

Life-table analysis of the risk of perinatal death at term and post term in singleton pregnancies

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OBJECTIVE: This study was undertaken to estimate the cumulative risk of perinatal death associated with delivery at each gestational week both at term and post term.

STUDY DESIGN: The numbers of antepartum stillbirths, intrapartum stillbirths, neonatal deaths, and surviving neonates delivered at between 37 and 43 weeks' gestation in Scotland, 1985-1996, were obtained from national databases (n = 700,878) after exclusion of multiple pregnancies and deaths caused by congenital abnormality. The numbers of deaths at each gestational week were related to appropriate denominators: antepartum stillbirths were related to ongoing pregnancies, intrapartum stillbirths were related to all births (excluding antepartum stillbirths), and neonatal deaths were related to live births. The cumulative probability of perinatal death associated with delivery at each gestational week was estimated by means of life-table analysis.

RESULTS: The gestational week of delivery associated with the lowest cumulative risk of perinatal death was 38 weeks' gestation, whereas the perinatal mortality rate was lowest at 41 weeks' gestation. The risk of death increased more sharply among primigravid women after 38 weeks' gestation because of a greater risk of antepartum stillbirth. The relationships between risk of death and gestational age were similar for the periods 1985-1990 and 1991-1996.

CONCLUSION: Delivery at 38 weeks' gestation was associated with the lowest risk of perinatal death. (Am J Obstet Gynecol 2001;184:489-96.)

Key words: Fetal death, gestational age, infant mortality, life tables, population surveillance, risk

Most major textbooks of obstetrics and maternal-fetal medicine discuss the risk of perinatal death in relation to advancing gestational age at term and after term in the context of postdate pregnancy.^{1, 2} A meta-analysis of trials of routine induction of labor at 41 weeks' gestation appears to demonstrate a reduction in perinatal mortality with this practice.³ Understanding the potential for elective delivery to improve outcome and estimating sample size for trials of elective delivery require reasonable estimates of the probability of perinatal death at each gestational week. However, a number of different methods of estimating the risk of perinatal death at each gestational week have been described.⁴⁻⁶ Different methods of calculating the risk generate completely different patterns of estimated risk at term and after term, even

when applied to the same database,^{6, 7} and it is by no means clear which method is the best measure of the risk of perinatal death.

Estimating the probability of an event requires that the number of events (numerator) be divided by the number of subjects at risk for the event (denominator).⁸ Early studies of the risk of perinatal death at term used the perinatal mortality rate at each gestational week (the number of all perinatal deaths divided by the number of births in the given week) as an estimate of the probability of perinatal death at term. These studies are still quoted in recent texts.^{1, 2} However, it has been argued that the perinatal mortality rate is an inappropriate estimate of the probability of antepartum stillbirth, the commonest form of perinatal death at term, because the population at risk for antepartum stillbirth in a given gestational week consists of all ongoing pregnancies, rather than just the babies born in that week.⁴ Analyses of intrapartum stillbirths and neonatal deaths (at term) have demonstrated that most of these deaths are the result of intrapartum events, such as cord accidents, intrapartum asphyxia, meconium aspiration, and birth trauma.^{9, 10} The population at risk for these outcomes is those born in a given gestational week. It therefore follows that estimating the summed risk of perinatal death (antepartum stillbirth, intrapartum stillbirth, and neonatal death) associated with birth in a given gestational

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week requires summation of risks calculated with different denominators.

Furthermore, all current methods for estimating the risk of a given type of perinatal death calculate the risk for a given gestational week conditional on survival of the fetus until that given gestational week. However, the fetus is clearly exposed to the risk of antepartum stillbirth in the weeks preceding the week of delivery. The week-on-week risk of stillbirth is termed the *cumulative risk*, and the relative contribution of the cumulative risk of antepartum stillbirth to the total risk of perinatal death has not previously been addressed.

In this study the issues of summing risks from different denominators and estimation of cumulative risk were addressed by means of life-table analysis.

Material and methods

Population. The numbers of singleton births at each gestational week at term and after term in Scotland were obtained through analysis of the Scottish Morbidity Record (maternity), a national database of pregnancy information that has been >99% complete since the late 1970s,¹¹ between 1985 and 1996. Gestational age at birth was recorded in completed weeks' gestation and was calculated from the estimated date of delivery in each woman's clinical record, derived from her menstrual history and adjusted for ultrasonography when performed. Cases were excluded if the gestational age at delivery was >43 weeks' gestation (0.03% of the total), because these were the most likely to have an incorrect gestational age assignment.

