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the OPCS Longitudinal Study of England and Wales, 1971-87**

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Introduction

Women's circumstances in utero, infancy and childhood appear to have an effect upon their own reproductive outcomes. Aside from genetic influences, the strong positive association between maternal height and offsprings' size at birth is regarded as evidence of the effect of cumulative nutritional status on a woman's reproductive performance. Socio-economic circumstances in childhood have also been related to women's birth outcomes. Illsley ¹ in his classic study of Aberdeen primagravidas in the early 1950s, showed that the social class of a woman's father had an effect upon her risk of having both a stillbirth or early neonatal death, that was independent of the social class of her husband. This result was subsequently confirmed in an analysis of a national sample of births occurring in 1958 ².

Since the 1950s however, mortality rates in the first year of life have declined dramatically in Britain. Moreover, the childhood conditions of most women born since 1950 will have been much better than those prevailing in earlier decades. We undertook an analysis of births occurring 1971-87 among women born in 1955 or later to see if maternal circumstances in childhood were related to mortality rates in infancy in this more recent period.

Subjects and methods

The OPCS Longitudinal Study (LS) involves the linkage of census records to records of vital events, including birth and death registrations, for a one percent sample of the population of England and Wales. All individuals born on one of four dates spread evenly throughout the year and enumerated at the 1971 Census comprised the initial sample. The present paper focuses upon infant mortality (1971-88) among singleton, live births born 1971-87 among LS women who were enumerated at the 1971 Census when they were children (ie were aged less

than 16) and who were subsequently enumerated at the 1981 Census. This group is part of a larger subset of the female LS population, for whom information on births and infant deaths registered in England and Wales have been linked together³.

Prior to 1 January 1975, the linkage of infant deaths to births was done using an ad hoc system based on date of birth of mother. Linkage rates for this first period were not as high as subsequently, when a national system for the routine linkage of births to infant deaths was implemented⁴. As this system achieves linkage rates close to 100%, the recording of infant deaths in the LS may be regarded as essentially complete³.

Information from three separate sources has been used in the analysis. Age of mother at the birth of each infant was as recorded at birth registration. The parity of the mother at each birth was determined from the number of previous live and still births linked to the mother; parity as recorded at birth registration was not used, in part because it was not available for births outside of marriage. The socio-economic circumstances of the mother at the birth of each child was classified using the Registrar General's social class of the father recorded at birth registration. When the father registered the birth with the mother, their social class was categorised as non-manual (RG classes I-IIINM), manual (RG classes IIIM-V) and 'other' (occupation inadequately described, not stated). Women who registered their child alone (sole registrations) constituted a fourth category.

Maternal circumstances in childhood were characterised using data on the household in which the LS women was enumerated at the 1971 Census. Where the woman's father could be identified in the household, her childhood circumstances were classified according to her

father's Registrar General's social class (non-manual, manual and 'other') on the same basis as specified above for social class at birth registration. Where the father could not be found in the household, three further categories of childhood circumstances were defined : those enumerated in a private household where the woman's relationship to the head of household was either daughter, granddaughter or niece (no father in family household); those enumerated in any other private household (no father in non-family household); those enumerated in a non-private household such as a hospital, hotel or children's home (institution).

Deaths were divided into those occurring within 28 days of birth (neonatal deaths) and those occurring subsequently up to 1 year of age (postneonatal deaths). Age at death was determined from date of birth at birth registration and date of death from death registration. Crude neonatal and postneonatal rates per 1000 live births were calculated using total live births as the denominator. The simultaneous effects of the various explanatory variables were estimated using unconditional logistic regression ⁵, where the binomial denominator for the neonatal period was all live births, and for the postneonatal period all live births surviving up to and including 28 days. Tabulations and modelling was carried out using the STATA statistical package ⁶.

