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Perinatal Mortality and Low Birthweight by Socio-Economic Background: Evidence for Ireland*

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Abstract: Newly-available data from the perinatal reporting system are used to examine the variation across socio-economic groups in perinatal mortality and low birthweight rates in Ireland. The results show significant effects of socio-economic background, mother's age and parity (number of previous births) on both perinatal mortality and low birthweight. The risk of perinatal mortality is highest where the father is an unskilled manual worker or unemployed, and this effect is most pronounced where the mother is aged 35 or more. Low birthweight is most prevalent for mothers from that socio-economic background aged under 20.

I INTRODUCTION

Infant and child mortality rates have fallen dramatically in developed countries since the Second World War. However, within countries social disadvantage has continued to be associated with above-average mortality rates. Studies for Britain and other developed countries have found infant and child mortality to be closely linked with socio-economic background. While the extensive literature on inequalities in health has paid most attention to differentials in morbidity and mortality rates across socio-economic groups among adults, the analysis of health inequalities around the

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time of birth and during childhood has also been an important element.[1] In the case of Ireland, most research focusing on socio-economic health inequalities up to the present has been on illness and mortality among adults.[2] This paper uses an important new data source for Ireland to analyse differences across socio-economic groups in outcomes around the time of birth.

Specifically, we focus on differences in perinatal mortality and low birthweight rates. Perinatal mortality refers to stillbirths and deaths within the first week of life, whereas infant mortality refers to deaths within the first year (and by convention does not include stillbirths). Perinatal mortality rates have generally fallen much less dramatically than deaths outside the first week but within the first year. As a result, perinatal mortality now accounts for a high proportion — three-quarters or more — of all "infant loss" (Antonovsky and Bernstein's (1977) term for the total of stillbirths plus deaths within the first year) in many developed countries.[3] Both mother's age and parity are known to be related to the risk of perinatal death, so differences across socio-economic groups in perinatal mortality rates may arise partly from differences across these groups in the profile of births by mother's age and parity. It is important both for our understanding of the processes at work and from a policy perspective to be able to disentangle these effects, something in which there has been a good deal of interest elsewhere.[4] The perinatal reporting system introduced in Ireland in the early 1980s now covers all births and, as part of the birth registration procedure, obtains information on *inter alia* mother's age and parity, father's occupation, and perinatal outcome. In this paper we use data from this source for the five years 1984-88 to analyse the relationship between the perinatal mortality rate and socio-economic group, mother's age and parity.

Low birthweight is positively related to the probability of death within the first week or year, and also appears to be an important influence on health in later life, through for example the heightened risk of congenital anomalies and developmental handicaps. The percentage of births which would be classified as "low weight" has also been found to vary depending on socio-

1. See for example Antonovsky and Bernstein (1977) for a survey of evidence across developed countries, and OPCS (1985) for recent figures for England and Wales.

2. See Cook (1990) for a review of available evidence on health inequalities in Ireland. Subsequently, Nolan (1990) used death registration and Census of Population data for Ireland to examine mortality differentials across socio-economic groups for men aged 15-64. Nolan (1991) looked at differences across socio-economic groups in self-reported physical health status for adults in a large national representative household sample.

3. For a review of Irish infant and perinatal mortality rates in comparative context see Kirke (1981).

4. For studies of biological and social factors associated with perinatal mortality see for example, Cramer (1987), Eberstein, *et al.* (1990), Murrells, *et al.* (1985), OPCS (1991), Adelstein, *et al.* (1980).

economic background, both in Ireland and elsewhere.[5] Since it is a good deal more common than perinatal death, low birthweight can also be analysed with greater statistical precision. The perinatal database includes information on birthweight, and using the conventional cut-off to define what constitutes "low" we also examine the relationship between low birthweight and mother's socio-economic background, age and parity.

Section II describes the data, Section III reports the findings for perinatal mortality, Section IV presents those for low birthweight, and Section V draws together the conclusions.

II THE DATA

The data to be employed are produced by a perinatal reporting system introduced in Ireland in the early 1980s. This forms part of the birth registration procedure, whereby all births are registered and notified using a standard form which contains information on, *inter alia*, birthweight and gestation period, mother's age, marital status and parity, father's occupation, perinatal care, perinatal outcomes, and cause of death where relevant. These forms are coded and checked by the Department of Health, computerised by the Central Statistics Office, and form the basis for the Annual Report on Perinatal Statistics issued since 1984 by the Department of Health (see for example Department of Health (1988)).

Standard definitions of live birth, still-birth and early neonatal death (i.e. death of a live-born infant within the first week) are employed, following WHO guidelines.[6] Parity refers to the mother's number of previous live plus stillbirths. The categories for mother's age and parity to be employed here are:

Mother's age:	under 20, 20-24, 25-34, 35 and over;
Parity:	0 previous births, 1 previous birth, 2 previous births, 3 or more previous births.

Socio-economic status is based on information obtained about the father's occupation. This is coded and grouped according to the Irish Central Statistics Office's system of socio-economic groups (SEGs), with minor modifications. This system, like the corresponding SEG categorisation employed by the UK CSO, is intended to group together persons (and their dependants) with generally similar occupations as regards the level of skill or

5. See Dowding (1981) for an earlier study of the relationship between low birthweight and socio-economic status using Irish data. On the relationship between low birthweight and health outcomes see for example Institute of Medicine (1985), Schwartz (1989).

