Twin Research and Human Genetics
Volume 16 ▌ Number 4 ▌ pp. 845–860 ▌ © The Authors 2013 ▌ doi:10.1017/thg.2013.31

Medical Record Validation of Maternal Recall of Pregnancy and Birth Events From a Twin Cohort

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This study aims to assess the validity of maternal recall for several perinatal variables 8–10 years after pregnancy in a twin sample. Retrospective information was collected 8–10 years after the delivery event in a cohort of mothers from the University of Southern California Twin Study ($N = 611$) and compared with medical records for validity analysis. Recall of most variables showed substantial to perfect agreement ($\kappa = 0.60$–1.00), with notable exceptions for specific medical problems during pregnancy ($\kappa \leq 0.40$) and substance use when mothers provided continuous data (e.g., number of cigarettes per day; $r \leq 0.24$). With the exception of delivery method, neonatal intensive care unit admission, birth weight, neonatal information, and post-delivery complications were also recalled with low accuracy. For mothers of twins, maternal recall is generally a valid measure for perinatal variables 10 years after pregnancy. However, caution should be taken regarding variables such as substance use, medical problems, birth length, and post-delivery complications.

■ **Keywords:** twin, maternal recall, recall validity, recall reliability, perinatal pregnancy, birth complication

Research has increasingly shown that prenatal and perinatal events have an important effect on later and lifelong health outcomes of offspring. Complications during pregnancy, delivery, and early childhood have all been associated with neurological, developmental, and neuropsychiatric disorders (Cannon et al., 2002; Liu et al., 2009; Rice et al., 2007), as well as chronic diseases such as obesity, metabolic syndromes, cardiovascular disease, cancer, and neurocognitive disorders (Rice et al., 2007; Sou et al., 2006; Troude et al., 2008). Early life factors are also associated with the development of chronic diseases and increased rates of cognitive, behavioral, and emotional problems (Buka et al., 2004; Liu, 2011; Rice et al., 2007; Tomeo et al., 1999). For instance, recent studies have suggested an association between birth weight and cardiovascular diseases in adulthood (Frontini et al., 2004; Mzayek et al., 2007) that is not confounded by genetic and environmental factors (Bergvall et al., 2007). Furthermore, maternal health-related behaviors, such as substance use during pregnancy, are known to have important implications on offspring health and development.

Researchers are increasingly interested in obtaining information from the perinatal period and often do so through maternal recall. Although medical records are often considered to be the most accurate sources of information, using medical records and charts can be impractical due to time and cost restraints, and in some instances health registries and records may not even exist (Troude et al., 2008). Furthermore, recording errors can occur, medical criteria may vary from hospital to hospital, and abstraction of information may be difficult due to the Health Insurance Portability and Accountability Act (HIPAA) policies as well as inconsistencies in record organization (Elliott et al., 2010; Hewson & Bennett, 1987; Joffe & Grisso, 1985). As a result, pregnancy and neonatal information is commonly obtained through cost-effective, self-report questionnaires or interviews. However, the validity and reliability of maternal report are still debated, and despite the number of studies suggesting maternal recall is sufficiently reliable for some

RECEIVED 16 May 2012; ACCEPTED 16 April 2013. First published online 3 June 2013.

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pregnancy and early life characteristics (D'Souza-Vazirani et al., 2005; Launer et al., 1992; Li et al., 2005; McCormick & Brooks-Gunn, 1999; Olson et al., 1997; Quigley et al., 2007; Reich et al., 2003; Tomeo et al., 1999), evidence still suggests poor to moderate recall for information including lifestyle during pregnancy (Jaspers et al., 2010), complications and disease diagnosis (Coolman et al., 2010; Sou et al., 2006), and procedures during delivery (Quigley et al., 2007). These inconsistencies are in part attributed to the current literature's varied sample populations, methodology, length of recall, and measures of interest. Importantly, most studies have focused on the recall of one or a few related variables, such as birth weight (Catov et al., 2006; Lumey et al., 1994), and specific procedures or complications during delivery (Coolman et al., 2010; Quigley et al., 2007; Sou et al., 2006). Thus, it is unclear whether inconsistencies in findings actually reflect differences in the accuracy of maternal report for different variables or whether they are due to methodological variations (i.e., sample characteristics, questionnaire wording, measurement). Few studies have looked comprehensively at recall validity for perinatal, prenatal, and postnatal data, and those which have often use small samples (Githens et al., 1993; Rice et al., 2007; Tomeo et al., 1999). Even fewer studies have addressed maternal recall of pregnancy, delivery, or postnatal complications, and those that have often do so very broadly (Tomeo et al., 1999; Yawn et al., 1998). On the other hand, studies which have studied the recall validity for specific complications often leave out other important perinatal factors (Buka et al., 2004; Coolman et al., 2010; Sou et al., 2006). Finally, and importantly, validity has not been assessed in a large sample of mothers of twins who are asked to recall information for both twins simultaneously. To our knowledge, only Reich et al. (2003) have examined maternal recall with a focus on mothers of twins. In their study, mothers were re-interviewed 6–18 months after the initial interview, but comparison to medical records was not available. Thus, while the use of twins allowed for maternal recall to be assessed for reliability, validity of this information was not established.

