Acta Genet Med Gemellol 44: 11-23 (1995)

Received 30 April 1994
Final 30 November 1994

Zygosity as a Risk Factor for Complications and Outcomes of Twin Pregnancy

R.E. Hoskins

Department of Epidemiology, University of Washington, and the Division of Public Health Sciences, Fred Hutchinson Cancer Research Center, Seattle, Washington, USA

Abstract. All of the recorded twin live births in Washington State birth certificates between 1984 and 1988 were used a retrospective cohort study to determine the risk of zygosity on pregnancy complications and birth outcomes (n = 3458). Relative risks comparing different sex (DS) twins to same sex (SS) twins were corrected to relative risks relating dizygotic (DZ) to monozygotic (MZ) twins, using the Weinberg rule. A higher proportion of DS twin pregnancies (3.5%) than SS pregnancies (1.6%) were complicated by gestational diabetes, resulting in an estimated risk for DZ twin pregnancies relative to MZ pregnancies of 8.6 (95% CI = 3.5-21.0). DZ twin pregnancies were at a lower risk for complications of polyhydraminios ($RR_{DZ|MZ} = 0.2$, 95% CI = 0.1-0.4) and of pyelonephritis, ($RR_{DZ|MZ} = 0.3$, 95% CI = 0.1-0.8). MZ twins were more likely to have low birthweight and to have shorter gestations. The proportion of first-born babies of MZ twin pairs who died during their first year was similar to that of first twins of DZ pairs; however, the second-born of MZ twins were more likely to die in infancy than were second-born DZ pairs. First twins of DZ pairs were more likely to die of SIDS (sudden infant death syndrome) than the first of MZ twins ($RR_{DZ|MZ} = 1.5$, 95% CI = 0.4-5.1). In contrast, DZ second-born were less likely to die of SIDS than were MZ second-born twins ($RR_{DZ|MZ} = 0.1$, 95%CI = 0.1-0.7). DZ twins were less likely to have adverse newborn conditions or malformations. The high risk for gestational diabetes for DZ twin mothers is possibly due to the presence of two placentas which may support the development of greater insulin antagonism than the single placenta in the mother of MZ twins. The reduced risk of DZ relative to MZ twins for selected adverse birth outcomes may result from the increased tendency of MZ twins to be premature.

Key words: Zygosity, Twins, Perinatal complications, Monozygotic, Dizygotic

INTRODUCTION

The effect of zygosity on twin pregnancy complications and various birth outcomes is not understood. Since the biology of DZ and MZ twin pregnancies is profoundly different, it might be expected that twin pregnancies of different zygosity experience different risks for complications and selected outcomes.

As twin maternities appear to amplify the mother's response to pregnancy, knowledge of the role of zygosity in twin gestations may have a unique role in illuminating the etiology of problems for all pregnancies. It may also be useful to distinguish risk factors which are inherent in the biology of twin pregnancy from risk factors which are usually associated with pregnancy complications such as maternal age, race, smoking, or reproductive history. Studies which ignore zygosity and report risks for twin pregnancies relative to singleton pregnancies, may conceal effects specific to either mono- or dizygosity. Although we cannot change zygosity, intervention may be possible to limit its consequences.

METHODS

The Washington State Birth Registry collects information on maternal, paternal, and neonatal characteristics of all live births in the state through collection of live birth certificates. The attending physician, nurse, or midwife completes the certificate shortly after delivery. Variables displayed in a check-box format are defined on the certificate and are further explained in an appendix provided by the Registry in an attempt to standardize data collection throughout the state. This method of data collection is regarded as accurate and substantially complete [9].

Birth certificate data from 1984 through 1988 were used to identify all twin births for a retrospective cohort study, in order to evaluate the effect of zygosity on twin pregnancy outcomes and complications. The Washington State Department of Social and Health Services provided a file in which data concerning twin siblings from the same birth were linked. All of the 3458 twin births occurring from 1984 through 1988, where both twins were born alive, and for which birth certificate information was complete, were selected. This represents 93% of all twin births. These data were linked to the death certificates file allowing calculation of mortality rates during the first year of life. The risks of various birth complications and adverse outcomes among DZ pregnancies relative to those for MZ twin pregnancies were estimated by the use of an empirical correction based on the Weinberg rule [2]. This was necessary, as zygosity is not known from birth certificate data. Risk estimates for these same events among DS pregnancies relative to SS pregnancies were also calculated and displayed for comparison.

