Original Article

Antenatal care, identification of suboptimal fetal growth and risk of late stillbirth: Findings from the Auckland Stillbirth Study

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Introduction: Stillbirth remains an important public health problem in Australia and New Zealand. The role that antenatal care plays in the prevention of stillbirth in high-income countries is unclear.

Methods: Cases were women with a singleton, late stillbirth without congenital abnormality, booked to deliver in the Auckland region and born between July 2006 and June 2009. Two controls with ongoing pregnancies were randomly selected at the same gestation at which the stillbirth occurred. Data were collected through interview-administered questionnaires and from antenatal records.

Results: One hundred and fifty five of 215 (72%) cases and 310 of 429 (72%) controls consented to take part in the study. Accessing <50% of recommended antenatal visits was associated with a more than twofold increase in late stillbirth (adjusted odds ratio, aOR, 2.68; 95% CI, 1.04–6.90) compared with accessing the recommended number of visits. Small-for-gestational-age (SGA) babies that had not been identified as SGA prior to birth were significantly more at risk of being stillborn (aOR, 9.46; 95% CI, 1.98–45.13) compared with SGA babies that were identified as such in the antenatal period. No relationship was found between type or model of maternity care provider at booking and late stillbirth risk.

Discussion: This study reinforces the importance of regular antenatal care attendance. Identification of SGA may be one way by which antenatal care reduces stillbirth.

Key words: antenatal care, New Zealand, risk factors, small for gestational age, stillbirth.

Introduction

Stillbirth remains a common and devastating complication of pregnancy. More than 7 in 1000 births in Australia and New Zealand result in a stillbirth (fetal death $\geq$20 weeks gestation) with more than 1 in 300 resulting in late stillbirth (death $\geq$28 weeks gestation).[1–3] During the 20th century, there was a significant reduction in the rate of stillbirths in high-income countries, in considerable part because of improvements in antenatal care.[4,5] Unfortunately, the stillbirth rate has decreased little in the last two decades.[3,6–8]

Although antenatal care attendance is associated with improved perinatal and maternal outcomes, the actual number of antenatal visits required to make a difference to perinatal mortality is unclear.[9] No previous studies have explored the relationship between antenatal care utilisation and risk of late stillbirth in New Zealand. The model of maternity care provision in New Zealand altered significantly in the early 1990s following the Nurses Amendment Act of 1990, which resulted in a change from a predominantly doctor-led to a midwifery-led model of care. However, there have been no studies that have explored the relationship between type of maternity care provider or model of care and late stillbirth risk in New Zealand.

It is unclear what specific aspects of antenatal care might be associated with reduced risk of stillbirth. A relationship has long been established between suboptimal fetal growth and risk of stillbirth.[10,11] A small number of publications have also reported that the large majority of stillborn small-for-gestational-age (SGA) infants are not recognised before birth, but these studies have not had comparative rates of antenatal SGA recognition in a control population of live-born infants.[1,12]

The primary aim of the Auckland Stillbirth Study was to identify modifiable risk factors for late stillbirth. The specific aim of this analysis was to assess the relationship between antenatal care and late stillbirth risk.

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Materials and Methods

All women booked to give birth in the greater Auckland region and who experienced a late stillbirth ($\geq$28 weeks' gestation) between July 2006 and June 2009 were eligible to participate in this study. Women with multiple pregnancies and those where the baby died because of a congenital abnormality were excluded. Each case was matched with two randomly selected controls with an ongoing pregnancy from the same hospital area, and at the same gestation at which the stillbirth occurred; this allowed for an accurate comparison of the characteristics of pregnancy for cases and controls. To ensure appropriate control selection, only women who were booked for antenatal care were included in this study.

A description of the manner in which cases and controls were identified and recruited, and other details of the methods of this study have been described previously.[13] Data were obtained through interviewer-administered questionnaires that took place soon after the stillbirth (median, 25 days; interquartile range, 18–39 days) or at the equivalent gestation to the stillbirth for the controls. Clinical data were collected from antenatal records.

In New Zealand, as part of the publically funded maternity care system, a Lead Maternity Care provider is chosen by the woman to take responsibility for coordinating her care throughout the pregnancy and post-partum period. The Lead Maternity Carer was categorised primarily as midwife-led or doctor-led. To explore the impact of different models of care, further categorisation was made, specifically, self-employed midwife, hospital employed (caseloading midwife, community antenatal clinic or medical/high risk clinic), private obstetrician and general practitioner (GP)/shared care (GP only or shared care between the GP and community antenatal clinic). The Lead Maternity Carer was classified as that at the time of booking (initial contact with the antenatal care provider).