6. For the precise definitions employed see Perinatal Statistics 1988 pp. 10-11. In line with WHO guidelines, infants weighing less than 500 grammes are not included in the statistics.

educational attainment required.[7] It is not possible at present to take into account mother's occupation or to categorise by social class rather than SEG, though revision of the registration form to collect information which would make this possible is under consideration. The relatively low labour force participation rate of married women in Ireland means that mother's occupation is less important than it may be elsewhere. Unlike social class, SEG is not designed to provide a ranking in terms of socio-economic status, so for example, all farmers are allocated to the same SEG irrespective of farm size. None the less, by distinguishing those in professional/managerial, intermediate non-manual, skilled, semi-skilled and unskilled manual occupations it serves as a good indicator of socio-economic status for most of the population, and has been quite widely employed internationally in the analysis of mortality differentials.[8]

The CSO use a 12-point SEG scale, the final category being "Unknown", which includes those where the occupation has been stated as unemployed and no previous occupation given. In the perinatal reporting system the unemployed are shown as a separate group, distinguished from cases where the information was insufficient, or where no information was provided.[9] Here SEGs are combined to form the following five categories:

(i) Farmers, farm labourers and fishermen
(ii) Professional/managerial
(iii) Intermediate non-manual
(iv) Skilled/semi-skilled manual
(v) Unskilled manual/unemployed.[10]

The published statistics include the perinatal mortality rate classified by mother's age, by parity, and by socio-economic group separately. However,

7. See Census of Population 1981, Vol. 7, p. viii.

8. For example, the OPCS Decennial Supplements on Occupational Mortality include categorisation by both SEG and social class (OPCS, 1986). Nolan (1990) analyses mortality among adult males aged 15-64 for Ireland by SEG. O'Hare, Whelan and Commins (1991) discuss the relationship between the SEG system used by the Irish CSO and social class, and describe the development of the 6-point social class scale recently introduced by the CSO.

9. The published statistics also use mother's marital status to distinguish cases where no information is given and the mother is married from those where she is single, widowed, divorced or separated.

10 These consist of the following SEGs as defined by the CSO: (i) is SEG 0 farmers, farm relatives and farm managers, and 1 other agricultural occupations and fishermen; (ii) is SEG 2 higher professional, and 3 lower professional; (iii) is SEG 4 employers and managers, 5 salaried employees, 6 intermediate non-manual, and 7 other non-manual; (iv) is SEG 8 skilled manual and 9 semi-skilled manual; and (v) is SEG 10 unskilled manual plus the unemployed in SEG 11. For a full description of the SEGs and the coding of occupations see Census of Ireland 1981 Volume 7 (1986), Appendix B. For the coding in the perinatal reporting system see Perinatal Statistics 1988 Appendix E.

since mother's age, parity and socio-economic background are related to each other, to explore their influence on perinatal mortality we must make use of the individual-level data. This also allows the factors associated with low birthweight to be analysed. We confine our attention to singleton births, since the analysis of birthweight in particular would be complicated by inclusion of multiple births. While the number of perinatal deaths in any one year is quite small — about 400 stillbirths and 200 early neonatal deaths — we can make use of data for the five years 1984-88 taken together. Cases were omitted where information was missing on one of the independent variables. On this basis, 255,202 births, about 88 per cent of all (singleton) births reported, can be included in our analysis.[11] Of these, 1,856 were still-births and 1,044 were early neonatal deaths.

It is important to note at the outset the bearing which the omission of cases with incomplete information may have on the analysis. Since incomplete information is not random, particular groups are under-represented in the data available for analysis, relative to their importance among all births. The information missing in most cases was father's socio-economic group, which accounted for over 80 per cent of all the cases excluded from the analysis (with parity missing for about 10 per cent and age for about 7 per cent).[12] Unsurprisingly, father's socio-economic group was most often missing for single mothers. Among cases where socio-economic group was not stated, the reporting system distinguishes between married women and those who gave marital status as single, widowed, separated or divorced. The latter account for about 90 per cent of all cases where SEG was missing in 1988 (though only 60 per cent in 1984).

Marital status is not itself included as an explanatory variable in our analysis, but the concentration of missing cases among single mothers means that young mothers, a high proportion of whom were single, are severely under-represented. Primarily due to missing SEG for single mothers, only about one-third of all births to women aged under 20 could be included in the analysis, and this must be kept in mind in assessing the reliability of the results which can be obtained for that group. However, the perinatal mortality rate for the cases included in our analysis is almost exactly the same as the total for that age range, so that while there may be a loss of precision in the estimation results the mortality rate for the age group is not biased by the exclusion of so many cases.[13] Where the mother was aged 20 or

11. In 1984 the perinatal reporting system covered 94 per cent of all births in the State, while for subsequent years the coverage was complete.

