Selection of Mothers with Increased Risk of Delivering Low Birthweight Newborns at a Public Maternity Hospital in Rosario, Argentina[1]

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A retrospective analysis was made of births occurring over a six-month period at a public maternity hospital in the city of Rosario, Argentina, with a view to planning actions reducing the likelihood of low birthweight deliveries. Fifteen risk factors were assessed. While a history of delivering a low birthweight infant was the leading risk factor for both intrauterine growth retardation and preterm delivery, the other leading risk factors for these two types of low birthweight newborns differed. Many variables relating to socioeconomic and cultural levels that have traditionally been considered risk factors for low birthweight did not display any significant association.

Risk calculations for the study population were made using data gathered at the patients' first prenatal checkup. These calculations indicated that mothers with one or more of four leading risk factors (a history of delivering low birthweight newborns, smoking more than two cigarettes a day, weighing less than 46 kg, and being less than 148 cm tall) constituted only 26.6% of the study population but accounted for 51.6% of the low birthweight deliveries. Such screening can provide an effective way of selecting high-risk mothers, and simple analyses of this sort are essential in planning health actions relating to low birthweight deliveries.

Low birthweight (≤2,500 g) is perhaps the greatest public health problem confronting the world's developing countries. This is because of its high incidence, consequent morbidity, physical and neurologic sequelae, and adverse impact on mental development (*1–3*).

It is accordingly imperative that steps be taken to lessen the incidence and seriousness of the problem. One attractive approach consists of detecting expectant mothers early who are at high risk of delivering low birthweight newborns (*4*), applying available corrective measures to them, and also offering them and their children the fullest possible medical, psychological, and social support so that the consequences of low birthweight can be reduced as much as possible.

Two categories of low birthweight newborns can be distinguished: those that are delivered preterm and those that have suffered intrauterine growth retardation (IUGR). Preterm newborns generally present the greatest survival problems and the most neonatal complications, while those that have suffered IUGR generally have greater impairment of physical growth and mental development, especially in cases of chronic retardation

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(i.e., retardation that began in early pregnancy) (3).

The Martin Maternity Hospital, a public institution of the city of Rosario, serves the poorest segments of that city's population. As a first step in planning measures to reduce low birthweight deliveries at the hospital, a six-month retrospective study of 1,209 mothers was undertaken to identify low birthweight risk factors. The results were then used to select pregnant women at high risk for whom corrective measures could be taken.

MATERIALS AND METHODS

The data used had been gathered at the hospital in the six months from August 1984 through January 1985. The hospital uses the Perinatal Clinical History developed by a group of Latin American specialists (5), and the information gathered is then transferred to a coded perinatal statistical summary (5). Data from these records are entered for computer processing, with great care being taken to ensure consistency.

Our study considered 15 independent variables about which information was obtained at the first prenatal checkup. These included an assortment of biological, anthropometric, obstetric, and socioeconomic indicators.

The dependent variables of our study were as follows:

- Low birthweight (LBW): A birthweight of 2,500 g or less, regardless of the newborn's gestational age.
- Intrauterine growth retardation (IUGR): A condition defined by a birthweight below the tenth percentile of the weight curve for gestational age published by Hoffman et al. (6).
- Preterm delivery: Delivery in less than 37 weeks after the start of amenorrhea.

Each of the 15 independent variables was analyzed with each of the dependent variables, and cutoff points for the independent variables (where an increase in any of the dependent variables was seen) were established on the basis of this analysis. The 15 independent variables and the cutoff points selected were as follows:

1. Low birthweight history (at least one previous low birthweight newborn)
2. Mother smokes (more than two cigarettes per day)
3. Low maternal weight (weight at start of pregnancy below the tenth percentile of the study population: 46 kg)
4. Low maternal height (height below the fifth percentile of the study population: 148 cm)
5. Maternal employment (works over four hours a day)
6. Education of spouse (spouse had no formal education)
7. Marital status (mother single)
8. Maternal age (mother under 18 or over 35 years old)
9. Housework (mother does housework unassisted)
10. Low weight:height ratio (mother's weight:height ratio below the tenth percentile of the study population)
11. Water supply (no in-house water supply)
12. Employment (spouse unemployed or employed as a laborer)
13. Housing (mother lives in home where over four people sleep per room)
14. Mother's education (mother had no formal education or incomplete primary schooling)

15. Siblings (mother has more than two live children)

Once the cutoff points were established, the relative risk and the attributable risk were calculated for each variable (see Tables 1–3).