Gestation at the booking visit with the Lead Maternity Carer, and number of antenatal visits, were ascertained from the participants' antenatal records. There is currently no universally accepted antenatal care utilisation index that is recommended for assessing the adequacy of care. A number of indices exist[14,15]; however, each one adopts a different approach to the definition of adequate utilisation, based in part on local expectations of care utilisation, and they are not interchangeable.[16] Gestation at initiation of care, the number of visits attended (gestation adjusted) and an adapted antenatal care utilisation index are therefore reported in this study.

The Perinatal and Maternal Mortality Review Committee (New Zealand)[17] and the National Institute for Health and Clinical Excellence[18] (UK) recommend that booking with a health professional should take place prior to 10 weeks' gestation; this was therefore used as the 'gold standard' or reference category for booking gestation. To assess the impact of later initiation of care, a further category of booking by 20 weeks' gestation was also defined.

The number of recommended antenatal visits at each gestational age was based on the schedule proposed by the National Institute for Health and Clinical Excellence[18] and has been generally adopted in New Zealand. The recommendation is that, by term, in an uncomplicated pregnancy, there should be 10 antenatal visits for nulliparous women and seven for multiparous women. The NICE Clinical guideline for Antenatal Care[18] specifies at which gestation visits are recommended. The proportion of visits attended were divided into three categories; <50% of recommended visits, intermediate (more than 50% but <100%) and 100% or more of the recommended number of visits.

An overall adequacy of antenatal care access was also applied using an adapted version of the Adequacy of Prenatal Care Utilization Index[14] as described by Reime and others.[19] Two categories were defined: 'adequate', where care was initiated in the first trimester and at least 50% of the recommended visits were attended, and 'inadequate', where care was initiated after the first trimester and/or <50% of the recommended visits were attended.

Customised birthweight centiles were calculated[20] for all babies. SGA was defined as birthweight <10th customised centile, adjusted for maternal characteristics (ethnicity, parity, height and weight) as well as infant sex and gestation at delivery.[21] Duration of pregnancy was calculated in days, based on certain date of last menstrual period or early ultrasound. Data were collected on date of diagnosis of fetal death as well as date of birth. With stillbirths, the gestation at death may precede the gestation at diagnosis of death; post-mortem data have shown that the time of death is estimated to be within 72 h of post-mortem in over 90% of cases.[22] In a study assessing the role of SGA in antepartum stillbirths, Gardosi and others used a two-day correction from death to delivery by reducing the gestational age of each case by two days prior to applying the gestational age–specific customised centile.[22] In this study, as we had data on the date of diagnosis of death, we subtracted two days from confirmed diagnosis of death, thus ensuring an even more conservative estimate of gestational age for stillbirths. Clinical identification of suspected SGA prior to birth (cases) or prior to interview (controls) was ascertained from the antenatal records (where ultrasound has been ordered specifically to assess fetal growth because of suspected SGA). This method of ascertainment was the same for cases and controls.

Ethical approval was gained for this study from the Northern 'X' Regional Ethics Committee.

Analysis

All statistical analyses were performed using SAS version 9.1.[23] Standard conditional regressions were used for

matched case–control studies using the 'proc logistic' procedure, with the 'strata' statement to control for matching. The study was powered to detect an odds ratio (OR) of 2 with 80% power and significance level of 5%, with a prevalence of the risk factor of 20% or more in the control population. A multivariable regression model was developed to include maternal variables reported to be associated with increased risk of late stillbirth, based on previous literature (age (<20, 20–34, ≥35 years), body mass index (BMI) (<25, 25–29.9, ≥30 kg/m^2), ethnicity, parity (0, 1–3, ≥4), smoking (smoker/non-smoker) and socio-economic status (most deprived/other, based on the New Zealand Deprivation status[24]). Statistical significance in multivariable analysis was defined at the 5% level. Odds ratios (OR) and adjusted odds ratios (aOR) with 95% confidence intervals (CI) were used to estimate risk.

Results

One hundred and fifty five of 215 (72.1%) cases and 310/429 (72.3%) controls consented to take part in the study. The characteristics of the women who agreed to take part and those that declined were not significantly different.[13] Eighty nine (57.4%) stillbirths occurred at term (≥37 weeks' gestation), and 39.4% of all stillbirths were classified as unexplained. No significant difference was found between past adverse perinatal outcome and medical history of cases and controls (including prior fetal loss, SGA, caesarean section, pre-gestational diabetes and essential hypertension), although the study was underpowered to investigate the role of most of these factors.