Results

The distribution of live births, neonatal and postneonatal deaths are shown in table 1. Because the women included in the analysis were aged less than 16 in 1971, the number of births per 5-year period increases steeply with time, such that over 70% of the births occur in the latter 7 years. The distribution of live births by maternal age confirms this, 70% of them being to mothers aged less than 25 years at the birth of their child. For the same reason, the parity

distribution is weighted heavily towards the nulliparous. The distribution of live births by social class at registration parallels the distribution by maternal circumstances in childhood, in that similar proportions are allocated to non-manual, manual and 'other' social classes.

Among the 36519 singleton live births included there were 229 neonatal and 136 postneonatal deaths, corresponding to overall risks of 6.3 and 3.8 deaths per thousand live births respectively. As seen in table 1, the risk of neonatal and postneonatal death declines with time from 1971 Census. Decline in risk is also apparent with increasing maternal age, apart from the high risk of postneonatal death among infants born to mothers aged 30+, although this is based on only 6 deaths. Consistent with what is commonly observed in national data, postneonatal mortality is seen to increase with parity, while neonatal mortality is not so strongly associated with this factor. The increase in risks with declining social class at birth registration in the neonatal and postneonatal periods, with the highest risks being for infants registered solely by their mothers, is also broadly consistent with what is usually found.

The striking thing about maternal circumstances in childhood, as measured at the 1971 Census, is that this factor appears to have little impact upon neonatal mortality, while it is strongly associated with postneonatal mortality. The socio-economic effects are made more evident in table 2, where they are presented as odds ratios relative to risks in the non-manual categories, having adjusted for the potential confounding effect of the steep decline in infant mortality over the period of observation. The effect of social class at birth registration on neonatal mortality is very similar to that on postneonatal mortality, the odds ratios for sole registrations being around two in both cases, with confidence intervals that exclude 1.00. The effect of maternal circumstances in childhood upon postneonatal mortality is strong, all

categories having odds ratios that are appreciably above 1.00. In three instances the confidence intervals exclude 1.00 : births to mothers whose own fathers were manual workers, those living with immediate relatives but whose father could not be identified at Census, and those enumerated in institutions/non-private households.

As neonatal mortality does not appear to be associated with childhood circumstances of the mother, the remaining analyses examine further the strong associations with postneonatal mortality. In tables 3 and 4, the effects on postneonatal mortality of social class at birth registration, and of maternal childhood circumstances, are presented mutually adjusted for each other and for parity, maternal age at birth and period from Census to birth. For social class at birth registration (table 3), adjustment for each set of factors reduces the odds ratios compared to those shown in table 2, such that on adjustment for all simultaneously, only infants whose births were solely registered have an odds ratio above 1.00. In contrast, the postneonatal odds ratios for maternal childhood circumstances (table 4) change relatively little; adjustment for social class at birth registration having a minor effect. Adjustment for parity and maternal age at birth has a larger impact upon the odds ratios, suggesting that the effect of maternal childhood circumstances on postneonatal mortality are partly mediated through determining the time and number of pregnancies. The fully adjusted odds ratios in table 5, however, still show appreciable effects of maternal childhood circumstances some of which are unlikely to be due to chance.

Given that maternal circumstances in childhood were assessed at the 1971 Census, these Census characteristics might have a different significance according to the mother's age at this point. This possibility is examined in table 5, where the postneonatal odds ratios for maternal

childhood circumstances are shown stratified by age at 1971 Census. Dividing the data up in this fashion leads to rather imprecise estimates of effect. However, it is apparent that the effects of maternal childhood circumstances on postneonatal mortality appear to be similar among those aged 0-10 at Census and those aged 11-15.

Discussion

Our data show that a woman's circumstances in her own childhood can affect the risk of death of her own offspring between the ages of 1 to 11 months. These effects are independent of her socio-economic situation at the birth of her child, as characterised by the social class of the father of her child. Only part of this effect appears to be mediated through differences in numbers of births and the age at which a woman has her children.

