link in the causal chain leading from the postulated risk factor to the outcome.[34] In this case it would be incorrect to suggest that if a factor became non-significant after adjusting for confounders, that this factor had no effect on the outcome. Rather, this could arise because the effect was underestimated because of the confounders actually having a mediating relation between the explanatory variable and the outcome.[34] The second regression analysis (regression analysis II) took account of this by constructing a conceptual hierarchical framework[34]; it was reasoned that deprivation could directly or indirectly affect crowding and maternal behaviour and so in this analysis these factors were regarded as potential mediators of the relation between deprivation and the outcome under study, rather than confounders. The first model (model A) thus included the deprivation variables and was used to assess the overall effect of housing tenure and mother's educational level on the prevalence and the severity of wheeze and the prevalence and the persistence of diarrhoea. The second model (model B) included the crowding variables as well as the deprivation variables; the model was used to assess the overall effect of overcrowding and parity on the outcomes after adjusting for the appropriately defined confounders housing tenure and mother's educational level. The third model (model C) included the behavioural variables in addition to the deprivation variables and the crowding variables; this was used to assess the overall effect of the duration of breast feeding and maternal smoking on wheeze and the duration of breast feeding on diarrhoea after adjusting for all four confounding variables. In model C, any residual effect of deprivation is that part that is not mediated through maternal behaviour or crowding. In fact model C was identical to that produced by regression analysis I.

Results

Table 1 displays the characteristics of the sample according to the explanatory variables indicative of deprivation, crowding, and maternal behaviours and the outcome measures of wheeze with whistling on the chest and diarrhoea. The majority of the sample lived in mortgaged (80.1%) and uncrowded (88.3%) accommodation, with mothers who were qualified up to O level (60.8%) and being either the first (45.1%) or the second (35.8%) child in the family. A total of 77.3% of the sample were breast fed for some period in the first three months after birth, 45.4% being breast fed for over three months. Some 21.6% of mothers reported smoking at 8 months postpartum. Wheeze with whistling on the chest was reported for 18.4% of the sample with 5.2% having three or more episodes of wheeze in the first six months after birth. Diarrhoea was reported for 26.3% of the sample with 3.8% having a bout that persisted for six or more days.

Table 2 Logistic regression analyses showing the relation between the prevalence of wheeze and deprivation, crowding, and maternal behaviour for 8450 infants at 6 months after birth

		Regression analysis I (where all explanatory variables are treated as confounders) Adjusted odds ratios (95% CI)	*Regression analysis II (only adjusting for true confounders) Adjusted odds ratios (95% CI)*
Deprivation variables			*Model A*
Housing tenure	Mortgaged/owned	1.00 reference	1.00 reference
	Rented/other	1.20 (1.04, 1.39)	1.45 (1.28, 1.66)
	χ^2 (1) P	6.3 (p=0.0123)	30.3 (p<0.0001)
Mother's educational level	O level or lower	1.00 reference	1.00 reference
	Higher than O level	1.08 (0.95, 1.22)	0.89 (0.79, 1.00)
	χ^2 (1) P	1.4 (p>0.05)	3.6 (p>0.05)
Crowding variables			*Model B*
Ratio of persons per room	≤1 person per room	1.00 reference	1.00 reference
	>1 person per room	1.26 (1.06, 1.49)	1.30 (1.10, 1.54)
	χ^2 (1) P	6.8 (p=0.0089)	9.1 (p=0.0026)
Parity	1	1.00 reference	1.00 reference
	2	1.49 (1.31, 1.69)	1.50 (1.32, 1.70)
	3+	1.78 (1.52, 2.07)	1.77 (1.52, 2.06)
	χ^2 (2) P	65.3 (p<0.0001)	66.3 (p<0.0001)
Behavioural variables			*Model C*
Mother smokes	No	1.00 reference	1.00 reference
	Yes	1.38 (1.21, 1.58)	1.38 (1.21, 1.58)
	χ^2 (1) P	22.1 (p<0.0001)	22.1 (p<0.0001)
Duration of breast feeding	Never	1.00 reference	1.00 reference
	<3 months	0.79 (0.68, 0.91)	0.79 (0.68, 0.91)
	3 or more months	0.68 (0.59, 0.79)	0.68 (0.59, 0.79)
	χ^2 (2) P	25.7 (p<0.0001)	25.7 (p<0.0001)

Model A only includes the deprivation variables. Odds ratios for model A show the overall effect of the deprivation variables (that is, not adjusted for the "crowding" and behavioural variables).
Model B includes the deprivation variables and the "crowding" variables. The odds ratios in the table show the overall effect of the crowding variables (that is, not adjusted for the behavioural variables but appropriately adjusted for the deprivation variables).
Model C includes the deprivation variables, crowding variables, and the behavioural variables. The odds ratios show the overall effect of the behavioural variables (appropriately adjusted for the "crowding" and deprivation variables).

