CLINICAL RESEARCH

Distributions of birth weight in seven Dublin maternity units

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Abstract

Differences in birthweight distribution among babies born to Dublin residents during one year in seven maternity units were analysed. Large differences were found between the hospitals. The evidence indicated that most of the difference was attributable to the differing socioeconomic profile of the mothers in the hospitals. The socioeconomic gradients shown by the hospitals in the proportions of babies weighing ≤ 2500 g, ≤ 3000 g, and 3001-4499 g diverged with increasing socioeconomic disadvantage. Steepest gradients were found in hospitals where the socioeconomic disadvantage was greatest, and vice versa. The differences between the hospitals in the socioeconomic gradient of birthweight performance were tentatively ascribed to some sort of catchment area effect, which added to the disadvantage of the already most disadvantaged mothers. Differences in antenatal care and induction of labour between hospitals were not assessed but were thought unlikely to have made a major contribution to the differences in socioeconomic gradient.

Introduction

A recent report¹ described part of a birthweight study based on 20 698 singleton births in one year to mothers resident in greater Dublin. No previous community-based assessment of birth weight had been made in the Republic of Ireland. Such a study was necessary to permit proper interpretation of results from individual maternity units. The present paper describes the large differences in birthweight distribution among singleton births in the seven maternity units that each delivered over 300 singleton babies to mothers in Dublin in the year of the study (1 April 1978 to 31 March 1979). The analysis excluded 450 cases in which the mother's husband was in the armed Forces and 38 in which his occupation was unclassifiable. Among the remaining

19 661 cases in the seven units birth weight was obtained in 19 629. The analysis was based on these cases.

The relation between the sequence of socioeconomic group numbers (1-8) and the proportion of babies in each birthweight category (≤ 2500 g, ≤ 3000 g (this category includes that of ≤ 2500 g; it is valuable in providing larger numbers of cases), and 3001-4499 g), and the mean weights all showed a close fit to straight lines with steep gradients.¹ This sequence of socioeconomic numbers therefore seemed likely to provide a strong predictor of birth weight. Thus the extent to which differences between hospitals can be explained in terms of differences in the socioeconomic circumstances of the mothers has been investigated.

Several authors have pointed out the dangers of drawing conclusions from single hospital studies.²⁻³ It is often unclear how representative such studies are, particularly in their selection of patients. Bradshaw *et al*⁴ recently illustrated the importance of considering socioeconomic differences between regions when comparing infant mortality. They emphasised the unfairness of comparisons based on a simple league table of mortality.

Some measurement of the important socioeconomic factor is also necessary in any attempt to compare quality of care between hospitals by looking at the outcome of pregnancy or illness. The important, but little understood, "patient factor," as it influences outcome, rarely receives sufficient attention.

Data and statistical methods

The sources of data have been described.¹ Classification into eight socioeconomic groups was used, the British Registrar General's social classes I, II, IIIN, IIIM, IV, and V providing socioeconomic groups 1-6 respectively. Group 7 comprised mothers whose husband was unemployed and group 8 unmarried or otherwise unsupported mothers.

The mean socioeconomic number of patients in a hospital was calculated as:

$$s = \frac{\sum_{s=1}^8 (n_s \times s)}{N}$$

where n_s = number of mothers in socioeconomic group s and N = total number of mothers.

Patients who lived outside the greater Dublin area were excluded.

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Home addresses of unmarried mothers were not available, and all such mothers delivering in the seven units were included. A total of 257 pairs of twins and six sets of triplets were not included because their birth weights are not comparable with those of singletons in terms of prognosis for the infant; they should have been analysed separately, but the numbers were too small for this to be done.