The overall rate of infant mortality in the sub-sample of births selected for study is lower than found nationally in the corresponding period, despite the fact that the OPCS Longitudinal Study itself is a pseudo-random sample of the population of England and Wales. This difference is in part attributable to the fact that to be in the sub-sample we have analysed, women had to have been enumerated at the 1971 Census. We have thus excluded women entering Britain in the 1970s, many of whom were born in the New Commonwealth and Pakistan, and experience higher infant mortality than women born in the United Kingdom³. As well as reducing the overall rate of infant mortality in our sub-sample, this may also result in the effect of social class at birth registration being reduced compared to the national picture.

The sub-sample of women are also not representative of all births in England and Wales over the period in terms of maternal age and parity. Our data is weighted strongly towards

nulliparous births, and those occurring to women aged less than 25 years, because of the restriction that mothers had to have been less than 16 years of age at the 1971 Census. Examination of national data for the period suggests that neonatal social class gradient is strongest among women of parity 0 or 1, while the postneonatal gradient is strongest among women of high parity. These opposite tendencies may explain, given the parity composition of our data, why the postneonatal gradients by social class at birth registration are not as steep as seen nationally, and moreover are similar to those in the neonatal period, contrary to the national data in which the social class at registration gradients is steeper in the postneonatal than in the neonatal period⁷.

The measure of maternal circumstances in childhood that we have used combines information on the social class of the mother's father, and the nature of the household in which the woman was enumerated in at the 1971 Census. For women who were enumerated in the same household as their father, the use of father's social class follows the same approach as used in earlier similar analyses^{1,2}. However, 10% of births were to women who were not enumerated in the same household as their father. Most of these women lived in households where a close relative (other than the father) was the head of household - in most cases this being the mother. The final category covers women who were enumerated in a non-private household/institution. In this analysis we had insufficient numbers to distinguish between types of institution. However, overall at the 1971 Census, 1% of girls aged less than 15 were enumerated in non-private households. Of these, 19% were in children's homes, 23% were in hospitals (mainly accounted for by children in the first few years of life), and 27% were in 'educational establishments'⁸. The distribution of type of institution in our sub-sample of women who gave birth in the period 1971-87 may well be different to this, as it is unlikely that

the pattern of fertility is the same in each of these groups.

How may we explain the effects of maternal childhood circumstances on postneonatal mortality, and the contrasting lack of effect on mortality in the first month of life ? Is it because a woman's background, including her own experience in utero, influences her reproductive performance, and the health and viability of her offspring at birth ? There is evidence that birth outcome is influenced by factors operating across generations. Women who were themselves small for gestational age are at increased risk of delivering growth-retarded or preterm infants ⁹, and the birthweight of mothers are positively correlated with the birth weight of their offspring ¹⁰. However, it is unlikely that the mechanisms underlying these intergenerational effects could explain what we observe. Any effects mediated through size at birth would be expected to produce larger effects in the neonatal than in the postneonatal period (contrary to what we observe), as it is in the first month of life that birth weight is most strongly related to infant survival⁷.

An alternative explanation is that family circumstances of a mother in her childhood are powerful predictors of her behaviour and home circumstances in which her new born infant is raised. It has long been recognised ¹¹, that home environment, the nature of which is peculiarly sensitive to socio-economic factors, is a far more important determinant of infant survival in the postneonatal period than at younger ages. The fact that these childhood effects persist after adjusting for social class of father at birth registration indicates that this latter measure, although strongly associated with postneonatal mortality, is only a crude measure of the character of the infant's postnatal home environment.

Superficially, our results are at odds with the work conducted in the 1950s to look at the effect of family of origin on infant survival^{1,2}. These studies found strong effects of social class of origin upon stillbirth rates and perinatal mortality, but did not report any effects for the postneonatal period. However, it is possible that for the generation of women who gave birth in the 1950s or earlier, their childhood circumstances could have effected their growth and wellbeing in such a way as to in turn effect the size, viability and survival of their offspring in utero and in the immediate postnatal period¹². In contrast, the variation in family circumstances that existed in our cohort of women, born in 1955 or later, may not have been sufficiently acute to lead to measurable variations in reproductive efficiency and performance. The persistence of differences in neonatal mortality by social class at birth registration, rather than family of origin, may reflect a residual effect of differential access to and take up of prenatal and obstetric care. A parallel version of this argument has been put forward to explain the disappearance of socio-economic differences in neonatal mortality in Sweden, alongside the persistence of differences in the postneonatal period¹³. In Sweden, women of different backgrounds may not vary much in terms of reproductive efficiency or access to good health care during pregnancy. However, the character of their home environment, including factors such as smoking, may still vary appreciably according to socio-economic circumstances in childhood.