Since all of the 950 DS twin pairs in this study are, of course, dizygotic, according to Weinberg's rule, an equal number of the 2508 SS twins in this population are also dizygotic [17]. Thus for this twin population, 38% of SS twins are dizygotic. A correction for zygosity was made by applying the Weinberg rule, so that the risk for a complication or outcome among DS relative to SS pregnancies, $RR_{DS|SS}$, more closely estimates the relative risk of DZ to MZ twins, $RR_{DZ:MZ}$.

https://doi.org/10.1017/S0001566000001859 Published online by Cambridge University Press

If we assume that the probabilities of the occurrences of male-male (mm), female-female (ff), male-female (mf) and female-male (fm) dizygotic twin births are all equal,

$$Pr(mm|DZ) = Pr(ff|DZ) = Pr(fm|DZ) = Pr(mf|DZ)$$

then the number of DZ twins is twice the number of DS twins,

$$N_{DZ} = 2N_{DS}$$

where N_{DS} is the number of different sex twins and N_{DZ} is the number of DZ twins in the population. This leads to the estimation of the fraction of SS twin pairs which are DZ,

$$f_{DZ|SS} = N_{DS}/N_{SS}$$

where N_{SS} is the total number of SS twins.

Table 1 - Percent distribution of selected characteristics of different sex and same sex twins in Washington State (1984-88)

Characteristic	Different sex twins			Same sex twins		
	N	%[1]	%[2]	N	%[1]	%[2]
All twins	950	100.0	27.5	2508	100.0	72.5
Mother's age						
less than 30 years	568	59.9	25.1	1698	67.8	74.9
30 years or older	380	40.1	31.9	809	32.2	68.1
Mother's race						
White	846	89.4	27.9	2178	87.3	72.1
Black	49	5.2	28.3	124	5.0	71.7
Native American	18	1.9	24.3	56	2.3	75.7
Asian	14	1.5	15.7	75	3.0	84.3
Hispanic	19	2.0	24.1	60	2.4	75.9
Parity						
none	296	33.1	24.5	911	38.4	75.4
one	327	36.5	27.7	853	35.9	72.3
two or more	272	30.4	30.8	612	25.7	69.2
Maternal smoking during pregnancy	220	25.3	28.4	554	24.3	71.6
Marital status (unmarried)	153	16.1	25.8	440	17.5	74.2

[1] Percentage of DS (or SS) twins of column items.
[2] Percentage of row item which is DS (or SS).

https://doi.org/10.1017/S0001566000001859 Published online by Cambridge University Press

Table 2 - Percent distribution of selected complications in different sex and same sex twin pregnancies in Washington State (1984-88)

Characteristic	Different sex twins			Same sex twins		
	N	%[1]	%[2]	N	%[1]	%[2]
All twins	950	100.0	27.5	2508	100.0	72.5
Any complications of pregnancy	432	46.8	28.2	1095	45.1	71.8
Abruptio placenta	22	2.4	32.8	45	1.9	67.2
Chronic hypertension	19	2.1	30.6	43	1.8	69.4
Gestational diabetes	32	3.5	45.7	38	1.6	54.3
Polyhydraminios	5	0.5	9.6	47	1.9	90.4
Pre-eclampsia	90	9.8	26.7	247	10.2	73.3
Pyelonephritis	2	0.2	11.7	15	0.6	88.2
Other complications of pregnancy[3]	325	35.2	29.1	789	32.5	70.2

[1] Percentage of DS (or SS) twins of column items.
[2] Percentage of row item which is DS (or SS).
[3] Any complication not explicity specified on the birth certificate.

Since SS twins are $f_{DZ|SS} \times 100\%$ of the DZ twins, and assuming that the risk for disease in DS twins is the same as DZ twins, $Pr(D|DZ) = Pr(D|DS)$, then

$$Pr(D|SS) = Pr(D|MZ)(1\text{-}f_{DZ|SS}) + Pr(D|DS)f_{DZ|SS}.$$

From the expression above, the risk for MZ twins becomes

$$Pr(D|MZ) = (Pr(D|SS)\text{-}Pr(D|DS)f_{DZ|SS})/(1\text{-}f_{DZ|SS}).$$

The relative risk of DZ twins to MZ twins may then be calculated as

$$RR_{DZ|SS} = Pr(D|DZ)/Pr(D|MZ)$$
$$Pr(D|DS)(1\text{-}f_{DZ|SS})/Pr(D|SS)\text{-}Pr(D|DS)f_{DZ|SS}).$$

Adjustment for the potential confounding effect of maternal age, race, and parities was carried out by stratifying on each potential confounder, correcting the cell entries using the assumptions based on the Weinberg rule, and then calculating Mantel-Haenszel relative risks with 95% test-based confidence intervals [15]. Only those adjustments which affected the risk estimates were retained in the analysis.