Analysis of the results followed three stages. Firstly, the birthweight distribution and mean birth weight in each of the seven units were analysed in relation to the mean socioeconomic numbers. Secondly, "expected" numbers of cases in three birthweight categories were calculated for each hospital on each of three hypotheses—namely, that the birthweight distribution in each hospital can be predicted on the basis of (i) the average performance of the population. This calculation was made to provide a basis for comparison; (ii) the socioeconomic composition of patients in each hospital. Calculation was based on the numbers in each socioeconomic group in the hospital and the average weight distribution in that group in the total population. This hypothesis assumes that the socioeconomic groups perform true to form in all hospitals; and (iii) the birth-order composition of the deliveries in each hospital. The expected numbers calculated under these three hypotheses were compared with actual numbers using the χ^2 test. Finally, birthweight distributions in the socioeconomic groups in the four units providing sufficient cases were compared, with particular emphasis on the socioeconomic gradients.

Results

Table I summarises the excluded cases and the effect of their exclusion, which was to raise the mean weight by only 3 g; equally insignificant effects were seen on the birthweight distribution. The

TABLE I—Summary of cases excluded from analysis

	Socioeconomic group			All
	Unclassified	Military	1-8	
No of cases	38	450	19629	20117
Mean birth weight (SD)	3246 (960)	3366 (605)	3473 (579)	3470 (581)
% weighing:				
≤ 2500 g	13.2	5.1	4.4	4.4
≤ 3000 g	18.4	21.4	17.2	17.3
3001-4499 g	81.6	77.3	79.8	79.7
≥ 4500 g		1.6	3.0	3.0

TABLE II—Birthweight distributions and mean socioeconomic numbers in the seven maternity units

Unit	No of cases	Mean socioeconomic number (SE)	% of babies weighing:				Mean weight (SD) (g)
			≤ 2500 g	≤ 3000 g	3001-4499 g	≥ 4500 g	
A	296	2.470 (0.084)	2.4	11.8	84.5	3.7	3590 (605)
B	1186	2.825 (0.043)	2.5	13.3	83.6	3.1	3544 (561)
C	5133	4.103 (0.028)	3.7	15.3	80.9	3.8	3528 (572)
D	5590	4.160 (0.023)	4.6	17.0	80.4	2.7	3448 (557)
E	5333	4.368 (0.024)	4.8	18.1	79.1	2.8	3463 (601)
F	1772	5.173 (0.041)	5.3	22.9	74.5	2.6	3381 (578)
G	319	5.483 (0.117)	8.2	24.8	72.4	2.8	3324 (610)
All	19629	4.208 (0.013)	4.4	17.2	79.8	3.0	3473 (579)

analysis that follows was based exclusively on socioeconomic groups 1-8. The numbers of cases excluded because birth weight was unobtainable were distributed among the seven hospitals as follows: hospital A eight, hospital B four, hospital C eight, hospital D six, hospital E five, hospital F none, and hospital G one. Hospital A is now closed.

Table II summarises the birth weights. The seven units are listed in order of ascending mean socioeconomic numbers—that is, of increasing socioeconomic disadvantage among the mothers. Each mean socioeconomic number differed significantly from every other one at the 5% level. The proportions of babies in each birthweight category showed surprisingly wide ranges. The mean weight of babies born in the different units ranged from 3324 g to 3590 g. The order of ascending mean socioeconomic numbers was perfectly matched by the sequence of disimprovement in birthweight performance reflected in the proportions of babies in the first three weight categories; all of these therefore provided Spearman's rank correlation coefficients (r_s)

of unity with mean socioeconomic number. Mean weights, with one exception, followed the same sequence ($r_k = 0.96$, $p < 0.01$, $n = 7$).⁵

Table III shows the observed numbers of babies in each of the three mutually exclusive weight categories ≤ 3000 g, 3001-4499 g, and ≥ 4500 g. Listed beneath these are the numbers expected on the basis of each of the three hypotheses (i), (ii), and (iii) (see above). For each hospital χ^2 values are given with two degrees of freedom. The total χ^2 value for the table (12 df) was for (i) 102.56, (ii) 48.61, and (iii) 103.34.