The notion of transmission of behaviours and home circumstances as an explanation for social variation in birth outcome, has been proposed before¹². It is consistent not only with the differences between the survival of infants born to mothers who come from manual compared to non-manual backgrounds, but also with our finding that those mothers who were enumerated in institutions at the 1971 Census have children who are at particularly high risk of

death in the postneonatal period. This group of women is clearly heterogeneous, as discussed above. However, it may be that the excess is in particular contributed by women who were in children's homes or other institutions because of disturbances or difficulties in their biological family of origin. This question deserves further investigation.

Finally, although postneonatal mortality is even lower today than it was in the period we have analysed, it is very likely that less fatal variations in health of infants are associated with adverse home environments in similar ways. Policies designed to reduce social differences in infant health need therefore to take account of this transmission of disadvantage from one generation to the next.

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Table 1 - Live births, neonatal and postneonatal mortality (per 1000 live births) 1971-88 among women in the OPCS Longitudinal Study enumerated at the 1971 Census aged less than 16

	Number of live births	Neonatal mortality		Postneonatal mortality	
	N (%)	N	Risk/1000	N	Risk/1000
Period 1971 Census to birth (years)					
0-4	1532 (4.2)	27	17.6	14	9.1
5-9	8886 (24.6)	74	8.3	25	2.8
10-14	16581 (45.9)	84	5.1	61	3.7
15-16	9160 (25.3)	44	4.8	36	3.9
Maternal age at birth					
15-19	7624 (21.1)	77	10.1	43	5.6
20-24	17008 (47.0)	99	5.8	55	3.2
25-29	10421 (28.8)	49	4.7	30	2.9
30+	1106 (3.1)	4	3.6	8	7.2
Parity at birth					
0	20738 (57.4)	134	6.5	50	2.4
1	11245 (31.1)	61	5.4	65	5.8
2	3262 (9.0)	26	8.0	15	4.6
3+	914 (2.5)	8	8.8	6	6.6
Social class at birth registration					
Non-manual	8818 (24.4)	40	4.5	29	3.3
Manual	22565 (62.4)	145	6.4	78	3.5
Other	1377 (3.8)	7	5.1	5	3.6
Sole registration	3399 (9.4)	40	4.5	24	7.1
Maternal circumstances in childhood at 1971 Census					
Father : non-manual	7437 (20.6)	47	6.3	16	2.2
Father : manual	23332 (64.5)	150	6.4	91	3.9
Father : other	1339 (3.7)	10	7.5	6	4.5
No father in family household	2984 (8.3)	15	5.0	17	5.7
No father in non-family household	622 (1.7)	4	6.4	2	3.2
Institution	445 (1.2)	3	6.7	4	9.0
Total	36159 (100.0)	229	6.3	136	3.8

Table 2 - Odds ratios (95% confidence intervals) for neonatal and postneonatal death by social class at birth registration and maternal circumstances in childhood at the 1971 Census, adjusted for period between 1971 Census and birth, OPCS Longitudinal Study, 1971-88

	Neonatal mortality	Postneonatal mortality
Social class at birth registration		
Non-manual	1.00	1.00
Manual	1.27 (0.89 - 1.82)	1.05 (0.68 - 1.62)
Other	1.04 (0.46 - 2.33)	1.09 (0.42 - 2.82)
Sole registration	1.96 (1.24 - 3.11)	2.05 (1.17 - 3.57)
Maternal circumstances in childhood at 1971 Census		
Father : non-manual	1.00	1.00
Father : manual	0.95 (0.66 - 1.33)	1.81 (1.06 - 3.07)
Father : other	1.07 (0.54 - 2.14)	2.08 (0.81 - 5.33)
No father in family household	0.72 (0.40 - 1.30)	2.64 (1.33 - 5.24)
No father in non-family household	0.92 (0.33 - 2.56)	1.45 (0.33 - 6.32)
Institution	0.91 (0.28 - 2.93)	4.19 (1.39 - 12.65)

Note : in the models period from 1971 Census to birth included as a 4-level factor (0-4,5-9,10-15,15-16 years).