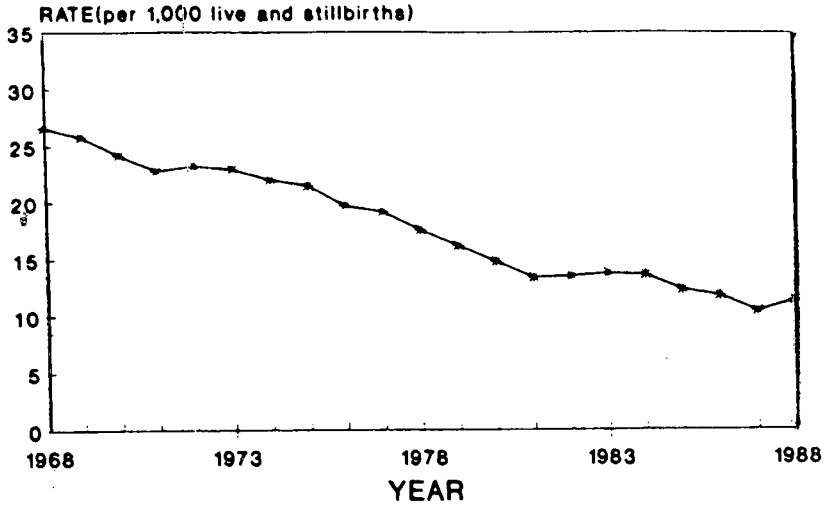
12. Only a small proportion of the omitted cases had more than one variable missing.

13. The perinatal mortality rate for mothers under 20 included in the analysis was 13.3 per thousand, while for all births in that age range it was 13.6 per thousand.

over, 90 per cent or more of all births are available for analysis. This is the case for about 97 per cent of births to mothers aged 35 or over, which like "young" mothers are of particular interest. Focusing on parity, it comes as no surprise that first births are under-represented in the cases available for analysis since a high proportion of births to single mothers are first births. However the problem is much less severe than for births to mothers under 20 — over three-quarters of all first births are available for analysis. Since socio-economic group itself is the variable which is most often missing, it is not known which SEGs are underrepresented in the cases available for analysis: the minority of cases excluded because age or parity are missing are not concentrated in particular SEGs.

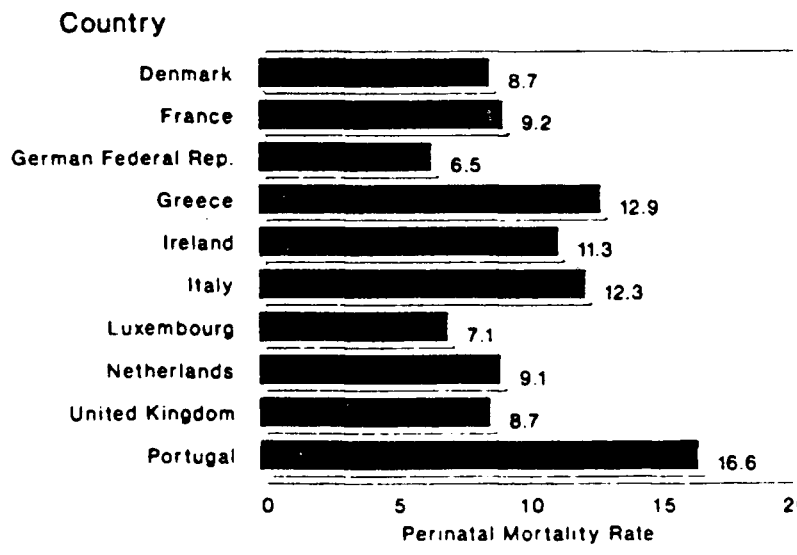
III PERINATAL MORTALITY

The perinatal mortality rate in Ireland has fallen dramatically from 30 per 1,000 live and stillbirths in 1965 to 11 per 1,000 in 1988 (Figure 1). The Irish rate is now slightly higher than that in some of the richer EC countries such as Germany, Denmark, The Netherlands or the UK, but lower than those of Greece or Portugal (Figure 2). The data for singleton births 1984-88 to be employed in this paper show a perinatal mortality rate over that period of 11.4 per 1,000 births (live plus stillbirths). Table 1 shows the way in which births and perinatal deaths are distributed, and how the perinatal mor-



Source: Annual Reports on Vital Statistics, Ireland: 1968-1988.

Figure 1: *Perinatal Mortality Rate, Ireland: 1968-1988*



Source: Demographic State Eurostat 1990.
Note: Data for Belgium and Spain are not sufficiently current to include. The rate for Ireland is the national figure from the Annual Report on Vital Statistics, 1988.

Figure 2: *Perinatal Mortality Rates, 1988 for EC Countries*

tality rate varies, by each of the three variables on which we are concentrating, that is, mother's age, parity and socio-economic background. The perinatal mortality rate is seen to be higher when the mother is aged under 20 or over 34 than when she is aged 20-34, when she has had no previous birth or 3 or more births rather than 1 or 2, and when the socio-economic group is unskilled manual/unemployed rather than any of the other four categories.