TABLE III—Comparison between observed birthweight distribution and that expected on the basis of each of three hypotheses (i), (ii), and (iii)†

	Total No of cases	Birth weight			χ^2
		≤ 3000 g	3001-4499 g	≥ 4500 g	
Observed	296	35	<i>Hospital A</i> 250	11	
(i)		50.93	236.05	9.02	6.23*
(ii)		41.09	245.38	9.53	1.22 NS
(iii)		48.66	237.55	9.79	4.63 NS
Observed	1186	158	<i>Hospital B</i> 991	37	
(i)		204.06	945.79	36.15	12.58**
(ii)		171.35	976.04	38.62	1.34 NS
(iii)		198.83	949.76	37.40	10.17**
Observed	5133	784	<i>Hospital C</i> 4154	195	
(i)		883.19	4093.37	156.44	21.54***
(ii)		877.63	4100.11	155.27	20.87***
(iii)		895.52	4081.57	146.91	30.92***
Observed	5590	949	<i>Hospital D</i> 4492	149	
(i)		961.82	4457.81	170.37	3.11 NS
(ii)		947.14	4468.55	174.31	3.80 NS
(iii)		947.22	4470.16	172.62	3.34 NS
Observed	5333	965	<i>Hospital E</i> 4217	151	
(i)		917.60	4252.86	162.54	3.57 NS
(ii)		930.06	4240.83	162.11	2.20 NS
(iii)		918.44	4249.71	162.86	3.47 NS
Observed	1772	406	<i>Hospital F</i> 1320	46	
(i)		304.89	1413.10	54.01	40.85***
(ii)		342.92	1379.00	50.08	14.45**
(iii)		307.48	1406.93	56.60	38.91***
Observed	319	79	<i>Hospital G</i> 231	9	
(i)		54.86	254.42	9.72	12.83**
(ii)		65.82	245.09	8.09	3.55 NS
(iii)		57.02	252.12	9.86	10.32**

†Hypotheses: (i) that each hospital mirrors the population performance; and (ii) that each socioeconomic group and (iii) each birth-order group shows its population average performance in each hospital. Significance of difference (χ^2 test; 2 df): * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

103.34. All three values were significant at $p \leq 0.001$, but the value obtained from comparing numbers expected on the basis of the socioeconomic composition of the mothers in the hospitals, (ii), was less than half that obtained with the two other predictions. The calculation on the basis of the birth-order composition, (iii), provided no better prediction than the simple hypothesis that each hospital would reflect the population's average performance, (i). Five hospitals showed significant deviation from the prediction on the basis of both (i) and (iii) but only two on the basis of their socioeconomic composition, (ii). The results from both these hospitals (C and F), as was the general rule, were closer to the socioeconomic prediction than to either of the two other predictions.

Hospital C showed a significantly better performance than predicted from its socioeconomic composition, and hospital F a significantly worse performance than predicted. None of the five other hospitals showed any significant deviation from predictions on the basis of the socioeconomic composition of the mothers. The results show that

while being a good overall predictor, the socioeconomic composition does not explain all the variations between hospitals.

The assumption that each socioeconomic group would show the same birthweight distribution in each of the hospitals as it did in the population as a whole formed the basis of the prediction in hypothesis (ii). The results from hospitals C and F show that this assumption is not fully vindicated. An investigation of the performance of the various socioeconomic groups in the different hospitals was therefore indicated. Hospitals C, D, E, and F had adequate numbers for such investigation. Hospital B had extremely small numbers of cases in socioeconomic groups 5, 6, and 7 and had to be omitted, while A and G were too small to permit breakdown by socioeconomic group.

The proportions of cases in the three weight categories ≤ 2500 g, < 3000 g, and 3001-4499 g showed the usual straight-line relation with the socioeconomic groups (1-8) within each of the four hospitals as confirmed by the high correlation coefficients r (table IV). The figure shows regressions on socioeconomic group of the proportions of cases in each of the three birthweight categories, and of the mean birth weight, for each socioeconomic group. These provide the best available approximation to the socioeconomic gradients in birthweight performance in the four hospitals.

Comparison of the slopes (regression coefficient) of these lines using Student's t test² ($df = 2n - 4$) showed that the gradients were significantly different as follows: proportion of babies weighing ≤ 2500 g: hospital C v hospital D $p < 0.001$, hospital C v hospital E $p < 0.05$, hospital C v hospital F $p < 0.01$; proportion of babies weighing < 3000 g: hospital C v hospital D $p < 0.01$, hospital C v hospital F $p < 0.001$; proportion of babies weighing 3001-4499 g: hospital C v hospital D $p < 0.01$, hospital C v hospital F $p < 0.01$; and mean weight: hospital F v hospital C $p < 0.01$, hospital F v hospital D $p < 0.01$, hospital F v hospital E $p < 0.05$.