Table 3 - Odds ratios (95% confidence intervals) for postneonatal mortality by social class at birth registration adjusted for maternal age at birth, parity, maternal circumstances in childhood and period between 1971 Census and birth, OPCS Longitudinal Study, 1971-88

Social class at birth registration	Adjusted for:		
	Maternal circumstances in childhood and period	Parity and maternal age at birth and period	Maternal circumstances in childhood, parity and maternal age at birth and period
Non-manual	1.00	1.00	1.00
Manual	0.95 (0.62 - 1.48)	0.85 (0.54 - 1.35)	0.80 (0.51 - 1.28)
Other	1.01 (0.39 - 2.61)	0.96 (0.36 - 2.53)	0.92 (0.35 - 2.43)
Sole registration	1.81 (1.03 - 3.17)	1.67 (0.90 - 3.09)	1.55 (0.83 - 2.87)

Note : in the models period from 1971 Census to birth included as a 4-level factor (0-4,5-9,10-15,15-16 years), parity as a 4 level factor (0,1,2,3+) and maternal age at birth as a 17-level factor (<17,18,19 32+)

Table 4 - Odds ratios (95% confidence intervals) for postneonatal mortality by maternal circumstances in childhood at the 1971 Census, adjusted for maternal age at birth, parity, social class at birth registration and period between 1971 Census and birth, OPCS Longitudinal Study, 1971-88

Maternal circumstances in childhood	Adjusted for :		
	Social class at birth and period	Parity and maternal age at birth and period	Social class, parity and maternal age at birth and period
Father : non-manual	1.00	1.00	1.00
Father : manual	1.77 (1.03 - 3.03)	1.58 (0.92 - 2.71)	1.61 (0.93 - 2.78)
Father : other	2.00 (0.78 - 5.16)	1.72 (0.66 - 4.44)	1.74 (0.67 - 4.52)
No father in family household	2.52 (1.26 - 5.03)	2.15 (1.07 - 4.29)	2.14 (1.07 - 4.31)
No father in non-family household	1.37 (0.31 - 5.99)	1.10 (0.25 - 4.83)	1.10 (0.25 - 4.84)
Institution	4.10 (1.36 - 12.38)	3.47 (1.14 - 10.53)	3.43 (1.13 - 10.42)

Note : in the models period from 1971 Census to birth included as a 4-level factor (0-4,5-9,10-15,15-16 years), parity as a 4 level factor (0,1,2,3+) and maternal age at birth as a 17-level factor (<17,18,19 32+)

Table 5 - Odds ratios (95% confidence intervals) for postneonatal mortality by age and maternal circumstances in childhood at the 1971 Census, adjusted for social class at birth registration and period between 1971 Census and birth, OPCS Longitudinal Study, 1971-88

Maternal circumstances in childhood	Age at 1971 Census	
	0-10 years	11-15 years
Father : non-manual	1.00	1.00
Father : manual	1.67 (0.87 - 3.21)	1.98 (0.74 - 5.27)
Father : other	1.86 (0.59 - 5.89)	2.32 (0.44 - 12.36)
No father in family household	3.20 (1.45 - 7.04)	0.95 (0.18 - 5.00)
No father in non-family household	0.95 (0.12 - 7.42)	2.48 (0.28 - 21.80)
Institution	3.51 (0.77 - 16.00)	4.94 (0.94 - 26.09)

Note : in the models period from 1971 Census to birth included as a 4-level factor (0-4,5-9,10-15,15-16 years).