Relative risk is the extent to which a particular risk factor increases the likelihood that affected mothers will deliver LBW, IUGR, or preterm newborns. The 95% confidence interval of each relative risk was also calculated. If the lower limit of this confidence interval failed to exceed 1, it was inferred that the risk incurred by the factor involved was not significant (4).

Attributable risk, for the purpose of this study, was considered to be the percentage by which the total incidence of LBW, IUGR, or preterm delivery would be reduced if the risk factor in question were completely eliminated.

RESULTS

Table 1 shows the different risk factors for detection of LBW. Column 1 shows the incidence of the risk factor in the study population. Column 2 shows the incidence of LBW occurring when this factor was present. Columns 3 and 4 show the relative risk (the multiplier by which LBW probability was increased or de-

Table 1. Apparent influence of the 15 risk factors upon low birthweight (LBW) among infants born to 1,209 mothers at the Martin Maternity Hospital in a six-month period (August 1984–January 1985). The overall incidence of LBW ($\leq$2,500g) in this population was 8.3%.

Risk factor	Risk factor incidence in study population (%)	Incidence of LBW (%)	Risk		Attributable risk (%)
			Relative risk	95% confidence limits	
1 Low birthweight history ($\geq$1 LBW newborn)	21.4	18.1	3.48	(2.37–6.65)	35
2 Mother smokes (>2 cigarettes/day)	14.8	13.3	1.56	(0.87–3.32)	7
3 Low maternal weight (<10th percentile: 46 kg)	11.3	7.7	1.26	(0.57–3.25)	3
4 Low maternal height (<5th percentile: 148 cm)	5.0	11.5	2.02	(0.74–7.88)	5
5 Maternal employment (>4 hours/day)	7.5	15.7	2.15	(1.29–4.51)	8
6 Education of spouse (none)	5.4	12.0	1.67	(0.79–4.44)	4
7 Single parent	17.2	10.0	1.32	(0.82–2.30)	5
8a Maternal age (<18 years)	11.8	12.0	1.56	(0.95–2.85)	6
8b Maternal age (>35 years)	5.6	13.4	1.70	(0.91–3.85)	4
9 Housework (mother does housework unassisted)	62.0	8.5	1.15	(0.75–1.80)	8
10 Low maternal weight:height ratio (<10th percentile)	10.0	4.3	0.78	(0.24–3.55)	−2
11 Water supply (none in house)	24.4	9.5	1.22	(0.78–2.02)	5
12 Employment (spouse unemployed or laborer)	65.8	7.5	0.91	(0.54–1.44)	−5
13 Housing (>4 per bedroom)	12.2	8.7	1.09	(0.60–2.09)	1
14 Mother's education (none or incomplete primary schooling)	46.8	8.6	1.09	(0.71–1.67)	4
15 Siblings (>2 live children)	39.0	5.6	0.60	(0.34–1.03)	−18

Table 2. Apparent influence of the 15 risk factors upon intrauterine growth retardation (IUGR) among infants born to the 1,209 study mothers. The overall incidence of IUGR was 6.8%.

Risk factor	Risk factor incidence in study population (%)	Incidence of IUGR (%)	Risk		Attributable risk (%)
			Relative risk	95% confidence limits	
1 Low birthweight history (≥1 LBW newborn)	21.4	14.8	3.75	(2.9–6.58)	37
2 Mother smokes (>2 cigarettes/day)	14.8	11.1	1.85	(0.94–4.41)	11
3 Low maternal weight (<10th percentile: 46 kg)	11.3	10.4	2.17	(1.06–5.28)	12
4 Low maternal height (<5th percentile: 148 cm)	5.0	12.5	2.5	(0.91–10.04)	7
5 Maternal employment (>4 hours/day)	7.5	10.4	1.65	(0.83–3.82)	5
6 Education of spouse (none)	5.4	9.1	1.57	(0.65–4.95)	3
7 Single parent	17.2	9.6	1.52	(0.92–12.27)	8
8a Maternal age (<18 years)	11.8	9.1	1.38	(0.78–2.75)	4
8b Maternal age (>35 years)	5.6	9.2	1.37	(0.64–3.47)	2
9 Housework (mother does housework unassisted)	62.0	7.4	1.34	(0.81–2.24)	17
10 Low maternal weight:height ratio (<10th percentile)	10.0	6.7	1.31	(0.46–4.80)	3
11 Water supply (none in house)	24.4	7.9	1.23	(0.75–2.16)	5
12 Employment (spouse unemployed or laborer)	65.8	6.3	1.05	(0.59–1.82)	3
13 Housing (>4 per bedroom)	12.2	6.7	1.00	(0.50–2.19)	0
14 Mother's education (none or incomplete primary schooling)	46.8	6.1	0.90	(0.55–1.46)	−5
15 Siblings (>2 live children)	39.0	4.5	0.59	(0.31–1.12)	−19