The numbers and types of singleton perinatal deaths at each gestational week between 1985 and 1996 were obtained from the Scottish Stillbirth and Neonatal Death Enquiry. This national system has routinely classified all perinatal deaths in Scotland since 1983 and is described elsewhere.¹² Deaths caused by a congenital abnormality were excluded. The inclusion and exclusion criteria left a study group of 700,878 singleton term pregnancies.

Definitions. Term was considered to be ≥ 37 weeks' gestation. Stillbirths were considered to be babies that showed no signs of life after delivery. Stillbirths were subdivided into antepartum stillbirths (deaths before the onset of labor) and intrapartum stillbirths (deaths during labor). Neonatal deaths were considered to be live-born babies that died within the first 4 weeks after birth. Late neonatal deaths (from the second week to the fourth week after birth) are not conventionally included in analyses of perinatal mortality. However, most late neonatal deaths can be attributed to obstetric factors,¹³ even when confined to term and postterm pregnancies,⁹ and late neonatal deaths were therefore included in this analysis. Deaths caused by congenital abnormality were considered to be indicated by the presence of any structural or genetic defect incompatible with life, or poten-

tially treatable but causing death. Autopsy was performed in 78% of stillbirth cases during the study period.

Data analysis. All estimates of probability were derived from the following information: the number of ongoing pregnancies at the beginning of gestational week n (P_n), the number of all births at gestational week n (B_n), the number of antepartum stillbirths at gestational week n (A_n), the number of intrapartum stillbirths at gestational week n (I_n), and the number of neonatal deaths among babies born at gestational week n (N_n).

Estimates of conditional probability. The conditional probability of an antepartum stillbirth at gestational week n (PA_n) was estimated by the number of antepartum stillbirths in that week, divided by the number of ongoing pregnancies minus half of the births in the given week as follows:

$$PA_n = A_n / [P_n - (0.5 \times B_n)] \quad [1]$$

The probability of intrapartum stillbirth in gestational week n (PI_n) was estimated by the number of intrapartum stillbirths divided by the number of all births in the given gestational week excluding antepartum stillbirths:

$$PI_n = I_n / (B_n - A_n) \quad [2]$$

The probability of neonatal death in gestational week n (PN_n) was estimated by the number of neonatal deaths among babies born at gestational week n divided by the number of live births in gestational week n :

$$PN_n = N_n / [B_n - (A_n + I_n)] \quad [3]$$

Estimates of cumulative probability. The cumulative probability of an event can be calculated by a number of methods. Computationally the simplest way is to calculate the cumulative probability of survival, which in turn is the product of the conditional probabilities of survival. The probability of survival is simply $1 - \text{Probability of death}$. Therefore the cumulative probability of death from antepartum stillbirth at gestational week n (PC_n) is estimated by the following equation:

$$PC_n = 1 - [(1 - PA_{37}) \times (1 - PA_{38}) \dots \times (1 - PA_n)] \quad [4]$$

The cumulative probability of perinatal death associated with delivery at gestational week n (PD_n) was estimated as $1 - \text{Product of the probabilities of survival relating to (1) surviving antepartum stillbirth from gestational week 37 to delivery, (2) surviving without intrapartum stillbirth after delivery in gestational week } n, \text{ and (3) surviving without neonatal death after delivery in gestational week } n$.

$$PD_n = 1 - ([1 - PC_{n-1}] \times [1 - (PA_n \times 0.5)] \times [1 - PI_n] \times [1 - PN_n]) \quad [5]$$

The perinatal risk index is simply the cumulative probability of perinatal death at gestational week n multiplied by 1000.