Thus the divergence that was apparent with increasing socioeconomic disadvantage in the birthweight categories was unlikely to be due to chance. The gradient at hospital F was almost significantly different from the two closely similar gradients at hospitals D and E, while these differed significantly from the gradient at hospital C. These three regressions were not independent and served to confirm one another. Regressions of mean weight on socioeconomic group also showed the steepest gradient at hospital F. The gradients at the three other hospitals were similar, but an overall difference in mean weight was evident between hospital C and the others.

Table IV provides detailed comparison of mean weights between hospitals. All eight socioeconomic groups showed a higher mean weight at hospital C than at hospital D (all eight achieving significance

at $p < 0.01$, average difference $97 \pm SE 13$ g) and at hospital C than at hospital E (five achieving significance at $p < 0.01$ and one at $p < 0.05$, average difference 69 ± 12 g). Seven of the eight socioeconomic groups showed a higher mean weight at hospital C than at hospital F (five with significance at $p < 0.01$, average difference 111 ± 28 g). Mean weight was consistently higher at hospital E than at hospital D, but this difference failed to reach significance except in socioeconomic group 6. Examination of table IV shows that the largest differences in mean weight between these pairs of hospitals occurred in socioeconomic groups 6, 7, 8, and, surprisingly, 1. The large differences in this last group served to reduce the differences in socioeconomic gradient in mean weight that would otherwise have emerged between hospitals C and D and E.

Discussion

The mean socioeconomic number provided a good overall predictor of the birthweight performance to be expected from each hospital studied. It provides a single measure of social-class composition that should be of value in comparing results from different hospitals. The more detailed calculation of expected numbers on the basis of the socioeconomic composition of the mothers in each hospital and the performance of the socioeconomic groups in the population as a whole confirmed this impression.

The study drew attention to two hospitals that showed some further variation. Hospital C showed a better, and hospital F a worse, birthweight distribution than predicted. Analysis of the socioeconomic gradient in birthweight distribution was possible for four hospitals and showed significant differences. Birthweight distribution into the three lighter categories showed straight-line trends diverging with rising socioeconomic number from similar values for the non-manual groups 1 to 3. The socioeconomic gradient in distribution of birth weights was thus steeper in some hospitals than in others. Hospital F showed the steepest gradients, hospitals D and E showed closely similar performances, and hospital C consistently showed the least steep gradient. This order reflects the order of descending mean socioeconomic numbers, although hospital D had a significantly lower mean socioeconomic number than hospital E. Hospital F

TABLE IV—Birthweight distribution by socioeconomic group in four largest maternity units. Correlation coefficients r with socioeconomic numbers indicate closeness of fit to straight line