RESULTS

A total of 3458 twin births for which both twins were born alive occurred from 1984 through 1988, including 950 (27.5%) DS twin pairs and 2508 (72.5%) SS twin pairs. For all the DS twins for which the mother's age was known (948), 40.1% were born to older

mothers (> = 30 years). For SS twins for which the mother's age was known (2507), 32.2% are born to older mothers. Older mothers who have twins are more likely to have DS twins.

The ratio of DS to SS twins was similar among all racial groups, except for Asians. Since the MZ twinning rate is thought to be independent of race, was a lower percentage of DS twins were expected to be born to Asians [14]. DS twin mothers were slightly more likely (66.9%) to be parous, compared to SS twin mothers (61.6%), while DS and SS mothers were similar with respect to smoking habits and marital status. In general, similar proportions of DS and SS births experienced pregnancy complications: 46.8% of DS and 45.1% of SS twin mothers had at least one problem identified on the birth certificate (Table 2). When corrected for zygosity (Table 4), the risk of complications among DZ pregnancies relative to that for MZ pregnancies was slightly elevated ($RR_{DZ:MZ} = 1.1$, 95%CI = 0.9-1.2).

A greater proportion of DS pregnancies (3.5%) were complicated by gestational diabetes, than were SS pregnancies (1.6%) resulting in a relative risk (after correction for zygosity and adjustment for maternal age) of $RR_{DZ:MZ} = 8.6$ (95%CI = 3.5-21.0). Pregnancies of MZ twins showed an increased risk for polyhydraminios and pyelonephritis.

Table 3 - Percent distributions of selected outcomes of different sex and same sex twin pregnancies in Washington State (1984-88)

Characteristic	Different sex twins			Same sex twins		
	N	%[1]	%[2]	N	%[1]	%[2]
All twins	950	100.0	27.5	2508	100.0	72.5
Birthweight 1st twin						
<1500g	78	8.3	23.2	258	10.3	76.8
1501-2500g	280	29.5	22.9	939	37.6	77.0
2501-3500g	530	55.4	30.4	1214	48.6	69.6
3501-4500g	58	6.1	39.2	90	3.4	60.8
Birthweight 2nd twin						
<1500g	80	8.5	23.8	255	10.4	76.2
1501-2500g	312	32.9	25.0	962	38.5	75.0
2501-3500g	500	52.9	29.7	1184	47.5	70.3
3501-4500g	54	5.7	37.5	90	3.6	62.5
Gestational age						
<25 weeks	22	2.5	27.8	57	2.5	72.2
25-28 weeks	25	2.9	25.5	73	3.2	74.5
29-32 weeks	58	6.6	23.4	189	8.2	76.6
33-36 weeks	251	28.7	26.2	705	30.6	73.8
37-41 weeks	470	53.8	28.7	1168	50.8	71.3
<41 weeks	48	5.5	30.5	109	4.7	69.5

https://doi.org/10.1017/S0001566000001859 Published online by Cambridge University Press