Table I. Life-table analysis of risks of antepartum stillbirth at term and after term, Scotland, 1985-1996

Gestational wk	Ongoing pregnancy (No.)	Antepartum stillbirth (No.)	All other births (No.)	Conditional probability of antepartum stillbirth	95% Confidence interval	Cumulative probability of antepartum stillbirth	95% Confidence interval
37	700,878	256	33,933	0.0004	0.0003-0.0004	0.0004	0.0003-0.0004
38	666,689	276	88,943	0.0004	0.0004-0.0005	0.0008	0.0008-0.0009
39	577,470	249	147,195	0.0005	0.0004-0.0006	0.0013	0.0012-0.0014
40	430,026	274	246,193	0.0009	0.0008-0.0010	0.0022	0.0021-0.0023
41	183,559	134	146,212	0.0012	0.0010-0.0014	0.0034	0.0032-0.0037
42	37,213	37	35,901	0.0019	0.0014-0.0026	0.0053	0.0047-0.006
43	1,275	4	1,271	0.0063	0.0017-0.0160	0.0115	0.0068-0.0196

The conditional probability of antepartum stillbirth was estimated according to equation 1 in the Material and Methods section, and the cumulative probability of antepartum stillbirth was estimated according to equation 4.

Table II. Estimated probabilities of intrapartum stillbirth and neonatal death associated with gestational week of delivery, Scotland, 1985-1996

Gestational wk	Live birth (No.)	Intrapartum stillbirth (No.)	Neonatal death (No.)	Probability of intrapartum stillbirth	95% Confidence interval	Probability of neonatal death	95% Confidence interval
37	33,909	24	43	0.0007	0.0005-0.0011	0.0013	0.0009-0.0017
38	88,915	28	54	0.0003	0.0002-0.0005	0.0006	0.0005-0.0008
39	147,162	33	70	0.0002	0.0002-0.0003	0.0005	0.0004-0.0006
40	246,118	75	154	0.0003	0.0002-0.0004	0.0006	0.0005-0.0007
41	146,169	43	82	0.0003	0.0002-0.0004	0.0006	0.0004-0.0007
42	35,887	14	21	0.0004	0.0002-0.0007	0.0006	0.0004-0.0009
43	1,271	0	1	0	0.0000-0.0024*	0.0008	0.0002-0.0044

The probability of intrapartum stillbirth was estimated according to equation 2 in the Material and Methods section, and the probability of neonatal death was estimated according to equation 3 in the Material and Methods section.

*One-sided 97.5% confidence interval.

Correction for censoring. It is assumed in all these equations that births occur randomly during a given gestational week. Therefore in equation 1 the denominator is all ongoing pregnancies minus half the number of births, and in equation 5 the risk of antepartum stillbirth in the gestational week of delivery is half the conditional risk in the gestational week of delivery. Both of these correct for the number of pregnancies in a given gestational week that are delivered.

Statistical analysis. Correlation was determined with the Pearson correlation coefficient. Risks of individual events were estimated by binomial 95% confidence intervals, and the risk of events was compared between gestational weeks by comparing the relative risks and 95% confidence intervals. Relative risks adjusted for gestational week of delivery and heterogeneity of relative risks across gestational weeks were calculated with the Mantel-Haenszel method.⁸ The method of life table analysis is described in detail elsewhere.⁸ Survival curves were compared with the likelihood ratio test for heterogeneity.¹⁴ Statistical analysis was performed with the Stata (version 6.0; Stata Corporation, College Station, Tex) software package.

Results

There were 700,878 singleton births at 37 to 43 weeks' gestation, excluding perinatal deaths caused by congenital abnormality, in Scotland between 1985 and 1996. Among this group there were 1230 antepartum stillbirths, 217 intrapartum stillbirths, and 425 neonatal deaths. There was no significant correlation (among primigravid women) between year of the birth and the proportion in whom labor was induced (overall, 25.8% had labor induced; r^2 vs year = 0.1; $P = .22$) or the proportion delivered at ≥ 42 weeks' gestation (overall, 6.9% were born after 41 weeks' gestation; r^2 vs year = 0.0; $P = .87$).

The conditional and cumulative probabilities of antepartum stillbirth from 37 weeks' gestation onward are tabulated in Table I. The conditional risk of antepartum stillbirth rose from 40 weeks' gestation onward. The risks of intrapartum stillbirth and neonatal death were elevated at 37 weeks' gestation and essentially constant from 38 weeks' gestation onward (Table II). Compared with 38 weeks' gestation, the relative risk of intrapartum stillbirth associated with delivery at 37 weeks' gestation was 2.2 (95% confidence interval, 1.3-3.9), and the relative risk of neonatal death was 2.1 (95% confidence interval, 1.4-3.1).