PREVALENCE OF WHEEZE (TABLE 2)

Table 2 shows the results of the regression analyses for which the prevalence of wheeze was the main outcome measure. In regression analysis I all factors apart from maternal education were associated with wheeze. Wheeze was significantly more likely if an infant lived in rented accommodation (odds ratios (OR)=1.20), 95% confidence intervals (CI) = 1.04, 1.39), if there was more than one person per room (OR=1.26, 95% CI = 1.06, 1.49), if there was another child in the family, particularly if there were three or more children (OR=1.78, 95% CI = 1.52, 2.07), and if the mother smoked (OR=1.38, 95% CI = 1.21, 1.58). Wheeze was significantly less likely if the mother breast fed, particularly for three or more months (OR=0.68, 95% CI = 0.59, 0.79). In regression analysis II there was no change in these relations, but the effect of housing tenure increased, when it was not adjusted for crowding variables and maternal behaviours such as smoking and breast feeding. This suggests that the role of housing tenure was underestimated in regression analysis I.

SEVERITY OF WHEEZE (TABLE 3)

When the same analyses were performed using the severity of wheeze as the main outcome measure, the only significant relation was with the duration of breast feeding; those infants for whom wheeze had been reported and who had

Table 3 Logistic regression analyses showing the relation between the severity of wheeze and deprivation, crowding, and maternal behaviour for 1108 infants with a history of wheezing at 6 months after birth

		Regression analysis I (where all explanatory variables are treated as confounders) Adjusted odds ratios (95% CI)	*Regression analysis II (only adjusting for true confounders) Adjusted odds ratios (95% CI)*
Deprivation variables			*Model A*
Housing tenure	Mortgaged/owned	1.00 reference	1.00 reference
	Rented/other	1.00 (0.73, 1.37)	1.11 (0.84, 1.48)
	χ^2 (1) P	0.0 (p>0.05)	0.6 (p>0.05)
Mother's educational level	O level or lower	1.00 reference	1.00 reference
	Higher than O level	0.89 (0.68, 1.18)	0.81 (0.62, 1.05)
	χ^2 (1) P	0.7 (p>0.05)	2.6 (p>0.05)
Crowding variables			*Model B*
Ratio of persons per room	≤1 person per room	1.00 reference	1.00 reference
	>1 person per room	1.15 (0.80, 1.66)	1.17 (0.81, 1.68)
	χ^2 (1) P	0.6 (p>0.05)	0.7 (p>0.05)
Parity	1	1.00 reference	1.00 reference
	2	1.00 (0.76, 1.32)	0.99 (0.75, 1.31)
	3+	1.21 (0.87, 1.68)	1.19 (0.85, 1.65)
	χ^2 (2) P	1.5 (p>0.05)	1.4 (p>0.05)
Behavioural variables			*Model C*
Mother smokes	No	1.00 reference	1.00 reference
	Yes	1.04 (0.78, 1.39)	1.04 (0.78, 1.39)
	χ^2 (1) P	0.1 (p>0.05)	0.1 (p>0.05)
Duration of breast feeding	Never/ < 3 months	1.00 reference	1.00 reference
	3 or more months	0.76 (0.58, 0.99)	0.76 (0.58, 0.99)
	χ^2 (2) P	4.3 (p=0.0388)	4.3 (p=0.0388)

See table 2 for footnotes.

