Recorded Pregnancy Histories of the Mothers of Singletons and the Mothers of Twins: A Longitudinal Comparison

Maxine L. Croft,[1,2] Vera Morgan,[1] Anne W. Read[2] and Assen S. Jablensky[1]

[1] *Neuropsychiatric Epidemiology Research Unit, School of Psychiatry and Clinical Neurosciences, The University of Western Australia, Australia*
[2] *Centre for Child Health Research, Telethon Institute for Child Health Research, The University of Western Australia, Australia*

A population-based record linkage case cohort of 239,995 births, to 119,214 women, born in Western Australia from 1980 to 2001 inclusive, was used to measure the recording of selected indicators of maternal health (current and prior) during pregnancy. We compared records of women with singleton pregnancies with that in twin pregnancies Mothers of first- and second-born singletons (n = 117,647) were compared with women with a first-born singleton followed by twins (n = 1,567). Binary indicators were used to calculate population prevalence of medical conditions, pregnancy complications and birth outcomes. Infant outcomes included stillbirth, low birthweight, preterm birth and birth defects. Women with twins were significantly older and taller, with similar rates of medical conditions and pregnancy complications during first singleton pregnancies compared with women with two consecutive singletons. However, during their second pregnancy, women with twins had significantly higher rates of essential hypertension, pre-eclampsia, threatened abortion, premature rupture of the membranes and ante partum hemorrhage with abruption than women with singletons. For both groups, maternal conditions in the first pregnancy were underreported in the second pregnancy, including diabetes, epilepsy, asthma, chronic renal dysfunction and essential hypertension. At the second birth, twins were 3 times more likely to be stillborn, 17 times more likely to be low birthweight and 4 times more likely to be delivered preterm compared with singletons. This research demonstrates the importance for epidemiologists and others, of having access to a complete maternal medical history for analyses of risks associated with maternal, infant and childhood morbidity.

Keywords: twins, pregnancy complications, population-based study, record linkage, maternal health

Twin pregnancy carries an increased risk of pregnancy complications, pregnancy loss prior to 20 weeks gestation, an increased incidence of preterm birth (Ananth & Smulian, 2005; Buscher et al., 2000), low birthweight, congenital malformations, chromosomal anomalies (Yang et al., 2006) and increased incidence of maternal morbidity (Coonrod et al., 1995) and mortality (Norwitz et al., 2005) as well as perinatal morbidity (Fisher & Stocky, 2003) and mortality (Ananth & Smulian, 2005; Blickstein & Keith, 2005; McMahon et al., 1998; Wen et al., 2003). Additionally, mothers who experience the death of a multiple are more likely to experience mental health problems such as prolonged anxiety, depression and grief 5 years after the death, than mothers whose singleton died (Swanson et al., 2009). Prior studies have also identified single maternal marital status and extremes of maternal age as risk factors for poor perinatal outcomes in multiples (Salihu, 2005)

The risk of adverse outcomes in twin pregnancies may be reduced by careful monitoring of the mother in the antenatal period (Campbell, 2001; di Renzo et al., 2001; Zhang et al., 2002). The assignment of an estimate of risk to the offspring of a particular woman in pregnancy is done in the hope of recognizing high-risk pregnancies at a stage where it is possible to prevent or minimize poor outcomes for the mother and baby. However, current methods of calculating estimates of risk for infant outcomes such as stillbirth, low birth weight and preterm birth, as well as for the subsequent mental health of the mother, generally assume that each birth is a random event independent of prior events for the mother. Such methods of calculation using cross-sectional data may be flawed by the lack of accurate, longitudinal data on a mother's reproductive history. For example, Bakketeig and Hoffman (Bakketeig & Hoffman, 1979) demonstrated the importance of using longitudinal data to investigate the association between perinatal mortality and parity in a Norwegian sample

Received 08 March, 2010; accepted 26 August, 2010.