creased) and the 95% confidence interval of this relative risk. Column 5 shows the attributable risk (the percentage by which elimination of the factor in question would appear to reduce the incidence of LBW). As can be seen, a low birthweight history was the factor associated with the greatest relative risk of LBW (3.48). In other words, a mother with a history of one or more LBW newborns was 3.48 times as likely to deliver a LBW baby as a mother without this history. Only this factor and maternal employment exceeding four hours a day entailed relative risks with confidence intervals having lower limits greater than one.

Tables 2 and 3 present similar data on IUGR and preterm delivery. With regard to IUGR, the two factors registering significant relative risk (lower 95% confidence limit >1) were a low birthweight history and low maternal weight. Regarding preterm delivery (Table 3), the factors found to involve significant relative risk were low birthweight history and four others not indicated by the Table 1 or Table 2 data—these being education of the spouse, a maternal age less than 18 years, employment of the spouse, and education of the mother. In addition, the relative risk associated with low birthweight history (1.81) was considerably lower than the relative risks shown in Table 1 (3.48) and Table 2 (3.75).

Further analysis (shown in Tables 4–6) was performed supposing that a screen-

Table 3. Apparent influence of the 15 risk factors upon preterm deliveries among infants born to the 1,209 study mothers. The overall incidence of preterm delivery was 16.3%.

Risk factor	Risk factor incidence in study population (%)	Incidence of prematurity (%)	Risk		Attributable risk (%)
			Relative risk	95% confidence limits	
1 Low birthweight history (≥1 LBW newborn)	21.4	25.4	1.81	(1.40–3.13)	14
2 Mother smokes (>2 cigarettes/day)	14.8	17.8	1.02	(0.58–1.85)	0.3
3 Low maternal weight (<10th percentile: 46 kg)	11.3	11.5	1.29	(0.67–2.89)	3
4 Low maternal height (<5th percentile: 148 cm)	5.0	15.4	1.79	(0.73–6.03)	4
5 Maternal employment (>4 hours/day)	7.5	16.9	1.07	(0.57–2.20)	0.5
6 Education of spouse (none)	5.4	30.0	2.04	(1.35–4.74)	6
7 Single parent	17.2	17.0	1.10	(0.74–1.68)	2
8a Maternal age (<18 years)	11.8	22.5	1.46	(1.06–2.47)	5
8b Maternal age (>35 years)	5.6	10.4	0.63	(0.29–1.35)	−2
9 Housework (mother does housework unassisted)	62.0	17.3	1.24	(0.93–1.81)	13
10 Low maternal weight:height ratio (<10th percentile)	10.0	8.7	1.24	(0.49–3.89)	2
11 Water supply (none in house)	24.4	19.3	1.30	(0.97–1.95)	6
12 Employment (spouse unemployed or laborer)	65.8	18.1	1.56	(1.12–2.46)	27
13 Housing (>4 per bedroom)	12.2	17.5	1.10	(0.71–1.82)	1
14 Mother's education (none or incomplete primary schooling)	46.8	19.4	1.53	(1.19–2.27)	20
15 Siblings (>2 live children)	39.0	16.6	0.95	(0.65–1.36)	−2

ing program existed to detect high-risk women in the same population. For this purpose only pregnant women making their first prenatal visit before 21 weeks of amenorrhea were included.

The first three columns of Table 4 show the number of study subjects with the risk factor listed, the number delivering low birthweight infants, and the percentage delivering such infants. Thus, line 1 shows that 100 of the women had a LBW history, 22 of these delivered low birthweight infants, and so the percentage delivering low birthweight infants was also 22. Line 2 shows that 47 of the women with no LBW history were smokers, nine of these delivered LBW infants, and so the percentage delivering LBW infants was 19.1.

The next three columns in the table provide the same data in cumulative form, as the number of risk factors is progressively increased; and the last two columns show the cumulative percentages of all low birthweight deliveries and study population members included as the number of risk factors increases. Tables 5 and 6 provide parallel data for IUGR and preterm delivery.