Table 4 Logistic regression analyses showing the relation between the prevalence of diarrhoea and deprivation, crowding, and maternal behaviour for 8488 infants at 6 months after birth

		Regression analysis I (where all explanatory variables are treated as confounders) Adjusted odds ratios (95% CI)	*Regression analysis II (only adjusting for true confounders) Adjusted odds ratios (95% CI)*
Deprivation variables			*Model A*
Housing tenure	Mortgaged/owned	1.00 reference	1.00 reference
	Rented/other	1.25 (1.10, 1.41)	1.41 (1.25, 1.59)
	χ^2 (1) P	11.9 (p=0.0006)	32.1 (p<0.0001)
Mother's educational level	O level or lower	1.00 reference	1.00 reference
	Higher than O level	0.99 (0.88, 1.10)	0.76 (0.69, 0.84)
	χ^2 (1) P	0.1 (p>0.05)	27.7 (p<0.0001)
Crowding variables			*Model B*
Ratio of persons per room	⩽1 person per room	1.00 reference	1.00 reference
	>1 person per room	1.10 (0.94, 1.29)	1.16 (1.00, 1.36)
	χ^2 (1) P	1.4 (p>0.05)	3.6 (p>0.05)
Parity	1	1.00 reference	1.00 reference
	2	0.95 (0.85, 1.06)	0.95 (0.85, 1.06)
	3+	1.10 (0.96, 1.27)	1.04 (0.91, 1.20)
	χ^2 (2) P	4.2 (p>0.05)	1.9 (p>0.05)
Behavioural variables			*Model C*
Duration of breast feeding	Never	1.00 reference	1.00 reference
	<3 months	0.82 (0.72, 0.93)	0.82 (0.72, 0.93)
	3 or more months	0.42 (0.37, 0.48)	0.42 (0.37, 0.48)
	χ^2 (2) P	198.0 (p<0.0001)	198.0 (p<0.0001)

See table 2 for footnotes.

Table 5 Logistic regression analyses showing the relation between the duration of the "worst bout" of diarrhoea and deprivation, crowding, and maternal behaviour for 2164 infants for whom diarrhoea was reported at 6 months after birth

		Regression analysis I (where all explanatory variables are treated as confounders) Adjusted odds ratios (95% CI)	*Regression analysis II (only adjusting for true confounders) Adjusted odds ratios (95% CI)*
Deprivation variables			*Model A*
Housing tenure	Mortgaged/owned	1.00 reference	1.00 reference
	Rented/other	1.29 (0.97, 1.70)	1.34 (1.03, 1.75)
	χ^2 (1) P	3.1 (p>0.05)	4.5 (p=0.0335)
Mother's educational level	O level or lower	1.00 reference	1.00 reference
	Higher than O level	1.06 (0.80, 1.39)	0.95 (0.73, 1.23)
	χ^2 (1) P	0.2 (p>0.05)	0.1 (p>0.05)
Crowding variables			*Model B*
Ratio of persons per room	⩽1 person per room	1.00 reference	1.00 reference
	>1 person per room	0.97 (0.68, 1.39)	0.99 (0.69, 1.41)
	χ^2 (1) P	0.0 (p>0.05)	0.0 (p>0.05)
Parity	1	1.00 reference	1.00 reference
	2	1.22 (0.93, 1.60)	1.22 (0.93, 1.61)
	3+	1.43 (1.04, 1.97)	1.41 (1.02, 1.94)
	χ^2 (2) P	5.1 (p>0.05)	4.8 (p>0.05)
Behavioural variables			*Model C*
Duration of breast feeding	Never/ <3 months	1.00 reference	1.00 reference
	3 or more months	0.75 (0.56, 0.99)	0.75 (0.56, 0.99)
	χ^2 (2) P	4.2 (p=0.0395)	4.2 (p=0.0395)

See table 2 for footnotes.

been breast fed for more than three months were significantly less likely to have had three or more episodes of wheeze in the first six months after birth (OR=0.76, 95% CI = 0.58, 0.99). There was no change in this result when crowding and behavioural variables were treated as possible mediators of deprivation rather than confounders in regression analysis II.

PREVALENCE OF DIARRHOEA (TABLE 4)

In regression analysis I it was found that those infants living in rented accommodation were significantly more likely to have had diarrhoea in the first six months after birth (OR=1.25, 95% CI = 1.10, 1.41); breast fed infants were significantly less likely to have had diarrhoea, especially if they had been breast fed for three or more months (OR=0.42, 95% CI = 0.37, 0.48). In regression analysis II maternal education became significant, with infants of women who were educated to above O level standard being significantly less likely to have diarrhoea (OR=0.76, 95% CI = 0.69, 0.84). The suggests that the effect of this variable was underestimated in regression analysis I .