Address for correspondence: Dr Maxine Croft, Neuropsychiatric Epidemiology Research Unit, School of Psychiatry and Clinical Neurosciences, the University of Western Australia, Nedlands, Western Australia 6009, Australia. E-mail: maxine.croft@uwa.edu.au

born 1967–1973. Likewise Skjærven et al. (1987) reported a marked increase in the risk of poor reproductive outcomes for women who have had one or more such outcomes in prior pregnancies. In both studies, the use of cross-sectional data alone to calculate risks for women with prior poor outcomes was shown to result in estimates of lower risk than if the risk was assessed taking into account prior outcomes. Conversely, the estimates of risk for women with no prior history of poor outcome were biased towards unnecessarily high estimates of risk.

The aims of the current research are twofold. The first is to investigate the incidence of certain medical conditions and pregnancy complications and infant outcomes for mothers of twins compared with mothers of singletons. Second, longitudinal versus cross-sectional data will be used to estimate the prevalence of these adverse maternal and pregnancy conditions in both groups of women. In particular, this article will examine whether there are differences in the recording of prior medical history in the birth records for mothers of multiples compared with mothers of singletons.

This substudy forms part of a larger record-linkage study, the 'Pathways from conception to disease: a study of the high risk children of women with psychosis and other severe mental illness' (Pathways study) with the sample drawn from Western Australian (WA) whole-of-population data. The findings from a subsample of this study have been published (Jablensky et al., 2005; Morgan et al., 2010). The Pathways study uses a well-validated scoring system for measuring obstetric complications as risk factors for development of later schizophrenia (Cantor-Graae et al., 1998; McNeil & Sjöström, 1994; McNeil & Sjöström, 2007). In this system, women with multiple pregnancies receive additional risk scores regardless of whether the mother has any adverse medical conditions or pregnancy complications. If prior maternal medical history is already well-recorded for mothers of multiples at that birth, then additional use of longitudinal data, in a scoring system that already weights multiple birth pregnancies, could result in a higher obstetric complication risk estimate than is appropriate. Alternately, if the prior medical history is poorly recorded, then to ignore the available historical data could seriously underestimate the contribution of those conditions to the risk of future adverse outcomes for the offspring.

Methods

Data Sources

The data used in this article have been collected as part of a large study of developmental and neuropsychiatric outcomes for children of women with severe mental illness compared to children of unaffected women (Jablensky et al., 2005; Morgan et al., 2010). The full Pathways study population included women born between 1931 and 1980 whose children were born in WA during 1980 to 2001 inclusive. It excluded women who were recorded on the WA Mental Health Register but whose diagnostic codes did not include psychosis. The total Pathways sample thus includes 472,722 children born 1980–2001 to 249,145 women.

The Western Australian Midwives' Notification System is a State-wide register including all births weighing at least 400 grams or having a gestational age of 20 weeks or more. The register contains data on up to 44 maternal and fetal health conditions (Gee & O'Neill, 2001) and has been linked to other health registers including the Registrar General's records of Births, Deaths and Marriages, hospital morbidity discharge records, the WA Birth Defects Registry, the Cerebral Palsy Register and the psychiatric case register (Holman et al., 1999; Kelman & Smith, 2000; Kelman et al., 2002; Stanley et al., 1997). Sibships within the Midwives' Notification System have been identified (Croft et al., 2002).

This substudy included all women in the Pathways study, with at least two births recorded between 1980–2001, whose first child was a singleton born during 1980 to 2001 inclusive, and whose second born infants were either singletons (117,647 women) or twins (1,567 women). Binary indicators of a range of maternal characteristics, pregnancy complications, medical conditions and the occurrence of stillbirth, preterm birth, low birth weight and birth defects were created for each birth. The medical conditions selected for inclusion were those that, once developed, were likely to be chronic, rather than transitory. These conditions included diabetes, asthma, epilepsy, chronic renal dysfunction and essential hypertension. A limited number of transitory conditions were also included as they were regarded as clinically important during pregnancy. These are all recorded on the Midwives' Notification System and included eclampsia and pre-eclampsia, ante partum hemorrhage and threatened abortion. A full set of the International Classification of Diseases Revision 9 (ICD9) (WHO, 1992) codes that were used to assign binary codes for each condition is available on request. The binary indicators were assigned to all births and, since all births to a woman were linked into sibships, it was possible to assess for an individual woman whether a condition reported at an earlier birth was also recorded at later birth(s). The selection of ICD-9 codes for each condition was independently validated by a clinical coding expert (Stevens, 1997). Some validation of the data on the Midwives' Notification System has been undertaken (Gee & Dawes 1994).