These tables can be used to plan screening strategies. For example, consider a case in which only four risk factors (the first four) are selected, and mothers with at least one of these factors

Table 4. Cumulative influence of 11 risk factors upon low birthweight (LBW) deliveries by 625 mothers at the Martin Maternity Hospital who began their prenatal checkups before week 21.

Risk factor	Subjects with risk factor, excluding subjects previously listed			Cumulative data on subjects with listed risk factors			Cumulative % of study subjects	
	No. of subjects	No. of LBW deliveries	% with LBW deliveries	No. of subjects	No. of LBW deliveries	% with LBW deliveries	with at least one risk factor	delivering LBW newborns
1 Low birthweight history (≥1 LBW newborn)	100	22	22.0	100	22	22.0	16.0	34.4
2 Mother smokes (>2 cigarettes/day)	47	9	19.1	147	31	21.1	23.5	48.4
3 Low maternal weight (<10th percentile: 46 kg)	11	1	9.1	158	32	20.2	25.3	50.0
4 Low maternal height (<5th percentile: 148 cm)	8	1	12.5	166	33	19.9	26.6	51.6
5 Maternal employment (>4 hours/day)	30	2	6.7	196	35	17.9	31.4	54.7
6 Education of spouse (none)	20	1	5.0	216	36	16.7	34.6	56.2
7 Single parent	74	5	6.8	290	41	14.1	46.4	64.1
8 Maternal age (<18 or >35 years)	51	8	15.7	341	49	14.4	54.6	76.6
9 Housework (mother does housework unassisted)	187	10	5.3	528	59	11.2	84.5	92.2
10 Low maternal weight:height ratio (<10th percentile)	64	4	6.3	592	63	10.6	94.7	98.4
11 Water supply (none in house)	1	0	0.0	593	63	10.6	94.9	98.4
Subjects without risk factors 1–11	32	1	3.1	—	—	—	—	—
Total	625	64	10.2	625	64	10.2	100	100

Table 5. Cumulative influence of 11 risk factors upon infants with intrauterine growth retardation (IUGR) delivered to mothers who began their prenatal checkups before week 21.

Risk factor	Subjects with risk factor, excluding subjects previously listed			Cumulative data on subjects with listed risk factors			Cumulative % of study subjects	
	No. of subjects	No. delivering newborns with IUGR	% delivering newborns with IUGR	No. of subjects	No. delivering newborns with IUGR	% delivering newborns with IUGR	with at least one risk factor	delivering newborns with IUGR
1 Low birthweight history (≥1 LBW newborn)	88	13	14.8	88	13	14.8	16.0	31.7
2 Mother smokes (>2 cigarettes/day)	40	6	15.0	128	19	14.8	23.3	46.3
3 Low maternal weight (<10th percentile: 46 kg)	11	1	9.1	139	20	14.4	25.3	48.8
4 Low maternal height (<5th percentile: 148 cm)	7	0	0.0	146	20	13.7	26.5	48.8
5 Maternal employment (>4 hours/day)	26	0	0.0	172	20	11.6	31.3	48.8
6 Education of spouse (none)	15	1	6.7	187	21	11.2	34.0	51.2
7 Single parent	66	5	7.6	253	26	10.3	46.0	63.4
8 Maternal age (<18 or >35 years)	46	7	15.2	299	33	11.0	54.4	80.5
9 Housework (mother does housework unassisted)	165	5	3.0	464	38	8.2	84.4	92.7
10 Low maternal weight:height ratio (<10th percentile)	53	3	5.7	517	41	7.9	94.0	100
11 Water supply (none in house)	1	0	0.0	518	41	7.9	94.2	100
Subjects without risk factors 1–11	32	0	0.0	—	—	—	—	—
Total	550[a]	41	7.4	550[a]	41	7.4	100	100

[a]The study subjects were limited to mothers whose infants' birthweights and gestational ages were provided by available records.

Table 6. Cumulative influence of 11 risk factors upon preterm deliveries by 625 mothers who began their prenatal checkups before week 21.