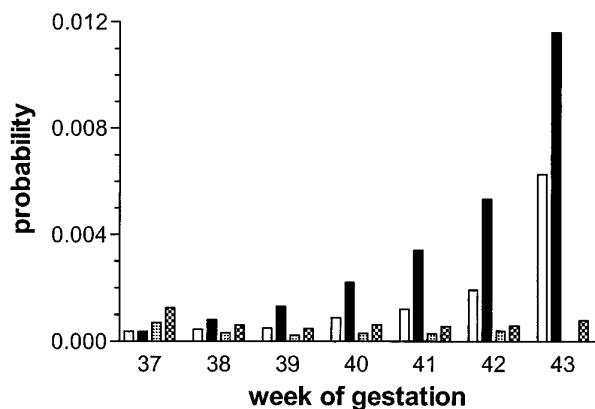


Fig 1. Estimated probabilities of antepartum stillbirth (both conditional risk, *white bars*, and cumulative risk, *black bars*), intrapartum stillbirth (*fine-dotted bars*), and neonatal death (*heavy-dotted bars*) associated with delivery at each gestational week at term and after term in Scotland, 1985-1996.

When the probabilities of the different events were graphed, the greatest risk of death associated with advancing gestational age at term and after term was the cumulative risk of antepartum stillbirth (Fig 1). From the individual risks the summed cumulative risk of perinatal death associated with delivery at each gestational week was estimated as the perinatal risk index (the cumulative probability of perinatal death multiplied by 1000), and the calculation is outlined with a conditional probability tree¹⁵ in Fig 2. The perinatal risk index associated with delivery at 38 weeks' gestation was lowest, whereas the perinatal mortality rate at 41 weeks' gestation was lowest (Fig 3). The pairwise differences in the perinatal risk index values associated with delivery at each gestational week at term and after term are shown in Table III.

The relationship between the perinatal risk index and gestational age was virtually identical in comparing births between 1985-1990 and 1991-1996 (Fig 4, *A*). The increase in perinatal risk index after 38 weeks' gestation appeared to be greater among primigravid women than among parous women (Fig 4, *B*). The survival curves for antepartum stillbirth differed for primigravid and parous women, with a greater cumulative probability of death with advancing gestational age among primigravid women (Fig 5). The risk of intrapartum stillbirth was not increased among primigravid women (Mantel-Haenszel combined relative risk, 1.15; 95% confidence interval, 0.88-1.51), and there was no evidence of heterogeneity in the relative risk related to gestational week of delivery (Mantel-Haenszel test of heterogeneity, $\chi^2 = 6.3$; $P = .28$). The risk of neonatal death was greater among primigravid women (Mantel-Haenszel combined relative risk, 1.26; 95% confidence interval, 1.04-1.53), but there was no evidence that the risk varied with gestational week of delivery (Mantel-Haenszel test of heterogeneity, $\chi^2 = 2.1$; $P = .83$).

To illustrate the effect of denominators on the estimation of risk of perinatal death, the risks of antepartum stillbirth, intrapartum stillbirth, and neonatal death were calculated at 41 weeks' gestation relative to 39 weeks' gestation with both ongoing pregnancies at the beginning of a given gestational week and all births during a given gestational week used as denominators. When the numbers of a given type of death were related to the number of ongoing pregnancies, the relative risks at 41 weeks' gestation compared with 39 weeks' gestation were as follows: antepartum stillbirth, 1.7 (95% confidence interval, 1.4-2.1); intrapartum stillbirth, 4.1 (95% confidence interval, 2.6-6.5); and neonatal death, 3.7 (95% confidence interval, 2.7-5.1). When the numbers of a given type of death were related to the number of all births in the given week, the relative risks at 41 weeks' gestation compared with 39 weeks' gestation were as follows: antepartum stillbirth, 0.5 (95% confidence interval, 0.4-0.7); intrapartum stillbirth, 1.3 (95% confidence interval, 0.8-2.1); and neonatal death, 1.2 (95% confidence interval, 0.9-1.6).

Comment

A range of denominators have been used to estimate the probability of perinatal death in relation to gestational week, including all births⁶ and all ongoing pregnancies.^{4, 16} In this study the probabilities of different types of perinatal death were estimated with different denominators, and the different consequences of antepartum and intrapartum obstetric events were taken into account. These probabilities were summed, and the cumulative probability of perinatal death associated with birth at each gestational week at term was estimated with a life-table approach. This estimated probability was then converted into a novel index, the perinatal risk index, by multiplying the estimated cumulative probability of perinatal death by 1000. The perinatal risk index can be conceptualized as the number of perinatal deaths that would be predicted among 1000 fetuses alive at the start of a reference gestational week (in this case, the 37th completed gestational week) and all delivered in the same gestational week. Estimating the risk of perinatal death in this manner demonstrated that the gestational week of delivery at term and postterm associated with the lowest cumulative risk of perinatal death was 38 weeks' gestation.