However, these gross relationships between perinatal mortality and the three factors of interest must be interpreted in the light of the fact that age, parity and socio-economic status are not independent. Parity is clearly related to age, with the number of previous births increasing on average with the age of the mother. Thus, 71 per cent of mothers aged under 20 had no previous birth, compared with 46 per cent of those aged 20-24, 24 per cent of those aged 25-34, and only 7 per cent of those aged 35 or over. Conversely, only 1 per cent of those aged under 20 had 3 or more previous births, compared with 5 per cent of those aged 20-24, 23 per cent of those aged 25-34, and 63 per cent of those aged 35 or over. Mother's age and parity are also related to social class. As Table 2 shows, a relatively high percentage of births in the unskilled manual/unemployed group are to mothers aged under 20

Table 1: *Perinatal Death Rate by Mother's Age, Parity and Socio-Economic Group, Ireland 1984-88*

A: Perinatal Death Rate by Mother's Age

Age	*Births*	*Perinatal Deaths*	*Perinatal Death Rate (per 1,000)*
Under 20	4,139	55	13.29
20-24	43,031	447	10.39
25-34	161,697	1,671	10.33
35 and over	46,335	727	15.69
All	255,202	2,900	11.36

B: Perinatal Death Rate by Parity

Number of Previous Births	*Births*	*Perinatal Deaths*	*Perinatal Death Rate (per 1,000)*
0	64,914	799	12.31
1	69,658	606	8.70
2	51,473	482	9.36
3 and over	69,157	1,013	14.65
All	255,202	2,900	11.36

C: Perinatal Death Rate by Socio-economic Group

SEG	*Births*	*Perinatal Deaths*	*Perinatal Death Rate (per 1,000)*
Farmers/Farm Labourers	33,456	346	10.34
Professional	22,903	211	9.21
Other Non-Manual	88,128	900	10.21
Skilled/Semi-skilled Manual	83,080	910	10.95
Unskilled, Manual/Unemployed	27,635	533	19.29
All	255,202	2,900	11.36

or 20-24, while the professional/managerial and especially the farmers categories have low proportions in those age groups and a high proportion born to mothers aged 35 and over. There are also significant differences across the socio-economic groups in the distribution of births by parity: 36 per cent of births in the farmers category and 41 per cent of those in the unskilled manual/unemployed category are to women with 3 or more previous births, compared with only 18 per cent for the professional/managerial and 25 per cent for the intermediate non-manual and skilled/semi-skilled manual groups.

Table 2: *Births by Socio-economic Group and Mother's Age (%)*

SEG/Age	*Under 20* % Number	*20-24* % Number	*25-34* % Number	*35 and over* % Number	*All* (% Number)
Farmers/Farm Labourers	1.0 (346)	11.4 (3,815)	60.0 (20,072)	27.6 (9,223)	100.0 (33,456)
Professional	0.3 (61)	5.8 (1,318)	72.5 (16,613)	21.4 (4,911)	100.0 (22,903)
Other Non-Manual	1.2 (1,039)	15.6 (13,737)	65.4 (57,642)	17.8 (15,710)	100.0 (88,128)
Skilled/Semi-Skilled	1.8 (1,491)	20.4 (16,945)	63.3 (52,554)	14.6 (12,090)	100.0 (83,080)
Unskilled/Unemployed	4.3 (1,202)	26.1 (7,216)	53.6 (14,816)	15.9 (4,401)	100.0 (27,635)
All	1.6 (4,139)	16.9 (43,031)	63.4 (161,697)	18.1 (46,335)	100.0 (255,202)

Cross-classification of perinatal mortality rates by two or by all three of the factors of interest is helpful in exploring the importance of the different factors. For example, Table 3 shows the cross-classification by age and socio-economic status. We can see that the rate for the unskilled manual/unemployed group is consistently higher than that for other socio-economic categories *within* age groups, so differences in mother's age do not fully explain the fact that the overall rate for that socio-economic category is so high. It also reveals that the perinatal mortality rate for the sub-group who are both in the unskilled manual/unemployed category and the 35 or over age group is extremely high, at 35 per 1,000 compared with the average for that socio-economic group of 19 and the overall average of 11.4. The fact that the number of observations underlying each of these rates varies a great deal and is sometimes small must also be kept in mind. As Table 2 shows, since the total number of births included for mothers under 20 is only 4,139, the number in this age range for some SEGs is very low indeed — notably for farmers etc. and for professional and managerial groups.

In the same way, one could look at the full three-way cross-classification by age, SEG and parity to also take the role of parity into account. This shows, for example, that the perinatal mortality rate for the unskilled manual/unemployed group remains consistently high within both age and parity categories, and is particularly high for the 35 or over age group irrespective of parity.[14] (Of course the number of cases in some cells is then even lower:

14. The full three-way cross-tabulation is available from the authors on request.

Table 3: *Perinatal Death Rate by Socio-economic Group and Mother's Age*

SEG / Age	*Under 20*	*20-24*	*25-34*	*35 and over*	*All*
Farmers/Farm Labourers	2.89	9.44	10.06	11.60	10.34
Professional	0	12.14	8.73	10.18	9.21
Other Non-Manual	14.44	8.88	9.28	14.51	10.21
Skilled/Semi-Skilled	12.07	10.09	10.10	15.72	10.95
Unskilled/Unemployed	17.47	14.14	17.41	34.54	19.29
All	13.29	10.39	10.33	15.69	11.36

again this arises for the most part for mother's age under 20, where for some SEG/parity combinations the number of births involved is very low indeed).[15] However, inspection of such cross-tabulations has clear limitations if the aim is to quantify and compare the contribution of the different factors and assess their statistical significance. In particular, as Murrells, *et al.* (1985) point out in this context, the wide variation across the cells in the number of births underlying the mortality rates means that one can be mislead by large differences in rates based on few births, or ignore relatively small differences based on many births.