Risk factor	Subjects with risk factor, excluding subjects previously listed			Cumulative data on subjects with listed risk factors			Cumulative % of study subjects	
	No. of subjects	No. of premature deliveries	% with premature deliveries	No. of subjects	No. of premature deliveries	% with premature deliveries	with at least one risk factor	delivering premature newborns
1 Low birthweight history (≥1 LBW newborn)	100	35	35.0	100	35	35.0	16.0	24.6
2 Mother smokes (>2 cigarettes/day)	47	12	25.1	147	47	32.0	23.5	33.1
3 Low maternal weight (<10th percentile: 46 kg)	11	1	9.1	158	48	30.4	25.3	33.8
4 Low maternal height (<5th percentile: 148 cm)	8	1	12.5	166	49	29.5	26.6	34.5
5 Maternal employment (>4 hours/day)	30	7	23.3	196	56	28.6	31.4	39.4
6 Education of spouse (none)	20	7	35.0	216	63	29.2	34.6	44.4
7 Single parent	74	17	23.0	290	80	27.6	46.4	56.3
8 Maternal age (<18 or >35 years)	51	10	19.6	341	90	26.4	54.6	63.4
9 Housework (mother does housework unassisted)	187	36	19.3	528	126	23.9	84.5	88.7
10 Low maternal weight:height ratio (<10th percentile)	64	15	23.4	592	141	23.8	94.7	99.3
11 Water supply (none in house)	1	0	0.0	593	141	23.8	94.9	99.3
Subjects without risk factors 1–11	32	1	3.1	—	—	—	—	—
Total	625	142	22.7	625	142	22.7	100	100

are included in the high-risk group. In the present instance, a total of 166 mothers (who delivered 33 LBW newborns) would have been included. In other words, 26.6% of the study population and 51.6% of the forthcoming low birthweight newborns would have been included. Clearly, an instrument that can detect half of all low birthweight newborns by selecting 25% of the population has much to commend it. Depending on the percentage of potential low-weight births one wishes to detect, one can raise or lower the number of risk factors, but of course this will also make the size of the selected high-risk group rise or fall.

DISCUSSION AND CONCLUSIONS

Some interesting points arise from this analysis that we believe will prove of interest to professionals working in this field.

First of all, it is recognized that the factors associated with IUGR and preterm delivery are different. Therefore, when designing a program to reduce the incidence of LBW, one must first determine whether reduction of preterm delivery and/or of IUGR should have priority, and should then select risk factors accordingly.

It is also noteworthy that a number of factors traditionally considered risk factors for the dependent variables of this study appeared to be of only minor significance. Thus, with regard to IUGR, socioeconomic and cultural variables such as education, spouse's occupation, crowding, and lack of an in-house water supply appeared to pose little relative risk. The question remains whether socioeconomic and cultural factors exercise little influence on IUGR or whether the particular indicators and cutoff points employed were not applicable to the study population for the purpose of distinguishing gradations of socioeconomic and cultural levels. For example, the condition of being a pregnant single woman has been described as a risk factor, but in our case it was not found to be significantly linked with IUGR or preterm delivery. Youthful pregnancy (below 18 years of age) appeared marginally linked with preterm delivery in our study but not with IUGR. (As was to be expected, the mother's height and weight were associated with IUGR but not with preterm delivery.)

Statistical analysis of these data also points up the importance and practical value of the attributable risk indicator. Proceeding on the basis of this indicator, health planners can pick out independent variables that can have a major impact on one or more of the dependent variables.

Nevertheless, selection of patients on the basis of risk factors has one limitation. The more cases with problems we want to detect, the larger will be the population we have to serve. If the corrective measures we propose to take are complex and costly, we would have to select the smallest possible population; but then, unfortunately, the theoretical number of selected cases with potential damage would also be smaller.

For instance, if the infrastructure of a maternity hospital can only provide special care for some 25% of its population, in the present instance it would be able to serve no more than 48.8% of those at high risk of delivering newborns with IUGR (see Table 5, "cumulative % of study subjects"). Assuming that the IUGR problem is considered extremely serious and that one wishes to provide advance coverage for 80% of the potentially affected newborns, in our case one would have to provide special care for 54.4% of the mothers. In general, health administrators will need to base their planning on considerations of this nature.

Finally, we would like to stress the importance of conducting this type of analysis before health actions are undertaken. The data processing involved is quite simple, no complex mathematical formulas need to be worked out, and a significant sample can be obtained quickly. Going ahead with expensive and laborious efforts without knowing what local factors hold sway or who should be the focus of priority actions, perhaps using rankings or risk factors derived from different situations, can result in the actions failing to achieve their desired aims, with a large consequent human and economic cost.

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