These data relate to a combination of spontaneous and elective deliveries. It does not follow that the apparent beneficial effect of delivery at 38 weeks' gestation would be maintained if all women were electively delivered at 38 weeks' gestation. Furthermore, rates of emergency cesarean delivery and assisted vaginal delivery are much greater with induced labor.¹⁷ A blanket policy of induction of labor at 38 or 39 weeks' gestation would certainly be associated with an unacceptable increase in the rate of obstetric intervention. However, the data do suggest that improved methods for inducing labor might be one av-

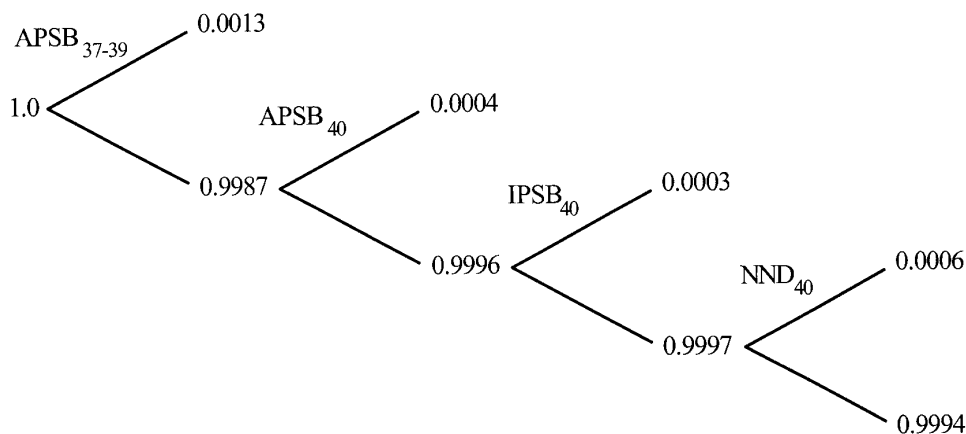


Fig 2. Schematic outline of calculation of cumulative probability of perinatal death (perinatal risk index) associated with delivery at 40 weeks' gestation. Cumulative probability of antepartum stillbirth until 39 weeks' gestation ($APSB_{37-39}$; 0.0013) is obtained from Table I (calculated with equation 4). Conditional probability of antepartum stillbirth in gestational week of delivery ($APSB_{40}$; 0.0004) is estimated with equation 1 and multiplied by 0.5 to correct for babies being born during the week. Probabilities of intrapartum stillbirth ($IPSB_{40}$; 0.0003) and neonatal death (NND_{40} ; 0.0006) are obtained from Table II and estimated with equations 2 and 3, respectively. Cumulative probability of survival is $0.9987 \times 0.9996 \times 0.9997 \times 0.9994 = 0.9974$. Cumulative probability of perinatal death is $1 - 0.9974 = 0.0026$. Perinatal risk index is cumulative probability of perinatal death multiplied by 1000.

enue of research in attempting to address the relatively high loss rate among normally formed babies at term through antepartum stillbirth. Further studies should attempt to determine whether elective delivery affects the risks of intrapartum stillbirth and neonatal death. The relatively modest increase in the conditional risk of antepartum stillbirth around 38 to 40 weeks' gestation (Table I) suggests that attempts to prevent stillbirth through increased antepartum fetal surveillance may not be feasible.

Three major technical issues were addressed in this study. First, previous studies of the risk of antepartum stillbirth at a given gestational week were estimated conditional on the survival of the fetus to that given week.^{4, 7, 16} This is the first study to my knowledge that has estimated the cumulative risk. The important distinction between cumulative and conditional risk can be illustrated by the example of Russian roulette. The risk of death with a 6-chambered revolver is 1 in 6. The risk at the sixth shot is still 1 in 6. However, this assumes survival after all the preceding exposures. The probability of death after a prospective decision to expose an individual to 6 shots is clearly not reliably estimated by the proportion of individuals killed while taking their sixth shot. Similarly, the conditional probability of antepartum stillbirth at a given gestational week fails to take into account the risks of death in all the preceding weeks. This analysis demonstrated that the cumulative risk of antepartum stillbirth is the major determinant of the risk of perinatal death associated with advancing gestational week (Fig 1).