When twins and higher order multiples are born in WA, separate Midwives' Notification System records are completed for each infant and a code for plurality of the birth (2 to 5) as well as a baby number (1 to 5) is allocated to each multiple birth infant. This study also investigated whether there were differences in the Midwives' Notification System records of maternal

https://doi.org/10.1375/twin.13.6.595 Published online by Cambridge University Press

medical conditions and pregnancy complications for first- and second-born co-twins. Each of the pairs of records was found to be identical. Hence, in the comparison of maternal medical conditions and pregnancy complications at second births, only the Midwives records for the first-born twins were compared to those of the singletons. When comparing infant outcomes, the occurrence of stillbirth, preterm birth, low birthweight or birth defects in either twin was compared with those outcomes in second-born singletons.

The SPSS statistical software package version 17 (SPSS, 2009) was used for statistical analysis. Frequency distributions were obtained for all binary variables. For all binary variables used to compare mothers of two singletons with mothers of a singleton followed by twins, the Mantel-Haenszel common odds ratios and 95% confidence intervals around the estimate was calculated (Mantel & Haenszel, 1959).

Results

The dataset included 119,214 women whose first birth occurred in WA from 1980 to 2001 inclusive and who had at least two births in WA during 1980 to 2001 (239,995 infants). As shown in Table 1, mothers of twins at the second birth were significantly older at their first birth and taller than the mothers of singletons, but did not differ significantly in terms of their marital status.

Infant Outcomes for First Births

Table 2 shows the incidence of selected outcomes (stillbirth, low birth weight, preterm birth and birth defects) for first-born singleton infants for these two groups of women and demonstrates that there were no statistically significant differences, in those outcomes, between the first-born infants of these mothers.

Maternal Medical Characteristics

First births: Table 3 shows the incidence of maternal medical conditions and complications of pregnancy recorded for first pregnancies to mothers of first and second born singletons only and mothers of a singleton followed by twins. The incidence of maternal medical conditions, recorded in the first pregnancy did not differ significantly for mothers who went to have twins in the second pregnancy compared with mothers who went on to have another singleton.

Second births: Table 4 shows the population prevalence estimates of the same medical conditions recorded for the second pregnancies in these two groups of women. Women whose second pregnancy was a twin pregnancy differed from mothers of two singletons in that they had statistically significantly increased odds ratio for essential hypertension (OR 1.9, 95% CI 1.3–2.7).

Pregnancy Complications

First births: There was no statistically significant difference in the incidence of pregnancy complications

Table 1

Demographic Characteristics of Mothers at the First Birth

Demographic characteristics of women at first birth	Mothers of two singletons (*N* = 117,647)	Mothers of twins at second pregnancy (*N* = 1,567)	Odds ratio
Maternal age (years)	No. and (%)	No. and (%)	(95% confidence interval)
< 20	13,908 (11.8)	160 (10.2)	0.8 (0.7–1.0)
20–24	37,723 (32.1)	419 (26.7)	0.8 (0.7–0.9)
25–29	44,590 (37.9)	607 (38.7)	1.0 (0.9–1.1)
30–34	18,204 (15.5)	310 (19.8)	1.3 (1.2–1.5)
35+	1,943 (1.7)	47 (3.0)	1.8 (1.4–2.5)
Marital status (married/de facto)	102,880 (87.5)	1,375 (87.7)	1.0 (0.9–1.2)
Height < 160 cms	31,497 (26.8)	366 (23.4)	0.8 (0.7–0.9)

Table 2

Infant Outcomes for First-Born Singletons

Infant outcomes	Mothers of two singletons (*N* = 117,647)	Mothers of twins at second pregnancy (*N* = 1,567)	Odds ratio
	No. and (%)	No. and (%)	(95% confidence interval)
Stillbirth	870 (0.7)	17 (1.1)	1.5 (0.9–2.4)
Preterm birth (<37 weeks gestation)	40,458 (34.4)	499 (31.8)	0.9 (0.8–1.0)
Low birthweight (< 2,500 gms)	6,729 (5.7)	81 (5.2)	0.9 (0.7–1.1)
Birth defect (up to 5 yrs of age)	6,659 (5.7)	92 (5.9)	1.0 (0.8–1.3)

https://doi.org/10.1375/twin.13.6.595 Published online by Cambridge University Press