Table 3 *(continued)*

Characteristic	Different sex twins			Same sex twins		
	N	%[1]	%[2]	N	%[1]	%[2]
Infant death						
1st twin	39	4.1	28.1	100	4.0	71.9
2nd twin	37	3.9	25.2	110	4.4	74.8
Cause of death anomalies						
1st twin	4	10.3	25.0	12	12.0	75.0
2nd twin	3	8.1	14.3	18	16.4	85.7
perinatal conditions						
1st twin	27	69.2	27.8	70	70.0	72.2
2nd twin	28	75.7	29.4	67	60.9	70.6
sudden infant death (SIDS)						
1st twin	4	10.3	36.4	7	7.0	63.6
2nd twin	1	2.7	7.7	12	11.0	92.3
Any conditions of the newborn						
1st twin	168	20.6	22.2	590	26.5	77.8
2nd twin	201	24.4	24.6	616	27.9	75.4
Apgar score < 7 one minute						
1st twin	160	19.9	24.8	484	19.8	75.2
2nd twin	254	27.3	25.9	728	30.2	74.1
Apgar score < 7 five minutes						
1st twin	44	4.7	25.0	132	5.4	75.0
2nd twin	254	27.3	25.8	728	30.2	74.2
Asphyxia						
1st twin	15	1.8	25.9	43	1.9	74.1
2nd twin	23	2.8	28.0	59	2.7	72.0
Cord prolapse						
1st twin	4	0.5	25.0	12	0.5	75.0
2nd twin	12	1.3	26.0	34	1.4	74.0
Hyaline membrane disease						
1st twin	39	4.8	22.4	135	6.1	77.6
2nd twin	47	5.7	23.0	157	7.1	77.0
Jaundice						
1st twin	62	7.6	23.5	201	9.0	76.0
2nd twin	67	8.1	24.0	212	9.6	76.0
Any malformations						
1st twin	21	2.5	22.3	73	3.2	77.7
2nd twin	24	2.9	24.5	74	3.3	75.5

[1] Percentage of DS (or SS) twins of column items.
[2] Percentage of row item which is DS (or SS).

https://doi.org/10.1017/S0001566000001859 Published online by Cambridge University Press

Table 4 - Comparing different sex to same sex and estimated dizygotic to monozygotic twin pregnancy complications in Washington State (1984-88)

Characteristic	DS relative to SS twins		DZ relative to MZ	
	RR	95% CI	RR	95% CI
Any complications of pregnancy	1.0	(1.0-1.1)	1.1	(0.9-1.2)
Abruptio placenta	1.3	(0.8-2.1)	1.6	(0.9-2.6)
Chronic hypertension[1]	1.2	(0.7-2.1)	1.4	(0.8-2.4)
Gestational diabetes[2]	2.0	(1.3-3.3)	8.6	(3.5-21.0)
Polyhydraminios	0.3	(0.1-0.7)	0.2	(0.1-0.4)
Pre-eclampsia[1]	1.1	(0.8-1.3)	1.1	(0.9-1.3)
Pyelonephritis	0.4	(0.1-1.5)	0.3	(0.1-0.8)
Other complications of pregnancy[3]	1.1	(1.0-1.2)	1.1	(1.0-1.3)

[1] Adjusted for parity.
[2] Adjusted for maternal age.
[3] Any complication not explicitly specified on the birth certificate.

Table 5 - Relative risks of different sex to same sex and estimated dizygotic to monozygotic twin pregnancy outcomes in Washington State (1984-88)

Characteristic	DS relative to SS twins		DZ relative to MZ	
	RR	95% CI	RR	95% CI
Birthweight 1st twin				
<1500g	0.7	(0.6-0.9)	0.6	(0.5-0.7)
1501-2500g	0.8	(0.7-0.9)	0.7	(0.6-0.8)
2501-3500g	1.0		1.0	
3501-4500g	1.4	(1.0-2.0)	2.3	(1.5-3.4)
Birthweight 2nd twin				
<1500g	0.8	(0.6-1.0)	0.7	(0.6-0.8)
1501-2500g	0.9	(0.6-0.8)	0.8	(0.7-0.9)
2501-3500g	1.0		1.0	
3501-4500g	1.4	(1.0-1.9)	2.0	(1.4-2.8)
Gestational age				
<25 weeks	1.0	(0.6-1.6)	0.9	(0.6-1.4)
25-28 weeks	0.9	(0.5-1.2)	0.8	(0.5-1.2)
29-32 weeks	0.8	(0.6-0.9)	0.9	(0.8-1.0)
33-36 weeks	0.9	(0.8-1.0)	0.9	(0.8-1.0)
37-41 weeks	1.0		1.0	
>41 weeks	1.1	(0.8-1.6)	1.2	(0.8-1.6)

https://doi.org/10.1017/S0001566000001859 Published online by Cambridge University Press

Table 5 (continued)