This study aims to help bridge the gaps in the existing literature by examining the validity of maternal recall in a large twin cohort. Mothers of twins were asked to complete a questionnaire that was developed by the first author and asked mothers to report on pregnancy and birth-related events including maternal history, medical problems during pregnancy, substance and vitamin use, delivery procedures, neonatal information for both twins, and postdelivery complications for both twins. The validity of the data was obtained by comparing questionnaire answers to medical records.

Methods

Study Sample

The subjects were participants in the University of Southern California (USC) Risk Factors for Antisocial Behavior (RFAB) twin study, which is an ongoing prospective longitudinal study of the interplay of genetic, environmental, social, and biological factors on the development of antisocial behavior from childhood to early adulthood. The twins and their parents were recruited from the larger Los Angeles community and the sample is representative of the ethnic and socio-economic diversity of the greater Los Angeles area. On the first assessment (Wave 1), the twins were 9–10 years old (mean age = 9.59, $SD = 0.58$). On the second assessment (Wave 2), the twins were 11–13 years old (mean age = 11.79, $SD = 0.92$). On the third assessment (Wave 3), the twins were 14–15 years old (mean age = 14.82, $SD = 0.83$), and during Wave 4 the twins were 16–18 years old (mean age = 17.22, $SD = 1.23$). The total sample contains 1,564 subjects (781 twin pairs), including 169 monozygotic (MZ) male, 171 MZ female, 121 dizygotic (DZ) male, 120 DZ female, and 200 DZ opposite-sex twin pairs. Complete details on the procedures and measures can be found elsewhere (Baker et al., 2006, 2007, 2013).

Caregiver participation was primarily by the biological mothers (>90%). Information on prenatal recall was collected from 611 of the twins' mothers. The mean age of pregnancy among the women in this sample was 29.5 years.

Study Measures

Retrospective birth complications recall questionnaire. Birth complications recall was measured with a retrospective questionnaire developed by the first author who has a master degree in Maternal-Child Health Nursing (see the Appendix). It was developed from the birth complications-medical records instrument (see below), which asked mothers about birth complications on a more general level. The form includes questions regarding three main areas: prenatal (during pregnancy), perinatal (during birth), and postnatal (newborn) complications. Mothers were asked to fill in a computerized version of the birth complications questionnaire at their visit to the USC laboratory.

Birth complications-medical records instrument. We developed the Birth Complications-Medical Records Instrument, which incorporated more detailed birth complications information. This was derived from two well-established instruments: the Lewis–Murray Obstetric Complication Scale (Lewis & Murray, 1987; Lewis et al., 1989) and the McNeil–Sjöström Scale for Obstetric Complications (McNeil & Sjöström, 1995). In this study, we asked for the mother's permission to obtain the children's medical records, which were stored at the birth hospitals. We then contacted each hospital and the records were mailed to the laboratory.

Statistical Analyses

Items were grouped into those events occurring prior to the pregnancy of interest (maternal history), during the

https://doi.org/10.1017/thg.2013.31 Published online by Cambridge University Press

pregnancy (medical problems during pregnancy; substance use during pregnancy; vitamins during pregnancy), during delivery (medical procedures), information on the infant (neonatal information), and events occurring after delivery (post-delivery complications); see Table 1.

Measures of agreement for both categorical and continuous measures are presented. For the continuous variables (e.g., birth weight and birth length), we computed Pearson's correlation coefficient along with *p* values. The κ statistic was calculated for categorical variables. The κ statistic measures the extent of exact agreement, adjusting for chance agreement. All analyses were performed using the statistical software SAS (SAS, 2005).

Results

Recall validity for several perinatal factors obtained from the USC Twin Study is presented in Table 1.

Prenatal

Perfect agreement was obtained for maternal history (previous live births; κ 1.00). Poor agreement was found among medical problems during pregnancy, such as bleeding (0.39), edema (0.30), proteinuria (0.10), and nausea and vomiting (0.38). Substance use during pregnancy, specifically alcohol use and vitamin use, was very poorly recalled. However, smoking during pregnancy showed moderate agreement. Information regarding substance use was collected as continuous data (e.g., number of cigarettes per day), and validity analysis was repeated after dichotomizing these data, where any answer >0 would, for example, represent having ever smoked during pregnancy. This produced better recall accuracy for smoking throughout pregnancy (κ 0.73, 95% CI 0.48–0.98) as well as during the first, second, and third trimesters (0.79, 0.80, 0.78, respectively), but validity recall of alcohol use remained poor (0.08, 95% CI 0.18–0.35).