We therefore wish to fit a statistical model to the individual data. The dependent variable is dichotomous, taking the value 1 in the case of perinatal deaths and 0 otherwise. We fit the logit model, based on the cumulative logistic probability function, which involves transforming the dependent variable to the log of the odds of the event in question occurring. This model is widely used for the analysis of dichotomous dependent variables, and ensures that the predicted probabilities — in this instance the risk of perinatal death — will lie within the 0-1 range.[16]

The independent variables are all categorical, entered in the form of dummy variables. The model is estimated using maximum likelihood methods, and the results are shown in Table 4. In column (1), main effects only are included in the model — that is, the age, parity and socio-economic

15. At the extreme, the number of births for this age group, parity 0 and the professional SEG was only 45. However the number of births involved for this age/parity combination for the unskilled manual/unemployed SEG was considerably higher, at 812. (There are some cells which are virtually empty but this would be expected, for example the number of mothers aged under 20 having a fourth child).

16. Use of the logit model with categorical independent variables is closely related to log-linear analysis of contingency tables, see Murrells, *et al.* (1985), Hanushek and Jackson (1977) Ch. 7.

group categories without interaction terms. The omitted categories reflected in the intercept are age 20-24, parity 1, and the farmers etc. socio-economic group. The estimated coefficients on age 35 or over, parity 0, parity 3 or more, and occupational groups skilled/semi-skilled manual and unskilled/unem-

Table 4: *Estimation Results for Logit Model, Perinatal Deaths*

Independent Variable	*Model (1)* *Coefficient (t-statistic)*	*Model (2)* *Coefficient (t-statistic)*	*Model (3)* *Coefficient (t-statistic)*
Intercept	-4.98 (61.95)	-4.94 (61.12)	-4.85 (130.88)
Age under 20	0.08 (0.56)	0.10 (0.68)	—
Age 25-34	0.09 (1.58)	0.08 (1.36)	—
Age 35 or over	0.46 (6.66)	0.38 (5.18)	0.31 (5.89)
Parity 0	0.38 (6.98)	0.38 (6.89)	0.36 (7.58)
Parity 2	0.02 (0.30)	0.02 (0.40)	—
Parity 3 or more	0.32 (5.66)	0.32 (5.70)	0.32 (6.75)
Professional	–0.07 (0.80)	–0.75 (0.84)	—
Inter. Non-Manual	0.05 (0.78)	0.04 (0.65)	—
Skilled/Semi-Skilled Manual	0.14 (2.16)	0.13 (1.98)	0.11 (2.54)
Unskilled/ Unemployed	0.69 (9.82)	0.59 (7.60)	0.56 (9.41)
Age 35 or over+ Unskilled/ Unemployed	—	0.36 (3.31)	0.37 (3.42)
Number of Observations	255,202	255,202	255,202
Log-Likelihood	–15,703	–15,698	–15,700
Chi-squared	329.32	339.95	335.55

Note: Omitted categories reflected in intercept are age 20-24, parity 1, farmers etc.

ployed are all significant and have the expected positive sign — that is, compared with the omitted categories each of these characteristics is associated with a higher probability of perinatal death.

Before looking at the magnitude of these estimated effects, the generalisation of the model to include interaction terms will be discussed. Models which included different sets of two-way and three-way interactions between the independent variables, and a full or saturated model which included all such interactions, were also estimated. In addition to t-tests on individual coefficients, various sets of interactions were examined for statistical significance using likelihood-ratio tests. These tests indicated that the set of two-way interactions between age and occupation added significantly to the explanatory power of the equation.[17] Further testing showed that in fact one particular term, namely the interaction between age 35 and over and the unskilled manual/unemployed socio-economic group, was responsible for the improvement in fit. Column (2) shows the estimated model with main effects and this additional explanatory variable, which is clearly significant. Some of the main effects terms remain insignificant, and Col. (3) shows the estimated model when these are omitted. This shows that the characteristics being aged 35 or over, having no previous children, having three or more previous children and being in the skilled/semi-skilled or unskilled/unemployed socio-economic group are all statistically significant predictors of a perinatal mortality rate higher than that for the omitted categories. In addition, being both aged 35 or over and in the unskilled/unemployed group is associated with an even higher probability than their separate coefficients would suggest — the interaction term is significant and positive.[18]

To see the size of these estimated effects, we can calculate the predicted probability of perinatal death, and thus the perinatal mortality rate, for any combination of the independent variables. (This involves converting the figure calculated from the estimated equation, which is predicted log(p/1–p), to the implied value for p). These results are shown in Table 5. In the case of a mother aged 20-34, parity 1 or 2, and occupation farmer/professional/other non-manual, the predicted log(p/1–p) from the equation is simply the inter-

17. The log-likelihood value for the estimated equation with all two-way interactions between age and occupation was –15,690, compared with –15,703 for the model with main effects only shown in Col. (1). Twice the difference in the log-likelihoods, 26, exceeds the critical value in chi-squared distribution (5 per cent level) with 12 degrees of freedom, that being the difference in number of parameters between the model with and without these interactions, so they jointly add significantly to the explanatory power of the equation. When the set of interactions between age and parity are added to the main effects the log-likelihood value is –15,701, and for those between occupation and parity it is –15,696, neither of which pass this test, nor do sets of three-way interactions.