Table 3

Recorded Maternal Medical Conditions and Pregnancy Complications (at the first birth) for Women who had at Least Two Births in WA During 1980 to 2001 Inclusive

Maternal conditions	Mothers of two singletons (*N* = 117,647)	Mothers of twins at second birth (*N* = 1,567)	Odds ratio
	Prevalence/1,000 women.	Prevalence/1,000 women.	(95% confidence interval)
Asthma	45 (5,286/117,647)	43 (67/1,567)	0.9 (0.7–1.2)
Epilepsy	4 (502/117,647)	7 (11/1,567)	1.6 (0.9–3.0)
Essential hypertension	22 (2,545/117,647)	21 (33/1,567)	1.0 (0.7–1.4)
Renal dysfunction.	2 (189/117,647)	3 (4/1,567)	1.6 (0.6–4.3)
Diabetes (any type)	5 (639/117,647)	6 (9/1,567)	1.1 (0.5–2.0)
Incidence of pregnancy complications recorded in the first pregnancy			
Pre-eclampsia	105(12,320/117,647)	113(177/1,567)	1.1 (0.9–1.3)
Eclampsia	<1 (26/117,647)	0 (0)	
Placenta praevia	1 (142/117,647)	1 (1/1,567)	0.5 (0.1–3.8)
Antepartum hemorrhage (placenta praevia)	5 (610/117,647)	6 (9/1,567)	1.1 (0.6–2.1)
Antepartum hemorrhage with abruptio placentae	7 (855/117,647)	11 (17/1,567)	1.5 (0.9 – 2.4)
Antepartum hemorrhage (other)	28 (3,245/117,647)	30 (47/1,567)	1.1 (0.8–1.5)
Threatened abortion	46 (5,431/117,647)	40 (63/1,567)	0.9 (0.7–1.1)
Premature preterm rupture of membranes	48 (5,593/117,647)	56 (88/1,567)	1.2 (1.0–1.5)

Table 4

Recorded Maternal Medical Conditions and Pregnancy Complications (at the Second Birth) for Women who had at Least Two Births in WA During 1980 to 2001 Inclusive

Maternal conditions	Mothers of two singletons (*N* = 117,647)	Mothers of twins at second pregnancy (*N* = 1,567)	Odds ratio
	Period prevalence/1,000 women.	Period prevalence/1,000 women	(95% confidence interval).
Asthma.	49 (5,760/117,647)	53 (83/1,567)	1.1 (0.9–1.4)
Epilepsy.	4 (476/117,647)	5 (8/1,567)	1.3 (0.6–2.5)
Essential hypertension.	11 (1,271/117,647)	20 (32/1,567)	1.9 (1.3–2.7)
Renal dysfunction.	1 (132/117,647)	1 (2/1,567)	1.1 (0.3–4.6)
Diabetes (any type)	11 (1,264/117,647)	15 (23/1,567)	1.4 (0.9–2.1)
Incidence of pregnancy complications recorded for the second pregnancy			
Pre-eclampsia	44 (5,207/117,647)	123 (193/1,567)	3.0 (2.6–3.5)
Eclampsia	< 1 (5/117,647)	0 (0)	
Placenta praevia	1 (163/117,647)	0 (0)	
Antepartum hemorrhage placenta praevia)	7 (850/117,647)	6 (10/1,567)	0.9 (0.5–1.6)
Antepartum hemorrhage with abruptio placentae	6 (739/117,647)	14 (22/1,567)	2.3 (1.5–3.5)
Antepartum hemorrhage (other)	25 (2,899/117,647)	31 (48/1,567)	1.3 (0.9–1.7)
Threatened abortion	49 (5,781/117,647)	71 (111/1,567)	1.5 (1.2–1.8)
Premature rupture of membranes	31 (3,665/117,647)	119 (186/1,567)	4.2 (3.6–4.9)