PERSISTENCE OF DIARRHOEA (TABLE 5)

In regression analysis I, the only factor significantly associated with the persistence of diarrhoea for those infants for whom diarrhoea had been reported, was the duration of breast feeding; infants who were breast fed for three or more months were significantly less likely to have had an episode of diarrhoea lasting for six or more days (OR=0.75, 95% CI = 0.56, 0.99). In regression analysis II housing tenure became an additional risk factor, with infants living in rented accommodation being significantly more likely to have had an episode of diarrhoea lasting six or more days (OR=1.34 95% CI = 1.03, 1.75). The role of this factor was thus underestimated in regression analysis I.

Discussion

The purpose of this study was to assess the impact of adverse social conditions on infant morbidity in the 1990s compared with that of maternal behaviours such as smoking and breast feeding. The historical context of this research is that improved social conditions, together with smaller family size have reduced

exposure to infection and increased host resistance to disease in infancy: hence the sharp decline in infant mortality. These changes have been accompanied by a rise in maternal behaviours such as smoking and formula feeding for mothers living in deprived circumstances; these behaviours are associated with increased respiratory illness and reduced resistance to infection in infancy, which could counterbalance the ameliorative effect of improved social conditions for infant health.

The association between the deprivation, crowding, and behavioural variables used in this study and infant morbidity in the first six months after birth was dependent on the condition studied and on whether the outcome being considered was its prevalence or its severity. For wheeze all factors apart from maternal education were independently associated with prevalence and so wheeze was more likely to be reported if the infant lived in rented accommodation, if there was more than one person per room, if there were other children in the household, if the mother smoked, or if the mother did not breast feed her infant. These findings exactly replicate those of a smaller scale study in which the infants were from families with one or more atopic members.[29] The association of crowding variables with higher prevalence and breast feeding with lower prevalence of wheeze supports the increasing volume of evidence suggesting that wheeze in early childhood is more commonly the consequence of viral infection rather than allergy.[35] It is interesting in this regard that the presence of three or more siblings in the household, taken as an indicator of crowding, was independent of living in rented accommodation as a risk factor for wheeze, suggesting that the consequences of larger family size for respiratory health in infancy are not necessarily concomitant with those of deprivation in the 1990s.

The severity of wheeze, as determined by the number of episodes in the first six months after birth, was however only related to the duration of breast feeding, so that for infants for whom wheeze was reported, those who were breast fed for three or more months had fewer episodes of wheeze. This supports evidence suggesting that the protective effect of breast feeding extends beyond the first few months of life and shows that even if adverse social conditions have led to wheeze, its severity is likely to be reduced by the practice of breast feeding. These findings contrast with other studies in which severity as well as the prevalence of wheeze was measured[16–18] in relation to socioeconomic status. In these studies lower socioeconomic status was associated with severity, but not with prevalence. The most plausible explanation for this is that the populations studied were school age children for whom recurrent wheeze is most likely to be an indication of asthma. Social conditions or infections may well trigger individual episodes for children of this age, but such factors are unlikely to account for the presence or the absence of the condition.

KEY POINTS

- A higher prevalence of wheeze and diarrhhoea in infancy is associated with deprivation in England in the 1990s.
- Maternal smoking is also an independent risk factor for wheeze in infancy.
- The evidence presented suggests that breast feeding protects against both wheeze and diarrhoea and minimises their severity and duration.
- Changing maternal behaviour and improving living conditions are priorities for reducing inequality in health in infancy in the 1990s.

For diarrhoea, deprivation and maternal behaviours were related to prevalence, but the crowding factors were not significant; diarrhoea was more prevalent if the infant lived in rented or council house accommodation, and for those infants who were not breast fed. This contrasts with patterns of mortality from diarrhoea in the 1920s and 30s when it was crowding that constituted the most significant risk factor for diarrhoea.[27] It is thus likely that the extent of overcrowding in the 1990s is not severe enough to generate the insanitary and unhygienic living conditions associated with infant mortality in the earlier part of the century and with morbidity in the developing countries of the world today. In common with countries of the developing world the duration of an episode of diarrhoea was associated with breast feeding[36]; those infants with diarrhoea who were breast fed for three or more months were less likely to have an episode of diarrhoea that lasted six or more days.