18. The number of births to mothers aged 35 or over and in the unskilled manual/unemployed SEG, which underlies this result, was 4,401 and the number of perinatal deaths was 152.

cept, which converts to a value of 0.008 for p, or a perinatal mortality rate of 8 per 1,000. If the only change in characteristics from this benchmark is that the mother is aged 35 or over, the predicted rate goes up to 11. A similar figure is predicted if the only difference is that the birth is the first to that mother (i.e. parity is 0). For a mother still aged 20-24 and parity 1 but from an unskilled manual/unemployed background the predicted rate is 13.5. A combination of age 35 or over and parity 3 or more, for someone in the farmer, professional or other non-manual socio-economic groups, raises the predicted rate to 15. Much higher rates are predicted, though, for those in the unskilled manual/unemployed group where the mother is either aged 35 or over, parity is 3 or more, or both. For someone in that group aged 35 or over but parity less than 3, the predicted rate is 26.5; when parity is also 3 or more, the rate is as high as 36.[19]

This analysis of the factors associated with perinatal mortality has therefore allowed us to go beyond the gross relationships between high risk and mother's age, parity and socio-economic background. The results show clearly that controlling for the other two, each of these factors has a statis-

Table 5: *Predicted Perinatal Mortality Rates by Characteristics*

Characteristic	*Predicted Perinatal Morality Rate*
Benchmark (age 20-34, parity 1 or 2, Farmer/professional/inter. non-manual)	8.0
As benchmark except:	
Age 35 or over	10.9
Parity 0	11.5
Parity 3 or more	11.1
Skilled/Semi-Skilled Manual	8.7
Unskilled/Unemployed	13.5
Age 35 or over + Parity 3 or more	15.0
Age 35 or over and Unskilled/ Unemployed	26.5
Age 35 or over, Parity 3 or more, Unskilled/Unemployed	36.2

Note: Predicted from Model (3), Table 4.

19. The pattern of rates predicted by the model is generally similar to that of the observed rates — for example, the actual rate for the benchmark group is 10 and that for the "age 35 or over/parity 3 or more/unskilled or unemployed" is 35, compared with the predicted rates of 8 and 36 respectively.

tically significant impact on the risk of perinatal mortality. For women in the non-manual or farmers socio-economic groups and with 1 or 2 previous births, being age 35 or over raises the risk of perinatal mortality by about 40 per cent. A similar increase in risk is seen for a woman aged 20-34 in those groups comparing the first birth or parity of 3 or more with second/third birth. Being in the unskilled manual/unemployed group in itself raises the risk for a woman aged 20-34 having her second or third child, by about 70 per cent. However, it is the combination of membership of this socio-economic group with age and parity effects which results in dramatically higher risks. For someone in the unskilled manual/unemployed group where the mother is aged 35 or over, the risk is over three times as high as for younger mothers in other socio-economic groups. The analysis, by allowing the separate and joint effects of these variables to be seen, highlights the combination of characteristics where very high perinatal mortality rates are experienced.

IV LOW BIRTHWEIGHT

Perinatal deaths occur relatively rarely in developed countries such as Ireland. The factors associated with relatively high risk of perinatal mortality may however have wider-ranging effects on health outcomes. The information provided by the perinatal reporting system includes birthweight, allowing the analysis to be extended beyond perinatal mortality to low birthweight. Low birthweight is known to be closely associated with the risk of death within the first week, and therefore a strong relationship between low birthweight and perinatal mortality is to be expected. However, most low birthweight babies do not die, and low birthweight has been shown to be an important influence on health in childhood and later life.[20] This means that the incidence of low birthweight — across socio-economic groups, for example — is of interest both in itself and as a contributory factor to perinatal mortality.

The conventional cut-off for defining low birthweight, of 2,500 grammes or under, is employed. The low birthweight rate is defined as the number of live births of this weight relative to the total number of live births (whereas for the perinatal mortality rate the denominator is the total live plus stillbirths). The total number of singleton live births for the 1984-88 period (on which we have full information) was 253,346, of which 8,700 weighted 2,500 grammes or less. The low birthweight rate per 1,000 was therefore 34.3. The fact that this is over four times as high as the perinatal mortality rate increases the power of the statistical analysis to distinguish the effects of the independent variables.