	Socioeconomic group								r
	1	2	3	4	5	6	7	8	
Hospital C									
No of cases	397	698	929	1530	455	360	184	580	
% babies weighing:									
≤ 2500 g	2.5	2.9	3.3	3.6	2.6	5.0	2.7	6.7	0.65*
≤ 3000 g	10.6	11.9	13.7	14.4	17.8	16.9	17.4	23.6	0.94***
3001-4499 g	85.9	84.5	81.5	81.6	77.1	79.2	79.3	75.2	- 0.91**
Mean weight (g)	3610	3567	3585	3545	3504	3485	3516	3342	- 0.87**
SD of mean	528	532	589	578	566	574	542	577	
Hospital D									
No of cases	256	645	852	2103	625	453	351	305	
% babies weighing:									
≤ 2500 g	2.0	2.9	3.2	4.1	5.0	7.9	7.7	8.9	0.97***
≤ 3000 g	10.9	13.5	12.9	15.8	17.1	24.9	23.4	29.2	0.95***
3001-4499 g	86.7	83.3	83.8	81.4	80.8	72.4	74.4	69.8	- 0.94***
Mean weight (g)	3500	3504	3523	3469	3422	3332	3360	3266	- 0.93***
SD of mean	504	545	513	546	558	614	579	603	
Hospital E									
No of cases	239	572	621	1881	705	573	377	365	
% babies weighing:									
≤ 2500 g	3.3	2.8	3.5	4.4	4.3	5.9	5.3	11.5	0.81**
≤ 3000 g	14.6	13.6	14.8	17.5	16.5	20.1	22.0	31.8	0.87**
3001-4499 g	83.3	83.0	82.0	79.2	81.6	77.3	75.1	66.8	- 0.88**
Mean weight (g)	3502	3536	3526	3489	3458	3424	3398	3220	- 0.85**
SD of mean	558	557	603	596	572	628	562	687	
Hospital F									
No of cases		93	125	592	233	265	213	251	
% babies weighing:									
≤ 2500 g		2.2	3.2	4.7	3.0	5.7	8.5	8.0	0.89***
≤ 3000 g		11.8	15.2	20.8	21.9	23.0	25.8	34.3	0.96***
3001-4499 g		86.0	80.0	76.0	75.5	74.7	71.4	65.3	- 0.96**
Mean weight (g)	3407	3611	3536	3414	3416	3342	3341	3197	- 0.79**
SD of mean	580	520	534	571	560	575	655	520	

Significance of r : * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

drew its patients from the most disadvantaged area, hospitals D and E from intermediate areas, and hospital C from the most favoured area of the region.

Regressions of proportions of births in three lightest weight categories and of mean weight on social group in hospitals C, D, E, and F.

This difference between hospitals in the performance of the socioeconomic groups is probably mostly attributable to some sort of "area" effect. This may result from differences in attitudes and customs as much as in the physical attributes of the areas themselves. These differences may derive from social deprivation, especially in exchange of ideas, information, and behavioural norms. Whatever it was, this area factor had the effect of steepening the gradient in birthweight performance associated with social class by worsening the plight of the lower socioeconomic groups; it had little effect on socioeconomic groups 1 and 2, but even these may be experiencing some reduction in birth weight in the disadvantaged areas.

The alternative explanation that some hospitals are having more success than others in reducing the socioeconomic gradient in birthweight performance may also have contributed to the results obtained. It must, for instance, be possible to give more time and attention to antenatal advice for the most socially deprived mothers in a hospital where the proportion of such mothers is low.

Induction of labour may influence birth weights,⁶ though it is difficult to see how it might alter socioeconomic gradients.

Miller *et al.*⁷ noted that the key to the strong influence of socioeconomic condition on the outcome of pregnancy may lie among attitudes and practices rather than housing and unemployment. Alberman⁸ urged that, ideally, most preventive effort should be applied before conception in the promotion of good health and health behaviour. Recent important studies are pointing to a key role for nutrition, particularly vitamins^{9,10} and trace elements,¹¹ in determining the quality of outcome of pregnancy. Baric *et al.*¹² made a useful start in analysing the factors influencing health behaviour relevant to pregnancy. Much more needs to be done. Planners and educators, public health nurses, social workers, and even the Church need to be aware of the crucial influence of social, behavioural, and nutritional factors acting before conception to determine the mental and physical health of the next generation.

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Note. The names of hospitals A-G are available from VMD on request. Since the data include only those patients resident in the Dublin area, they are therefore not fully representative of any of the hospitals.

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THE British legislature has, of late years, shewn great attention to the preservation of infant-lives, by supporting the foundling hospital, &c. But we will venture to say, if one-tenth part of the sums laid out in supporting that institution, had been bestowed towards promoting the practice of inoculation of the small-pox among the poor, that not only more useful lives had been saved, but the practice ere now rendered quite universal in this island. It is not to be imagined what effect example and a little money will have upon the poor; yet, if left to themselves, they would go on for ever in the old way, without thinking of any improvement. We only mean this as a hint to the humane and public-spirited. Should such a scheme be approved, a proper plan might easily be laid down for the execution of it.

(Buchan's *Domestic Medicine*, 1786.)