The second major technical issue addressed by this study was the use of appropriate denominators when the probabilities of different types of perinatal death are esti-

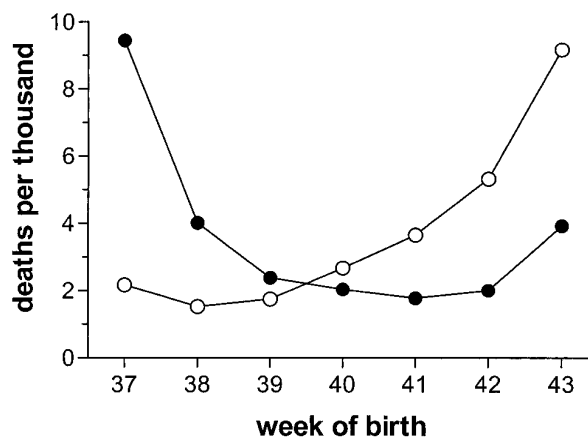


Fig 3. Perinatal risk index (open circles) and perinatal mortality rate (filled circles) related to birth at each gestational week between 37 and 43 weeks' gestation in Scotland, 1985 through 1996, expressed as deaths per thousand. Perinatal risk index is cumulative probability of perinatal death (equation 5) multiplied by 1000. Perinatal mortality rate is number of perinatal deaths with delivery in given gestational week divided by total number of births in that week multiplied by 1000.

mated, an issue that was in turn related to the distinction between antepartum and intrapartum obstetric events leading to perinatal death. Most perinatal deaths are related to obstetric events.¹³ Some authors have equated obstetric events with antepartum events, which has led them to relate the number of all types of perinatal death to the number of ongoing pregnancies in a given gestational week.¹⁶ Although antepartum stillbirths must necessarily be caused by antepartum events, analyses of the causes of intrapartum stillbirth and neonatal death indi-

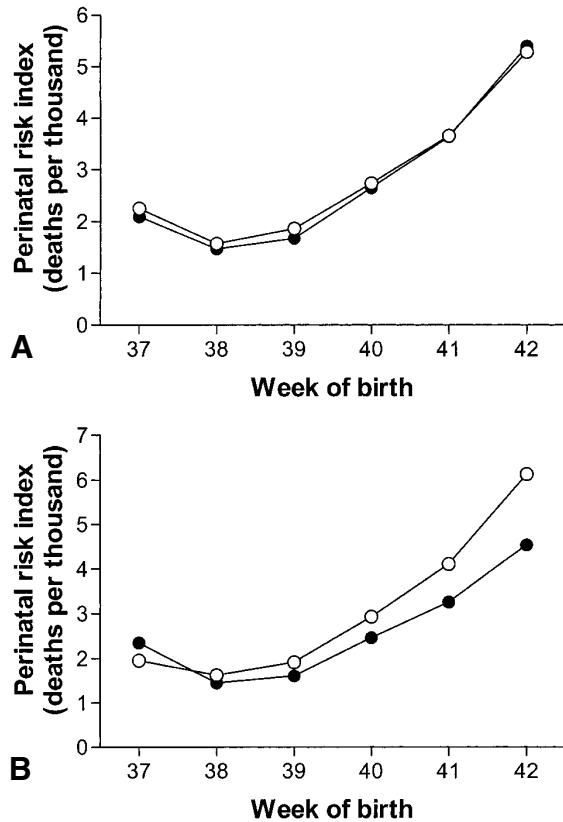


Fig 4. A, Perinatal risk index values for all births in Scotland, 1985-1996, compared between intervals 1985-1990 (*open circles*) and 1991-1996 (*filled circles*). **B,** Perinatal risk index values for all births in Scotland, 1985-1996, compared between primigravid (*open circles*) and parous (*filled circles*) women. No comparison was made for 43rd gestational week and beyond because of very small numbers of perinatal deaths ($n = 5$) and surviving infants ($n = 1270$).