First, the way in which the low birthweight rate varies with each of

20. See for example the report by the US Institute of Medicine (1985) on *Preventing Low Birthweight.*

mother's age, parity and socio-economic group is shown in Table 6. As was the case for perinatal mortality, the low birthweight rate is relatively high for mothers aged under 20 or 35 or over, for parity 0 or 3+, and for the unskilled manual/unemployed socio-economic group. There are some differences though. Compared with the overall average of 34, the low birthweight rate for mothers aged under 20 is 60 (though these constitute only a small pro-

Table 6: *Low Birthweight Rate per 1,000 by Mother's Age, Parity and Socio-economic Group, Ireland 1984-88*

A: Low Birthweight Rate by Mother's Age

Age	*Live Births*	*<2,500 grammes*	*Low Birthweight Rate (per 1,000)*
Under 20	4,116	246	59.77
20-24	42,764	1,602	37.46
25-34	160,640	5,034	31.34
35 and over	45,826	1,818	39.67
All	253,346	8,700	34.34

B: Low Birthweight Rate by Parity

Number of Previous Births	*Live Births*	*<2,500 grammes*	*Low Birthweight Rate (per 1,000)*
0	64,420	2,927	45.44
1	69,301	1,948	28.11
2	51,158	1,358	26.54
3 and over	68,467	2,467	36.03
All	253,346	8,700	34.34

C: Low Birthweight Rate by Socio-economic Group

Socio-economic Group	*Live Births*	*<2,500 Grammes*	*Low Birthweight Rate (per 1,000)*
Farmers/Farm Labourers	33,232	956	28.77
Professional	22,777	607	26.65
Other Non-Manual	87,552	2,936	33.53
Skilled/Semi-Skilled Manual	82,512	2,875	34.84
Unskilled Manual/ Unemployed	27,273	1,326	48.62
All	253,346	8,700	34.34

portion of all births). For the much larger number giving birth aged 35 or over the rate is 40, lower than that for the youngest age group though still well above average. For perinatal mortality, by contrast, the rate for the under-20s was considerably lower than that for the over-34s. Similarly, in terms of parity it is those with no previous births who have a particularly high low birthweight rate of 45, whereas those with 3 or more previous births have a rate of 36, just above average: for perinatal mortality it was again those with 3 or more previous births who had the highest rates. Focusing on socio-economic background, the unskilled manual/unemployed group has a low birthweight rate of 48, well above average. The "excess" compared with the average is only about one-third, though, whereas in the case of perinatal mortality the rate for this group was over two-thirds above the average.

Again, going beyond the gross averages to two- and three-way cross-tabulations is informative. The full three-way cross-classification of low birthweight by mother's age, parity and socio-economic group reveals, *inter alia*, that the rate for the under 20s is consistently higher than for other age categories, within socio-economic groups (almost all being parity 0). Likewise, the rate for the unskilled manual/unemployed group is consistently high within age and parity categories.[21] It is most informative, though, to combine this with statistical analysis at individual level. The logit model is once again estimated, with the same independent variables as in the analysis of perinatal mortality, and the key results are shown in Table 7.

The estimated model including main effects only is shown in Col. (1). All the main effects are significant with the exception of age 25-34, which simply means that there is no difference between that and the omitted age category 20-24. The other variables are all significant with the expected sign: being aged under 20 or 35 or over, parity 0 or 3+, and being in the other non-manual, skilled/semi-skilled or unskilled/unemployed groups all increase the probability of low birthweight, while parity 2 and being in the professional/managerial group reduce it, compared with the omitted categories. In terms of the size of these effects, parity 0 and membership of the unskilled/unemployed group have the largest impact.

Extensive testing of possible interaction effects was carried out. The results showed that, whereas for perinatal mortality age/occupation interactions were important, in the case of low birthweight it was age/parity and occupation/parity interactions which added most to the explanatory power of the equation. As Col. (2) of Table 7 shows, a number of such terms were significant, as was one age/occupation term. (The main effects term for age 25-34 remained insignificant and has been dropped from the equation.)

21. Once again this three-way cross-tabulation is available from the authors on request.

Table 7: *Estimation Results for Logit Model, Low Birthweight*

Independent Variable	*Model (1) Coefficient (t-statistic)*	*Model (2) Coefficient (t-statistic)*
Intercept	–3.75	–3.83
	(81.18)	(91.76)
Age under 20	0.31	0.33
	(4.38)	(4.86)
Age 25-34	–0.03	—
	(0.87)	
Age 35 or over	0.28	0.53
	(6.87)	(10.23)
Parity 0	0.50	0.64
	(16.81)	(13.69)
Parity 2	–0.08	0.12
	(2.29)	(1.53)
Parity 3 or more	0.12	0.56
	(3.81)	(5.52)
Professional	–0.07	–0.09
	(1.42)	(1.70)
Other non-manual	0.18	0.24
	(4.66)	(5.72)
Skilled/Semi-Skilled Manual	0.22	0.27
	(5.85)	(6.25)
Unskilled/Unemployed	0.58	0.55
	(13.25)	(11.68)
Age 25-34 + Parity 2	—	–0.24
		(2.87)
Age 25-34 + Parity 3 or more	—	–0.33
		(3.30)
Age 35 or over + Parity 2	—	–0.34
		(3.11)
Age 35 or over + Parity 3 or more	—	–0.75
		(6.53)
Inter. non-manual + Parity 0	—	–0.20
		(3.53)
Skilled/Semi-Skilled Manual Manual + Parity 0	—	–0.14
		(2.42)
Unskilled/Unemployed + Age 35 or over	—	0.14
		(1.76)
Number of Observations	253,346	253,346
Log-Likelihood	–37,498	–37,460
Chi-squared	763.75	840.68

Note: Omitted categories reflected in intercept are age 20-24, parity 1, farmers etc.