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Table 5

Omission From the Second Midwives' Birth Record, of Medical Conditions That Were Recorded on the Prior Midwives' Birth Record, for That Woman

Maternal condition	Singleton mothers (*N* = 117,647) second birth records missing prior information.	Twin mothers (*N* = 1,567) second birth records missing prior information.	Odds ratio
	No. and percentage of prior records (%)	No. and percentage of prior records (%)	(95% confidence interval)
Asthma	2,713/5,286 (51.3)	28/67 (41.8)	1.2 (0.8–1.9)
Epilepsy	213/502 (42.4)	4/11 (36.4)	1.2 (0.4–3.7)
Essential hypertension	2,388/2,546 (93.8)	31/33 (93.9)	1.0 (0.6–1.6)
Renal dysfunction	177/189 (93.6)	4/4 (100)	0.9 (0.2–3.8)
Diabetes	412/639 (64.5)	4/9 (44.4)	1.4 (0.4–4.7)

recorded during the first pregnancy for the mothers who went on to have a singleton compared with the mothers who went on to have twins.

Second births: The population prevalence estimates of pregnancy complications in the second pregnancy for women with twins compared with women, who went on to have a singleton, were statistically significantly increased. Specifically, women with twins experienced higher rates of pre-eclampsia (OR 3.0, 95% CI 2.6–3.5), ante-partum hemorrhage with abruption (OR 2.3, 95% CI 1.5–3.5), threatened abortion (OR 1.5, 95% CI 1.2–1.8) and pre-labour rupture of membranes (OR 4.2, 95% CI 3.6–4.9). In this study it was not possible to determine the clinical indication for pre-labour rupture of the membranes.

Omissions of Documented Prior Maternal Health Conditions From the Current Record

Omissions from data were defined as the absence, from the Midwives' Notification System record of the second birth, of a code for a maternal medical condition, where that maternal condition had been documented in the first birth record for that woman. Table 5 shows a comparison of the rates of omitted data for mothers of singletons versus mothers of twins at the time of the second birth to each woman. There was no statistically significant difference in the rates of omissions of data between the two groups of women. Rates of omissions of data, for mothers of two singletons, were lowest for epilepsy (42.4%) and asthma (51.3%) and highest for essential hypertension (93.8%) and chronic renal dysfunction (93.6%). Rates of omissions of data, for mothers of a singleton followed by twins, were similarly lowest for epilepsy (36.4%) and asthma (41.8%) and highest for essential hypertension (93.9%) and chronic renal dysfunction (100%).

Infant Outcomes for Second Births

Table 6 shows the incidence of the same selected outcomes (stillbirth, low birthweight, preterm birth and birth defects) for infants at the second birth for these women. Comparing second born singletons with twin infants, there were statistically significant differences, in most outcomes, with singletons having much better outcomes. The odds ratio of a stillbirth for mothers of twins relative to mothers of singletons was 3.0 (95% CI 1.9–4.5). Twins were 4.1 times (95% CI 3.7–4.6) more likely to be born preterm and 17.7 times (95% CI 16.0–19.7) more likely to be born weighing less than 2,500 grams. There was no significant difference in the incidence of birth defects between the groups.

Discussion

Recording of Pre-Existing Maternal Medical Conditions

Epidemiologists and other researchers may believe that a medical record created by skilled midwives at the time of a birth will be sufficiently accurate to preclude the need for computational strategies such as construction of longitudinal measures of maternal health. However, many factors can interfere with collection of a complete patient history and these factors are not always unbiased in their occurrence. A population registry study has found that errors in maternal recall were selective with women's recall of late pregnancy losses inaccurate (Kristensen & Irgens, 2000). Additionally, instructions to the midwife, contained in the handbook for the WA Midwives' Notification System (Downey & Gee, 2006), specifically preclude coding of some information unless it relates to the current pregnancy and birth. There is no place on the form for recording prior pregnancy complications such as ante partum hemorrhage, pre-eclampsia, eclampsia, threatened abortion, premature rupture of the membranes and placenta praevia. Current practice throughout Australia is to only record maternal medical conditions and complications if they occur in the current pregnancy and birth. It has been recognized that prior obstetric information could be helpful in guiding clinical care of the mother and the planned place of birth (Neilsen, 2003). In addition, epidemiologists and others conducting risk analyses may also want to know whether the woman has a history of prior poor health in pregnancy that could influence her ability to carry a pregnancy to term and deliver a healthy infant. For example, it is likely that a woman