Table III. Pairwise differences in perinatal risk index values at different gestational weeks, Scotland, 1985-1996

	37 wk	38 wk	39 wk	40 wk	41 wk	42 wk
38 wk	-0.7	—	—	—	—	—
39 wk	-0.4	0.2	—	—	—	—
40 wk	0.5	1.2	0.9	—	—	—
41 wk	1.5	2.1	1.9	1.0	—	—
42 wk	3.1	3.8	3.6	2.6	1.7	—
43 wk	7	7.7	7.4	6.5	5.5	3.9

Perinatal risk index is calculated as the cumulative probability of perinatal death (from equation 5 in the Material and Methods section) multiplied by 1000. Differences are expressed in deaths per thousand pregnancies, and the column was subtracted from the row. A positive value indicates that the perinatal risk index was lower in the gestational week in the column and a negative value indicates that the perinatal risk index was lower in the gestational week in the row.

cate that most of these are caused by events that will occur only during labor and delivery, such as cord prolapse, birth trauma (including shoulder dystocia), intrapartum asphyxia, and meconium aspiration.^{9, 10}

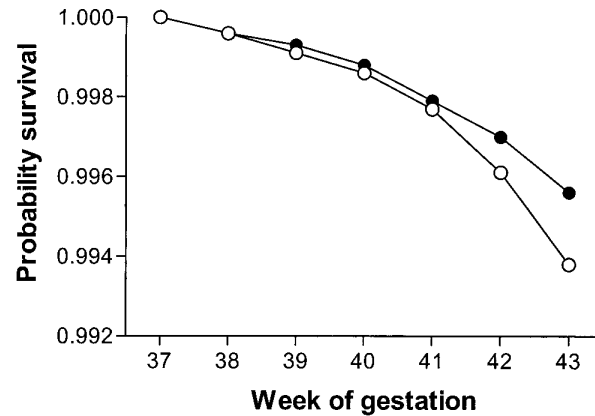


Fig 5. Cumulative probabilities of survival with respect to antepartum stillbirth for primigravid (*open circles*) and parous (*closed circles*) women, Scotland, 1985-1996. Start is at 37 weeks' gestation with value of 1.0. Value at each gestational week thereafter is probability of survival to very beginning of that completed week (eg, 38 weeks' gestation is 38 completed gestational weeks 0 hours 0 days). No data are presented for 43rd gestational week and beyond because there were only 4 antepartum stillbirths in this period. Likelihood ratio test for homogeneity comparing primigravid and parous women yielded $\chi^2 = 21.3$ (1 degree of freedom); $P < .0001$.

The significance of denominators is 2-fold. First, if most intrapartum stillbirths and neonatal deaths are caused by events during labor and delivery, then the number of these deaths should be related to the population exposed to this risk, namely, that fraction of pregnancies delivered in a given gestational week. If labor-related and delivery-related events are expressed as a proportion of all ongoing pregnancies, the risks of these events will tend to be systematically underestimated, and the magnitude of the underestimate will be systematically greater at earlier gestational ages, because the actual population at risk (babies being born) makes up a progressively larger proportion of all ongoing pregnancies as gestational age advances. Second, if these events are largely related to labor and delivery, then (because labor and delivery are necessarily not recurrent) there is no issue of cumulative risk.

I sought to determine whether the data included any inferences that might shed light on this question. The risks of antepartum stillbirth, intrapartum stillbirth, and neonatal death were directly compared at 41 weeks' gestation and at 39 weeks' gestation. This was done twice for each analysis, once with all ongoing pregnancies as the denominator and once with the number of births in the given gestational week as the denominator. When compared with all births as the denominator, the relative risks of intrapartum stillbirth and neonatal death were very similar between 41 and 39 weeks' gestation. When compared with ongoing pregnancies as the denominator, however, apparent, dramatically increased risks of both of

these events were observed at 41 weeks' gestation. As discussed previously, the effect of using ongoing pregnancies as the denominator for delivery-related events would be to overestimate the risk associated with advancing gestational age. There is no evidence elsewhere to suggest dramatically increased risks of either intrapartum stillbirth or neonatal death at 41 weeks' gestation relative to 39 weeks' gestation. Conversely, when the risks of antepartum stillbirth at 41 and 39 weeks' gestation were compared with different denominators, the relative risk at 41 weeks' gestation was 1.7 when related to ongoing pregnancies but only 0.5 when related to all births. This is consistent with the assertion of Yudkin et al⁴ that relating antepartum events to births systematically underestimates the risk associated with advancing gestation. These findings underline the necessity to clarify and justify denominators when the risks of different types of perinatal death are estimated.