Characteristic	DS relative to SS twins		DZ relative to MZ	
	RR	95% CI	RR	95% CI
Infant death				
1st twin	1.0	(0.7-1.5)	1.05	(0.8-1.5)
2nd twin	0.9	(0.6-1.3)	0.8	(0.6-1.1)
Cause of death				
anomalies				
1st twin	0.9	(0.3-2.7)	0.8	(0.3-2.2)
2nd twin	0.4	(0.1-1.5)	0.3	(0.1-0.9)
perinatal conditions				
1st twin	1.0	(0.7-1.6)	1.0	(0.7-1.57
2nd twin	1.1	(0.7-1.7)	1.2	(0.8-1.8)
sudden infant death (SIDS)				
1st twin	1.5	(0.4-5.1)	2.2	(0.6-8.2)
2nd twin	0.2	(0.1-1.7)	0.1	60.1-0.7)
Any conditions of the newborn				
1st twin	0.8	(0.7-0.9)	0.7	(0.6-0.8)
2nd twin	0.9	(0.8-1.7)	0.8	(0.7-1.0)
Apgar score <7 one minute				
1st twin	0.9	(0.7-1.07	0.8	(0.7-0.9)
2nd twin	0.9	(0.8-1.0)	0.8	(0.7-0.9)
Apgar score <7 five minutes				
1st twin	0.9	(0.6-1.2)	0.8	(0.6-1.1)
2nd twin	0.9	(0.7-1.2)	0.8	(0.6-1.0)
Asphyxia				
1st twin	0.9	(0.5-1.7)	0.9	(0.5-1.6)
2nd twin	1.0	(0.6-1.7)	1.1	(0.7-1.7)
Cord prolapse				
1st twin	0.9	(0.3-2.7)	0.8	(0.3-2.2)
2nd twin	0.9	(0.5-1.8)	0.9	(0.5-1.6)
Hyaline membrane disease				
1st twin	0.8	(0.6-1.1)	0.7	(0.5-1.0)
2nd twin	0.8	(0.6-1.1)	0.7	(0.5-1.0)
Jaundice				
1st twin	0.8	(0.6-1.1)	0.8	(0.6-1.0)
2nd twin	0.8	(0.6-1.1)	0.8	(0.6-1.0)
Any malformations				
1st twin	0.8	(0.5-1.3)	0.7	(0.5-1.0)
2nd twin	0.9	(0.6-1.4)	0.8	(0.6-1.2)

https://doi.org/10.1017/S0001566000001859 Published online by Cambridge University Press

Polyhydraminios was present in 0.5% of DS pregnancies and 1.9% of SS pregnancies ($RR_{DZ|MZ}$0.2, 95%CI = 0.1-0.4). Although the frequency of pyelonephritis in the mothers in either group is small (0.2% of DS mothers and 0.6% of SS mothers), the relative risk for this condition in DZ relative to MZ pregnancies is $RR_{DZ|MZ} = 0.3$, (95% CI = 0.1-0.8). DS twins weighed more at birth, and were less likely to fall in the low birthweight categories (Table 5). These birthweight patterns hold for the second-born as well as the first-born twin. MZ twins were also more likely to have a shorter gestation than DZ twins.

For most causes of infant death, there appeared to be no difference in risk for DZ and MZ twins for the first-born twin. However, there was a difference for SIDS. The first-born DZ twin was more likely to die from SIDS ($RR_{DZ|MZ} = 2.2$, 95%CI = 0.6-8.2). In contrast, the second-born DZ twin was less likely to die from SIDS than a second-born MZ twin ($RR_{DZ|MZ} = 0.1$,95%CI = 0.1-0.7). DZ twins were slightly less likely to have any of the newborn conditions indicated on the birth certificate; DZ twins were slightly less likely to have low one-minute Apgar scores, hyaline membrane disease, or to develop neonatal jaundice than MZ twins. Malformations were more likely in MZ twins, although only to a very slight degree.

DISCUSSION

Twins have infant mortality rates which are about six to seven times higher than those for singletons, and are at greater risk for adverse outcomes such as prematurity, low birthweight, intrauterine growth retardation, birth asphyxia, and respiratory distress syndrome [21]. Twin perinatal mortality is estimated at 10% of all perinatal mortality, although twins contribute less than 2% of all maternities [13]. In a recent study of twin births it was found that 47% of all twins had some morbidity, compared with 26.6% for singletons [3]. Little is known about twin morbidity and mortality with respect to zygosity.