Once again, the magnitude of the estimated effects can be seen by comparing the predicted low birthweight rate for different combinations of characteristics, as seen in Table 8. The predicted low birthweight rate for the omitted categories is 21 per 1,000. Where the mother's age is under 20, this increases to 29, or when that age is 35 or more it increases to 35. The influence of parity is notable though: the fact that it is the woman's first birth is on its own enough to increase the low birthweight rate from the benchmark to 39. This is even more than the impact of being in the unskilled/unemployed socio-economic group, taken alone. Once again, however, it is when adverse characteristics are found together that the predicted rate is very high. A woman aged under 20 and having her first child faces a risk of 54 per 1,000, while a woman with the same characteristics and in the unskilled/unemployed socio-economic group has a predicted rate of 90.[22] Once again it is worth recalling that the number of births on which these predicted rates

Table 8: *Predicted Low Birthweight Rates by Characteristics*

Characteristic	*Predicted Low Birthweight Rate*
Benchmark (age 20-34, parity 1, farmer	21.22
As benchmark except:	
Age under 20	29.38
Age 35 or over	35.45
Parity 0	39.31
Parity 3 or more	36.51
Skilled/Semi-Skilled Manual	27.55
Unskilled/Unemployed	36.15
Age under 20 + Parity 0	54.04
Age 35 or over and Unskilled/ Unemployed	68.12
Age under 20, Parity 0, Unskilled/Unemployed	89.96

Note: Predicted from Model (2), Table 7.

22. As in the case of perinatal mortality, the general pattern of rates predicted by the model is similar to the observed rates: for example, the actual rate for the benchmark case is 21 and that for the "age under 20/parity 0/unskilled or unemployed" is 75, compared with predicted rates of 21 and 90 respectively. (The predicted rate does however understate that for "age under 20/parity 1/farmer".)

are based are in some cases low — at the extreme, a total of 806 births to women aged under 20, parity 0, in the unskilled/unemployed SEG. However, the results clearly highlight the variation in risk across groups in the population and they point towards the characteristics associated with a high risk of having a low birthweight baby.

V CONCLUSIONS

This paper has analysed the factors associated with perinatal mortality and low birthweight in Ireland, using data for the years 1984-88. Both perinatal mortality and low birthweight are relatively high for mothers aged under 20 or over 34, for those having their first child or with 3 or more previous births, and for those from the unskilled manual/unemployed socio-economic group. These factors are not independent, however — for example, a relatively high proportion of births to the unskilled manual/unemployed group are to mothers aged under 20 or over 34. To assess the contribution of the different factors and their interrelationships, logit models were estimated. The results show statistically significant independent effects of age, parity and socio-economic background on both perinatal mortality and low birthweight. Particularly high risks are faced by those combining several adverse factors. In the case of perinatal mortality, this is most pronounced for mothers aged 35 or over, with parity of 3 or more, and in the unskilled manual/unemployed group. For low birthweight, the combination of age under 20 and no previous birth with that socio-economic background is the most adverse. In focusing on such combinations of characteristics the number of births underlying the results was relatively low, so the results are most robust in highlighting the variation in risk across groups in the population and pointing towards the characteristics associated with high risk of perinatal mortality and having a low birthweight baby.

In terms of understanding the higher rates of perinatal mortality and low birthweight experienced by those from relatively disadvantaged socio-economic backgrounds, the analysis shows that differences across socio-economic groups in family size and mother's age are important, but are not the whole story. A variety of factors which differ across socio-economic groups and may contribute to the higher risk facing the disadvantaged has been suggested, including the spacing of births, maternal health (influencing the probability of infection or hypertension during pregnancy), maternal nutrition during pregnancy, smoking/alcohol/drug usage during pregnancy, genetic factors, and the extent and quality of prenatal care utilised. Using the data available through the perinatal reporting system, it will be possible to explore a number of these, by extending the models presented in this paper to

include for example interval since last birth, marital status, and when during the pregnancy prenatal care was first sought. It will also allow the analysis of low birthweight to be developed to make the important distinction between low birthweight due to prematurity and low birthweight full-term births. The results presented here point up the areas on which future research using this important source of data might best focus.[23] Although the processes at work are not yet fully understood they also indicate where public health services and health education measures could most profitably be directed in order to further reduce the incidence of perinatal mortality and low birthweight. Directing resources to the provision of high-quality antenatal care and efforts to improve maternal health and practices for high-risk groups offers the best prospect of bringing down the overall incidence of perinatal mortality and low birthweight while reducing differentials between socio-economic groups.[24]

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23. Ideally, in addition to the comprehensive data which the perinatal reporting system produces for all births, one would like to be able to analyse successive births to each mother over time. Longitudinal studies of this type carried out in Scandinavian countries have been particularly illuminating, and data of this type is now becoming available for England and Wales from the OPCS Longitudinal Study (see Bethune, *et al.*, 1992).

24. See for example Mustard (1991).

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