Gestational age at booking with a maternity care provider was not found to be associated with risk of late stillbirth (Table 1). In contrast, adequacy of the number of antenatal visits was associated with risk of late stillbirth. After adjustment for known confounders, compared with women who received the recommended number of antenatal visits, women who received >50% of visits were found to have an almost threefold increased risk of late stillbirth (aOR, 2.68; 95% CI, 1.04–6.90). Although there was no significant association found between risk of late stillbirth and intermediate antenatal care attendance (ie less than the recommended number, but more than 50% of visits), a trend analysis showed a significant relationship between reduced antenatal care attendance and risk of late stillbirth ($P = 0.0005$). The modified index of overall adequacy of care, which incorporated both gestation at initiation of care and number of visits attended, showed no relationship with risk of late stillbirth.

One hundred and thirty seven (88.4%) cases and 274 (88.4%) controls booked with a midwife as Lead Maternity Carer, the majority being self-employed midwives (Table 2). No association was found between type or model of Lead Maternity Carer and risk of late stillbirth.

36.8% (57/155) cases were SGA at birth compared with 7.1% (22/310) controls; babies that were SGA at birth had a significantly increased risk of stillbirth compared with babies that were not (aOR, 9.67; 95% CI, 4.68–19.96). Of the babies that weighed less than the 10th customised centile at birth, 12.2% (7/57) of those that were stillborn were suspected to be SGA prior to birth/interview compared with 31.8% (7/22) of the SGA infants in the control mothers, $P = 0.04$. Those infants that were not identified as being SGA prior to birth/interview were nine times more likely to be stillborn compared with those that were (aOR, 9.46; 95% CI, 1.98–45.13) (Table 3).

Table 1 Antenatal care utilisation and risk of late stillbirth

Antenatal care	Cases		Controls		Univariable OR (95% CI)		Adjusted OR† (95% CI)	
Gestation at booking with lead	*n*	%	*n*	%	OR	95% CI	aOR	95% CI
Maternity carer‡								
≤10 weeks	43	27.7	84	27.1	1.00	–	1.00	–
10–20 weeks	82	52.9	178	57.4	0.94	0.61–1.45	0.78	0.46–1.30
>20 weeks	30	19.4	45	14.5	1.39	0.76–2.53	0.63	0.28–1.39
Number of antenatal visits§								
100% of recommended visits	116	74.8	267	86.1	1.00	–	1.00	–
Intermediate	18	11.6	22	7.1	1.81	0.94–3.48	1.40	0.68–2.88
<50% of recommended visits	19	12.3	14	4.5	3.73	1.64–8.45	2.68	1.04–6.90
Adequacy of antenatal care index¶,††								
Adequate	83	54.3	182	59.7	1.00	–		
Inadequate	70	45.7	123	40.3	1.21	0.83–1.78	0.78	0.50–1.23

†Adjusted for maternal age, BMI, ethnicity, smoking, parity, social deprivation and past medical and obstetric history.
‡Three controls missing.
§Two cases and seven controls missing.
¶Adequate care: care initiated in the first trimester and atleast 50% of recommended visits attended.
††Two cases and two controls missing.

Table 2 Type and model of antenatal care provider and risk of late stillbirth

	Cases		Controls		Univariable OR (95% CI)		Adjusted OR† (95% CI)	
Antenatal care provider	*n*	%	*n*	%	OR	95% CI	aOR	95% CI
Lead maternity carer – type								
Doctor	18	11.6	36	11.6	1.00	–	1.00	–
Midwife	137	88.4	274	88.4	1.00	0.53–1.90	1.17	0.52–2.64
Lead maternity carer – model								
Self-employed midwife	82	52.9	185	59.7	1.00	–	1.00	–
Hospital	47	30.3	73	23.6	1.47	0.92–2.36	1.14	0.65–2.02
Private obstetrician	10	6.5	26	8.4	0.85	0.37–1.97	0.90	0.35–2.30
GP/Shared care	16	10.3	26	8.4	1.43	0.69–2.97	0.83	0.34–2.04

†Adjusted for maternal age, BMI, ethnicity, smoking, parity and social deprivation.

Table 3 Identification of small for gestational age and risk of late stillbirth

	Cases		Controls		Univariable OR (95% CI)		Adjusted OR† (95% CI)	
SGA status	*n*	%	*n*	%	OR	95% CI	aOR	95% CI
≥10th centile at birth	98	63.2	288	92.9	0.44	0.15–1.29	0.45	0.14–1.48
<10th at birth, suspected to be SGA prior to birth/interview	7	4.5	7	2.3	1.00	–	1.00	–
<10th at birth, not suspected to be SGA prior to birth/interview	50	32.3	15	4.8	9.57	2.20–41.55	9.46	1.98–45.13

†Adjusted for maternal age, BMI, ethnicity, smoking, parity and social deprivation.
SGA, small-for-gestational-age.