Although this study was population based, and included a fairly large number of twin births, there is an inherent limitation in that we were unable to verify the zygosity of any of the same-sex twin pregnancies. An attempt to correct for the zygosity in the stratified analysis by applying a correction based on the Weinberg rule may bias the relative risks of DZ to MZ twin pregnancies in two ways. First, the Weinberg rule may not hold in this population. There may be a differential fetal loss rate for DZ and MZ twins, or for male-male versus female-female same-sex twins. One twin may die in utero while the other survives. It may be that the prenatal demise of one twin is better tolerated by the survivor in DZ pregnancies with separate placentas, than by a surviving MZ twin with only one placenta. MZ twin pregnancies would then be under-reported. It is also possible that there may be a higher proportion of males in SS twins which are DZ than those which are MZ twins [34]. Second, the calculation of confidence intervals is carried out without regard to any additional standard error introduced when the 2×2 tables from DS-SS are corrected to DZ-MZ. The confidence intervals reported here are likely to be too narrow. The correct way to calculate the confidence interval for nondifferential misclassification has not been determined [7],[35].

In this study, the mothers of DZ twins generally experienced more pregnancy complications, but their babies appeared to have better outcomes than MZ twins. However, we found that gestational diabetes may be an important problem for DZ twin maternities, and that polyhydraminios and pyelonephritis may be important problem for MZ twin pregnancies. Some studies have found an increased risk of gestational diabetes in twin mothers, whereas others have not [1], [2], [6]. None has examined the risk according to zygosity. Since about 50% of twins in any population are MZ twins (45.1% in this study), it is possible that combining these populations decreases the ability to detect an increased risk for a specific group. Twin pregnancies show more than twice the singleton mean level of plasma estriol, which is betacytotropic (enhances the beta to alpha cell ratio in the endocrine pancreas), so it would seem that twin mothers are well prepared to respond to the glucose needs of two fetuses [20]. Insulin receptors have been found in the human placenta which are localized to the microvillus brush border membrane, which is in direct contact with the maternal blood in the intervillous space [25], [36]. The placenta degrades insulin in the maternal circulation, and new insulin is produced by the maternal pancreas. In DZ twin pregnancies, which always have diamniotic and dichorionic placentation, particularly in instances where the chorion is not fused, the total area of the microvillus brush border is larger than in MZ twin pregnancies, where a chorion is shared [32]. In DZ pregnancies, there are two sites of connection to the uterus. This results in a greater number of insulin receptors available for maternal insulin degradation, and therefore possibly a greater demand for maternal insulin. The maternal pancreas may not be able to respond to a higher rate of insulin degradation in order to prevent gestational-onset diabetes. In MZ twin pregnancies, there is only one site of placental attachment, and insulin degradation is probably not much different than in singleton pregnancies.

Twin mothers show much higher levels of human placental lactogen (HPL), which is known to impair glucose tolerance. In fact, twin mothers show increased levels of all placental hormones: progesterone, estrogen, and pituitary prolactin, as well as HPL. It appears that the total placental mass is important in determining the amount of HPL and other placental hormones produced. All of these are diabetiogenic, but on their own do not appear to explain the degree of insulin resistance observed in gestational diabetes. However, it is possible that their combined result, in antagonizing the action of insulin, is greater than one would expect if they exerted an additive effect [5], [32], [19]. The presence of two placentas in a DZ pregnancy may markedly impair glucose tolerance when compared to the single placenta of an MZ pregnancy. Gestational diabetic women are at increased risk for later development of overt diabetes. It has been shown that 50-60% will become diabetic within 16 years [23], [24]. Since this risk is higher for mothers of twins, they may need to be monitored for such later development of overt diabetes; there may be an increased risk, even if they do not develop gestational diabetes. Interestingly, it has been found than twinning appears more frequently in families with a history of diabetes [11].

Polyhydramnios has been reported in other studies at a rate of 3% to 10% for twins, a frequency which is much higher than in this study. In our study, it was found that almost 75% of pregnancies complicated by this condition occurred in SS pregnancies. Although these findings are generally not supported by other studies, this relationship has been demonstrated [4], [10], [18]. In one study of polyhydramnios, twin pregnancies

accounted for 8.4% of the cases [28]. Since monochorionic placentas frequently have a vascular connection between fetuses, polyhydramnios may develop as a result of excess fluid being transferred in the vascular anastomosis from fetal urine [30]. This would explain the increased risk of polyhydramnios for MZ twins, who are more likely to have this vascular connection. The reported occurrence of pyelonephritis at 2.5% of all pregnancies, is higher than that reported on the twin birth certificates for this study [28]. The possibility of under-reporting on birth certificates in this study must be considered; however, at least one other study has reported rates similar to ours [29]. Our data shows an elevated risk of pyelonephritis among MZ twins. However, the number of cases among DZ twins is too small to determine if any relationship really exists.