The third technical issue addressed in this article is the effect of censoring. It was assumed by Yudkin et al⁴ that all pregnancies that were ongoing at the beginning of a 2-gestational week period were exposed to the risk of antepartum stillbirth for the full 2 weeks.⁴ In reality, however, a proportion of babies would have been delivered during that interval. Furthermore, the proportion of all ongoing pregnancies that would be delivered in a given interval will systematically increase with advancing gestational age. This analysis would therefore systematically overestimate the denominator for antepartum stillbirth, and the extent of the overestimate would be systematically greater with advancing gestational age. Consequently, this error will result in a systematic tendency to underestimate the conditional risk of antepartum stillbirth in a given gestational week with advancing gestational age. In this analysis this issue was also addressed with a life-table approach, which corrects the estimated probability for censoring caused by birth.

The reference gestational week in this study was taken as 37 weeks' gestation. The principal aim of this study was to determine which gestational week of delivery at term was associated with the lowest risk of death. Even if earlier gestational weeks had been taken into account, the pattern of change in the perinatal risk index at term and post-term would have been the same, because all babies ultimately delivered at term and after term would have been exposed to the same duration of risk of antepartum stillbirth before 37 weeks' gestation. The perinatal risk index could easily be calculated with an earlier gestational age as a reference. However, a major drawback of looking at earlier gestations is that the interval between antepartum intrauterine death and delivery of the stillborn baby is more likely to be very prolonged before term.

There are certain weaknesses in this analysis. First, as in previous studies of the stillbirth risk,^{4, 7, 16} it has been assumed that all antepartum fetal deaths took place in the

same gestational week as the gestational week of delivery. It is virtually certain that some of these deaths preceded delivery by >1 week. However, in Scotland women at term are generally seen for prenatal care at weekly intervals, and these visits routinely involve auscultation of the fetal heartbeat.¹⁸ The standard management of antepartum stillbirth in Scotland is immediate induction of labor.¹⁹ Furthermore, a previous analysis of the database demonstrated that at term the differences in the 25th, 50th, and 75th percentiles of birth weight between live births and stillbirths was generally <15%,²⁰ which is consistent with the association between growth restriction and stillbirth²¹ but not suggestive of widespread maceration of stillborn fetuses at term. A prolonged interval between intrauterine death and eventual delivery of the stillborn baby would have 2 opposing effects on the estimate of the cumulative risk of antepartum stillbirth. First, the conditional risk in a given gestational week would be overestimated, because the denominator (all ongoing pregnancies in a given gestational week) decreases with advancing gestational age. Second, the pattern of increase in the risk of antepartum stillbirth would be underestimated with respect to gestational age, because deaths occurring in earlier weeks are erroneously attributed to the actual gestational week of delivery. Current data do not allow the net effect of these errors on the cumulative risk to be established, and this would be another appropriate area for further study.

A second weakness in this study is that there was no attempt to exclude perinatal deaths related to maternal conditions. For instance, mothers with diabetes are more likely to be electively delivered before 40 weeks' gestation, and fetuses of mothers with diabetes are at increased risk for stillbirth and neonatal death.²² However, <5% of perinatal deaths at term are related to maternal illness, and the effect of excluding deaths related to maternal medical conditions is therefore likely to be small.⁹

Finally, the database recorded gestational age on the basis of the accepted estimated date of delivery in the patient's clinical record. It is likely that the proportion of cases in which this estimate was corrected because of early ultrasonographic results varied during the study period. Routine ultrasonographic dating is currently performed in >95% of pregnancies in Britain,²³ and standard criteria were disseminated by the British Medical Ultrasound Society in 1990 to establish continuity in the method by which an estimated date of delivery is calculated.²⁴ However, the pattern of change in the index was virtually identical comparing data from 1985-1990 with data from 1991-1996 (Fig 4, A). It therefore seems unlikely that increased use of ultrasonographic dating or other changes in obstetric practice during the study period had a major influence on the calculated relationship between gestational week at birth and the perinatal risk index.

The potential for this analysis to detect differences in risk and to determine the causes of these differences is highlighted by the comparison of primigravid and parous women (Fig 4, *B*). This comparison demonstrated a sharper rise in the risk of perinatal death after the 38-gestational week nadir among primigravid women. Examination of the individual determinants of the index demonstrated that there was an increased risk of antepartum stillbirth among primigravid women (Fig 5), which is consistent with other studies.⁷

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