The robustness of the results reported in this study have been considered in relation to both the methods used and the analysis adopted. Prevalences of wheeze (18.4%) and diarrhoea (26.3%) were in accordance with estimates derived from other geographical locations in the UK and other countries in the developed world.[16–18 28 37] These prevalences were drawn from maternal report of infant morbidity, which is the best available method for gathering population data on the prevalence of common symptoms in early childhood, the majority of which will not see the inside of the doctor's surgery. Maternal report of infant symptoms in the first year of life has been shown in smaller scale studies to be a sensitive proxy for clinical diagnosis.[38 39] Some bias could have been introduced into estimates of prevalence as a consequence of the fact that poorer families were likely to be under represented in the ALSPAC sample. This would have meant that prevalence was, if anything, under rather than overestimated for diarrhoea and wheeze. The measurement of severity for wheeze, recording the number of separate episodes, was not completed by the whole of the selected sample; almost a third (29.6%) of those reporting wheeze for their infants in the first six months of life did not complete the section on the number of episodes. There was no significant

difference between those who did and those who did not complete this part of the questionnaire in terms of housing tenure, maternal education, overcrowded living conditions, maternal smoking, and feeding practice. However not replying to this question was significantly associated with parity, those not replying being more likely to have three or more children (χ^2 = 7.3, df=2, p= <0.03); this could have reduced the effect of parity as a factor associated with the severity of wheeze. It could be argued that details about the number of episodes of wheeze would be less likely to be completed for infants with more severe wheeze, because they had so many episodes that there was no attempt to estimate the number. This could not be directly assessed by questionnaire material; however infants for whom the number of episodes of wheeze were reported were significantly more likely to also have breathlessness and to have been taken to the general practitioner with their symptoms (χ^2 = 11.6, df=1, p = < 0.001) when compared with those for whom this information was missing. This would suggest that the question about number of episodes of wheeze was completed for those infants with more severe wheeze.

The use of a conceptual hierarchical framework in the logistic regression analyses highlighted an interpretative point that is often not considered when such methods of statistical modelling are used. This was the extent to which it was appropriate to treat all the explanatory variables—deprivation, crowding, and maternal behaviour variables—as if they were on the same hierarchical level and thus confounding of one another, or whether the crowding and behavioural variables were more appropriately treated as mediators in the relation between deprivation and the measures of health outcome. The use of both of these approaches showed clear examples of the different results they are likely to produce. For instance housing tenure was not significantly associated with the persistence of diarrhoea when the deprivation, crowding, and behavioural variables were treated as if they were confounding of one another in regression analysis I; this relation did however become significant when crowding and behavioural variables were treated as possible mediators of housing tenure in regression analysis II. It is important therefore that consideration is given to the hierarchical relation between such explanatory variables and to its implications for their treatment in logistic regression modelling.

The findings of this study show the "causal complexity" of inequality in morbidity in infancy in a developed country such as Britain in the 1990s. They illustrate that deprivation, while no longer associated with high levels of premature mortality in infancy, continues to be associated with poorer infant health in the first six months after birth; the actual social conditions underlying this relation require further clarification. The results also show the importance of maternal behaviours such as smoking in its association with wheeze in infancy, and breast feeding as being the factor most consistently associated with a reduction in the severity of wheeze and the duration of diarrhoea. Future research and health policy could benefit from distinguishing more clearly between the influence of deprivation and that of maternal behaviours on infant health. Maternal behaviours such as smoking and artificial infant feeding should not, in general, be considered to be the natural consequence of deprivation; indeed there is little evidence of any difference between manual and non-manual occupational classes in these behaviours until the 1960s and 70s.[40–43] But they are practices that have now become entrenched in the culture of disadvantage and inevitably serve to exacerbate the consequences of poor living conditions on infant health. Health education has so far failed to initiate and maintain change in the contemporary social patterning of these behaviours that could lead to greater equality in health in infancy. Understanding why this is the case—and designing health policy accordingly—should be at the core of any agenda to reduce inequality in health in infancy; demands for concerted action to alleviate deprivation in Britain in the 1990s[44] necessarily require constant re-iteration.

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Appendix

Questions asked about infant morbidity at six months after birth

Wheeze

Has your baby ever had wheezing with whistling on his/her chest when he/she breathed?

Yes□No □

How many separate times has this happened?

once□ twice□ 3–4 times□ 5 or more times□ don't know

Diarrhoea

Has your baby ever had diarrhoea or gastroenteritis?

Yes□No □

How many days did the worst bout last? □ □

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