As in this study, previous work shows that MZ twins are lighter at birth than DZ twins, which might indicate an increased potential for interuterine growth retardation [8]. Also, we found that MZ twins appear to have a shorter gestations than DZ twins, although this is not supported by one study which found albeit weak evidence for the opposite relationship [33]. Both of these results may be explained by the geometry of MZ twin placentation. MZ twins may be lighter and of shorter gestation because of the constriction of one chorion (extra interuterine confinement), and presence of only one placental attachment for most MZ twin pregnancies. The maternal portion of the placenta, the decidua basalis, may be smaller, resulting in a smaller intervillous space and fewer chorionic villi. Thus, levels of nutrients available over time to MZ twin fetuses during gestation are relatively lower than those for DZ twins.

The greater risk for malformations in MZ twins than DZ twins has been reported in a variety of studies in several countries [16]. Perhaps the more constricted monochorionic placentation provides a less favorable environment for developing fetuses [1]. Perinatal mortality is thought to be higher in MZ twins than in DZ twins [26]. However, one author summarizes studies which report DZ and MZ infant death rates similar to those reported in this study [2]. Since MZ twins are more likely to be premature, any difference in perinatal mortality may be due to the same interuterine stresses that cause lower birthweights and shorter gestations in MZ twins.

There are two prior studies which show that the second-born twin is more likely to die of SIDS than a first-born twin; however, zygosity has not, until now, been evaluated [31]. Second-born twins have been found to be at greater risk than first-born twins for hyaline membrane disease, a finding which was apparent in this data. In addition, our data indicated a trend towards higher risks for this problem in MZ versus DZ twins. Asphyxia was also higher in the second twin in this study, but did not appear to depend on zygosity. It has been suggested that perinatal hypoxia as well as hyaline membrane disease may be important intermediate risk factors in SIDS. The extent to which birthweight differences or the presence of newborn or labour complications contribute to the risk for SIDS death for the second MZ twin, still needs to be studied.

Studies which evaluate the effects of zygosity in twin pregnancies, will further our understanding of pregnancy complications in singleton as well as twin pregnancies. Ultimately, it may be that early determination of the sex and perhaps zygosity of twin pregnancies may provide valuable clinical information for the early management as well as possibly the prevention of complications such as gestational diabetes, polyhydramnios, and pyelonephritis.