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Table 6

Infant Outcomes for Singleton Infants and First-Born Twins at the Second Birth

Infant outcomes (for either twin)	Singletons (*N* = 117,647).	Twins (*N* = 1,567).	Odds ratio
	No. and (%)	No. and (%)	(95% confidence interval)
Stillbirth	590 (0.5)	23 (1.5)	3.0 (1.9 – 4.5)
Preterm birth			
(< 37 weeks gestation)	23,621 (20.1)	799 (51)	4.1 (3.7 – 4.6)
Low birth weight (< 2,500 grams)	4,431 (3.8)	642 (41.0)	17.7 (16.0 – 19.7)
Birth defect (up to 6 yrs of age)	6,044 (5.1)	97 (6.2)	1.2 (1.0 – 1.5)

with a prior history of chronic renal dysfunction would be entering subsequent reproductive life at a disadvantage compared with other women who were in better prior health.

Omission from the midwives' record of conditions that could have been coded as existing during prior pregnancies, such as asthma, epilepsy and diabetes, could happen in several ways:

- women may forget to mention an item of their medical history
- women who have experienced the loss of a baby during pregnancy or a perinatal death may wish to forget that experience during a time of happiness
- a busy midwife may not have the time to probe for further details
- a lack of privacy and/or a wish to forget their illness at a happy time could inhibit women's disclosure of sensitive conditions such as epilepsy or psychiatric illness
- a medical condition that was once validly thought to exist, may, on further investigation, have been found not to exist
- a woman may feel that her medical condition is being, or has been, adequately treated and is no longer relevant.

Hence, each of the birth records may be an accurate record of the midwife's knowledge of the current pregnancy and yet still be imperfect as a record of that mother's prior health. The medical conditions coded in this study (asthma, epilepsy, essential hypertension, renal dysfunction and diabetes) were restricted to those that could reasonably be expected to persist and/or require clinical treatment throughout the life of any woman (Davison & Baylis, 2007; Liu et al., 2001; Mostello et al., 2008; Peek et al., 1995; Roberts, 1998). In addition, they are conditions that once diagnosed should have had an impact on the woman's future antenatal care (Foster-Powell & Cheung, 1998; Shand et al., 2008), infant outcomes (Bakketeig et al., 1979; Dobson et al., 1982; King et al., 1996; Morrell, 1996; Schwartz, 1998) and the management of her labour and delivery (Gallery, 1995; Taylor et al., 2002; Zhu et al., 1997).

An earlier study endeavoured to identify the cause of discrepancies between current and prior medical recording of the maternal medical conditions to determine whether record linkage errors could account for such differences (Croft et al., 2002). The linked sibship data (1980–1992) for women who had been recorded as having diabetes (of any type) in at least one pregnancy but not in all of their subsequent pregnancies were checked. A total of 227 women had at least one record of diabetes, and of these 122 (53.7%) had records that indicated diabetes prior to pregnancy. Of those 122 women, 16 women (13.1%) did not have that history recorded in their subsequent Midwives' records. Clerical review of those 16 sets of linked Midwives' records found that only one of those sibships contained a linkage error that accounted for the discrepancy. Of the 227 women with diabetes, 211 (93%) were women whose pregnancies had been complicated by gestational diabetes (as indicated by an ICD-9 code of 648.01 to 648.09 inclusive or 648.80 to 648.89 inclusive), in the Midwives' record of birth (WHO, 1992).

Maternal Pregnancy Complication Fields

This study has coded and classified selected pregnancy complications and medical conditions for a defined subset of the population of WA women. A rigorous approach was taken to the determination of whether a particular maternal pregnancy or prior medical condition existed. The pregnancy conditions included in this study (preeclampsia, eclampsia, placenta praevia, ante-partum hemorrhage, threatened abortion and premature preterm rupture of membranes) are a selection of conditions that have a known likelihood of impacting immediately on the pregnancy.