Discussion

This is the first study to examine an association between antenatal care utilisation and risk of late stillbirth in New Zealand. We found that inadequate antenatal care attendance, but not gestation at initiation of care, was associated with late stillbirth risk. Type or model of maternity care provider was not found to be associated with risk of late stillbirth.

The optimal gestation at which antenatal care should begin is not well established; the Ministry of Health in New Zealand recommends that antenatal care be commenced by 10 weeks' gestation.[17] However, in this study, we found no association between gestational age at booking and late stillbirth risk. Although an association has previously been described, the findings have been inconsistent and difficult to interpret. Some studies that found a significant relationship between risk of stillbirth and late initiation of care combined late initiation of care with no care, thus making it difficult to determine whether it was the lack of overall care, or the gestation at initiation of care that was of significance.[25,26] Other studies have also found no association between gestational age at onset of care and risk of stillbirth.[27]

There is no high-quality evidence as to what should be the optimal schedule of antenatal visits for low-risk women. It has been shown that a relatively reduced schedule of visits in high-income countries (reducing from 13 to 14 visits during pregnancy to an average of 8–9 visits) had no significant impact on perinatal mortality.[9] However, inadequate antenatal care utilisation has been associated with an increased risk of poor perinatal outcomes, including an increase in risk of stillbirth.[27–32] Our study supports the finding that it is the substantial under utilisation of care (rather than a relative reduction in the number of visits) that is associated with increased mortality. This finding was independent of other factors associated with reduced utilisation of care such as social deprivation and high parity. Previous studies may have overestimated the strength of this association as many have not adjusted for gestational age[30,31]; stillbirth is associated with preterm birth, and therefore comparing antenatal care utilisation with live births, predominantly born at term, will exaggerate any association. In this study, we not only matched for gestational age but also determined adequacy of care throughout the third trimester when appropriate.

The lack of association seen between overall adequacy of care as defined by an adapted Adequacy of Prenatal Care Utilization Index is likely due to the lack of association between booking gestation and late stillbirth risk in our population.

In New Zealand, the Lead Maternity Carer is responsible for the provision and coordination of maternity care. This study found that there was no significant difference in risk of late stillbirth between midwife-led or doctor-led care and different models of care. The univariable odds ratio for stillbirth was remarkably similar

between groups regardless of care provider. However, we cannot exclude that the lack of significance may be due to insufficient power. Our data are consistent with previous studies that have found that there was no significant difference in perinatal mortality with midwife-led care compared with other models of maternity care.[33,34]

Suboptimal fetal growth has long been associated with increased risk of stillbirth,[10,11] particularly when SGA is defined using customised rather than population-based birthweight centiles.[21] Unfortunately, in routine antenatal care, the majority of SGA babies are not currently indentified antenatally.[35] In this study, SGA infants were more likely to be identified before birth in control mothers compared with those mothers with stillborn infants. This is consistent with a previous study that found that antenatal identification of SGA reduced the risk of adverse outcomes, including stillbirth.[36] Antenatal identification of suspected SGA in this study was ascertained up until the time of birth for cases and up until the time of interview for controls; it is therefore possible that more live-born babies that were SGA at birth would additionally have been identified as SGA antenatally (between the time of interview and birth) but not classified as such in this study. This means that, if anything, we may have underestimated the association between lack of identification of suboptimal fetal growth and risk of stillbirth. Women with stillborn infants in this study were more likely to be obese than control women,[37] and this may have contributed to the reduced rate of antenatal detection of SGA; however, when adjustment was made for potential confounders (including maternal body mass index), there was minimal change in the magnitude of association between lack of antenatal detection of SGA and stillbirth risk.

It has previously been found that utilisation of customised antenatal growth charts can improve the rate of antenatal detection of SGA[35,38] and this tool has been recommended for use in routine antenatal care in New Zealand.[1] However, if women do not regularly attend antenatal care, then it is much harder to perform adequate clinical assessment of fetal growth. It is likely that the effect of antenatal care on reduced stillbirth risk is multifaceted and that identification of suboptimal fetal growth is just one factor. Further studies that explore the impact of specific antenatal practices on stillbirth risk may help our understanding of what other elements of antenatal care are of importance.

This study reinforces the importance of regular antenatal care attendance for reducing the risk of late stillbirth. Antenatal identification of SGA infants may be one of the ways by which regular antenatal care reduces the risk of stillbirth.

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