REFERENCES

1. Bulmer, MG (1970): The Biology of Twinning in Man. Oxford: Clarendon Press.
2. Campbell DM, MacGillivray I (1988): Outcome of twin pregnancies. Twinning and Twins. MacGillivray I, Campbell DM, Thompson B (eds): Chichester: John Wiley & Sons Ltd.
3. Chaurasia, AR (1980): Perinatal mortality in twins. Acta Genet Med Gemellol 29:237-239.
4. Chescheir NC, Seeds JW (1988): Polyhydramnios and oligohydramnios in twin gestations. Obstet and Gynecol 71:882-884.
5. Coustan DR, Felig P (1988): Diabetes mellitus. In Burrow GN, Ferrus TF (eds): Medical Complications During Pregnancy. Philadelphia: W.B. Saunders Company, pp 34-64.
6. Dwyer PL, Oats JN, Walstab JE, Beischer NA (1982): Glucose tolerance in twin pregnancy. Aust NZJ Obstet Gynaecol 22:131-134.
7. Fleiss, JL (1981): Statistical Methods for Rates and Proportions. New York: John Wiley and Sons, p 205.
8. Fraser C, Nylander PPS (1988): The relationship of birthweight to later growth and intelligence in twins. In MacGillivray I, Campbell DM, Thompson B (eds): Twining and Twins. Chichester: John Wiley & Sons Ltd.
9. Frost F, Starzyk P, George S, et al (1984): Birth complications reporting: the effect of birth certificate design. Am J Public Health 74:505-506.
10. Gaehtens G (1936): Klinscher Beitrag zur Pathogenese des akuten Hydramnions. Monatsschr Geburtschilfe Gynaekol 103:40-48.
11. Gedda L, Segni G, Andreani D, Casa D, DiMarco G (1970): Diabete e gemellogenesi. Acta Genet Med Gemellol 19:98-99.
12. Getts A (1981): SIDS: Increased risk to second-born twins (letter to the editor). Am J Public Health 71:317-318.
13. Ghai V, Vidyasagar D (1988): Morbidity and mortality factors in twins, an epidemiologic approach. Clinics in Perinatology 15; 1:123-139.
14. Hollenbach KA, Hickok DE (1990): Epidemiology and diagnosis of twin gestation. Clin Obstet Gynecol 33:1-21.
15. Kleinbaum DG, Kupper LL, Morgenstern, H (1982): Epidemiologic Research: Principles and Quantitative Methods. London: Wadsworth.
16. Little J, Bryan EM (1988): Congenital anomalies in twins. In MacGillivray I, Campbell DM, Thompson B (eds): Twinning and Twins. Chichester: John Wiley & Sons Ltd.
17. MacGillivray I (1986): Epidemiology of twin pregnancy. Seminars in Perinatology 1:1-8.
18. MacGillivray I, Campbell DM (1988): Management of Twin Pregnancies. MacGillivray I, Campbell DM, Thompson B (eds): Twinning and Twins. Chichester: John Wiley & Sons Ltd.
19. Magiste M, Von Schenck H, Sjoberg N, et al (1976): Screening for detecting twin pregnancy. Am J Obstet Gynecol 126:697-698.
20. Masson GM (1973): Plasma estriol in normal and pre-eclamptic multiple pregnancies. Obstet Gynecol 42:568-573.
21. McCulloch K (1988): Neonatal problems in twins. Clinics in Perinatology 15; 1:141-158.
22. Naidoo L, Jailal I, Moodley J, Desai R (1985): Intravenous glucose tolerance tests in women with twin pregnancy Obstet Gynecol 66; 4:500-502.
23. O'Sullivan JB, Mahan CM (1964): Criteria for the oral glucose tolerance test in pregnancy. Diabetes 13; 3:278.
24. O'Sullivan JB (1975): Long term follow-up of gestational diabetics. In Camerini-Davalos RA, Cole HS (eds): Early Diabetes in Early Life. New York: Academic Press, pp 503-510.
25. Posner BI (1974): Insulin receptors in human and animal placental tissue. Diabetes 23; 3:209.
26. Potter EL (1963): Twin zygosity and placental form in relation to the outcome of pregnancy. Am J Obstet Gynecol 87; 5:566-577.
27. Queenan JT, Gadow EC (1970): Polyhydramnios: chronic versus acute. Am J Obstet Gynecol 108:349-355.

28. Simpson ML, Gaziano EP, Lupo VR, Peterson PK (1988): Bacterial infections in pregnancy. In Burrow GN, Ferris TF (eds): Medical Complications During Pregnancy. 3rd edition. Philadelphia: W.B Saunders Company, pp 345-361.
29. Spellacy WN, Handler A, Ferre CD (1990); A case control study of 1253 twin pregnancies from a 1982-1987 perinatal data base. Obstet Gynecol 75; 2:168-171.
30. Spellacy WN (1988): Antepartum complications in twin pregnancies. Clinics in Perinatology 15; 1:79-86.
31. Standfast SJ, Jereb S, Janerich DT (1980): The epidemiology of sudden infant death in upstate New York. Am J Public Health 70:1061-1067.
32. Strong SJ, Corney G (1967): The Placenta in Twin Pregnancy. Oxford: Pergamon Press, pp 39-45.
33. Thompson B, Fraser C (1988): Some aspects of first births and the heights of twin sisters of known zygosity. In MacGillivray I, Campbell DM, Thompson B (eds): Twinning and Twins. Chichester: John Wiley & Sons Ltd.
34. Vogel F, Motulsky AG (1979): Human Genetics. Berlin: Springer-Verlag, p 176.
35. Walter SD, Irwig LM (1988): Estimation of test error rates, disease prevalence and relative risk from misclassified data: a review. Journal of Clinical Epidemiology 41:9; 923-937.
36. Whitsett JA, Johnson CL, Hawkins K (1979): Differences in localization of insulin receptors and adenylate cyclase in the human placenta. Am J Obster Gynecol 133:204-207.

Correspondence: Richard E Hoskins, Department of Health/Epidemiology, 1102 SE Quince St, P.O. Box 47812, Olympia, WA 98504-7812, U.S.A.