Recording of Prior Health Conditions in Twin Versus Singleton Pregnancies

In their study of risk factors for preeclampsia, Coonrod et al. speculated that differential ascertainment of variables could exist dependent upon the presence of twinning (Coonrod et al., 1995). In this study, Table 5 demonstrates that mothers of twins after a singleton birth did not have significantly more omissions of prior history than did mothers of second-born singletons. This was contrary to expectation since we speculated that the additional stress involved (for parents and clinical staff) during a twin delivery might result in poorer recording. It is reassuring that this did not occur. However, it is of concern that for maternal conditions

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such as asthma, epilepsy, chronic renal dysfunction, and essential hypertension, between 36% (epilepsy) and 100% (renal dysfunction) of second birth records, for mothers of twins, did not mention that these conditions had occurred in the first pregnancy and birth. Similarly, between 42% (epilepsy) and 94% (renal dysfunction) of second-birth records, for mothers of singletons, did not mention these that conditions had occurred in the first pregnancy and birth.

Outcomes of Second Pregnancies

In common with other studies (Ananth & Smulian, 2005; Blickstein et al., 2000), we found that twins were more likely to be stillborn, preterm and low birthweight than singleton infants but the rate of occurrence of birth defects (in either twin) was not significantly higher for twins compared with singletons. In 102 (6.5%) of the twin pregnancies there was a birthweight disparity between the twins of 20% or greater, indicating an increased risk of poor perinatal outcomes for the disadvantaged twin.

Strengths and Weaknesses

This research has created an automated method for assigning binary codes to indicate the presence of important maternal medical conditions and pregnancy complications and has provided period prevalence estimates of those conditions for WA women. The rules applied in the coding scheme that was used in this study were designed to avoid spurious associations when these codes are used in analyses. The estimates of the period prevalence of pregnancy complications and pre-existing medical conditions presented in this study should therefore be viewed as minimal estimates of the true state of the health of the women in this study. The information reported by the women may have also been limited to what they considered was relevant (or appropriate to disclose) at the time of the birth. A validation study of the Midwives' Notification System was undertaken during 1994 in WA and examined a 2% sample of records of births (508 births). A case note review was conducted and found that in 81.9% of records the coding of all of the complications of pregnancy conditions was correct (Gee & Dawes, 1994). For the fields recording maternal medical conditions, validation showed that these were correctly coded in 91.3% of records. The authors noted that these results accorded well with an earlier validation study of data from 1986 (Hill, 1987) and showed some evidence of increased accuracy (Gee & Dawes, 1994).

The data on which this study is based are from a large subset of a total population registry of midwives' notifications of birth in which the maternal medical conditions (Hill, 1987) were prospectively collected and perinatal and infant outcomes have been well validated (Alessandri et al., 1995; Gee & Dawes, 1994). This research was, however, limited to a group of women who may have been particularly healthy, in that they had been able to sustain their first pregnancy either up to 20 weeks gestation or until the fetus weighed at least 400 grams.

Conclusions and Future Research

Future research will apply these techniques to the entire Pathways database. We will include a wider range of maternal medical conditions, pregnancy complications and infant outcomes. As it is clear that, for important medical conditions, a woman's past maternal history can be underestimated by using the current record alone, we will incorporate these longitudinal measures of maternal morbidity into our obstetric complication risk scoring systems. We will compare and contrast obstetric complication risk scores obtained using cross-sectional data with those obtained from longitudinal data. This research demonstrates the importance for epidemiologists and other researchers, of having access to a complete maternal medical history when assessing the risk of maternal, infant and childhood morbidity associated with obstetric complications. In particular, it demonstrates that the recording of maternal medical history by WA midwives is unbiased with regard to whether the woman is pregnant with a singleton infant or with twins.

Acknowledgments

This research has been funded by the Theodore and Vada Stanley Foundation Research Award Program, the National Health and Medical Research Council of Australia and the March of Dimes.

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