Perinatal and Postnatal

For both twins (A, B), near-perfect ($\kappa \geq 0.80$) agreement was obtained for medical procedures/method of delivery (0.94, 0.97) and birth weight (κ 0.84, 0.82), but not birth length (0.17, 0.21). Recall of specific delivery procedures such as the use of forceps and oxytocin to induce labor was excluded from validity analyses due to low frequency. Recall accuracy was generally low for neonatal information and post-delivery complications. Mothers generally recalled neonatal information for both twins with similar accuracy, and without consistently more accurate recall of information for twin A than B or vice versa. A notably pronounced difference in recall accuracy was, however, found in muscle tone: agreement between recall and medical records was substantial for Twin A (κ 0.70, 95% CI 0.51–0.89) but poor for Twin B (κ 0.26, 95% CI 0.05–0.46).

Discussion

This study examined the validity of maternal recall for perinatal variables in a large twin sample 8–10 years after birth. Overall, the data obtained from questionnaires completed by mothers around 9 years after pregnancy showed substantial agreement ($\kappa \geq 0.60$) with medical records for most pre-, peri-, and postnatal variables. Exceptions included poor validity for medical problems during pregnancy (e.g., bleeding, edema, proteinuria), substance and vitamin use, and some neonatal information (e.g., birth length, meconium, respiratory distress, and jaundice).

To our knowledge, these findings are the first that use medical records to demonstrate that that maternal recall is a valid method for obtaining neonatal information in twins. Although Reich et al. (2003) looked at reliability and stability of maternal report using a twin sample, this study's design compared sets of interview responses and did not assess validity through comparison with medical records. The findings for a number of pregnancy and neonatal factors are further discussed below.

Prenatal

The recall validity of medical problems such as bleeding, edema, and nausea and vomiting during pregnancy was mostly poor to moderate. Low rates of recall for ante partum vaginal bleeding and edema have been reported previously (Bryant et al., 1989; Buka et al., 2000; Olson et al., 1997; Sou et al., 2006). Low rates of maternal recall for these particular problems may reflect the fact that these complications may not be severe enough to warrant major actions (i.e., diet change, medications) and are thus less memorable to mothers (Sou et al., 2006). Indeed, the few women whose complications did require them to take medications recalled this information with near-perfect accuracy. The moderate recall of hypertension versus preeclampsia in our sample (κ 0.60, 95% CI 0.39–0.80) is in line with previous reports, which have generally promoted more accurate patient–doctor communication in order to address the reduced maternal recall (Coolman et al., 2010; Rice et al., 2007). Previous work has also suggested recall of hypertension to be particularly time-sensitive (Olson et al., 1997).

Our initial findings suggest very poor recall validity and reliability for both smoking and alcohol use. While our findings are in line with existing evidence that maternal recall for alcohol use is poor (Delgado-Rodriguez et al., 1995; Jaspers et al., 2010; Rice et al., 2007), these and other findings have demonstrated accurate recall for smoking (Tomeo et al., 1999; Yawn et al., 1998), which was not observed in our initial analysis. This discrepancy in recall validity for

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TABLE 1

Agreement Between Medical Records and Maternal Reports

					Mother ($N = 611$)	Twin A ($N = 287$)	Twin B ($N = 287$)
	Medical records (%)	Frequency	Prenatal recall (%)	Frequency	κ (95% CI)/ Pearson correlations	κ (95% CI)/ Pearson correlations	κ (95% CI)/ Pearson correlations
Maternal history							
Previous live births							
No	25.00	48	25.00	48			
Yes	75.00	144	75.00	144	1.00 (1.00–1.00)		
Medical problems during pregnancy							
Respiratory infection	16.7	1	0	0			
Urine infection	66.7	4	66.7	4			
Asthma	16.7	1	33.3	2	0.67 (0.24–1.00)		
Bleeding during pregnancy							
No	73.20	30	80.50	33			
Yes	26.80	11	19.50	8	0.39 (0.06–0.71)		
Edema during the pregnancy (any swelling in face, fingers, legs or feet)							
None	48.19	40	44.58	37			
Yes	51.81	43	55.42	46	0.30 (0.09–0.50)		
Proteinuria during the pregnancy							
None	24.68	19	85.71	66			
Yes	75.32	58	14.29	11	0.10 (0.03–0.17)		
Pre-elampsia vs pre-elampsia + hypertension							
No	65.71	46	74.29	52			
Yes	34.29	24	25.71	18	0.60 (0.39–0.80)		
Medication taken during the pregnancy							
Antibiotics	71.43	5	71.43	5			
Anti-hypertension	28.57	2	28.57	2	1.00 (-1.00–1.00)		
Nausea and vomiting during pregnancy							
No	43.10	28	63.10	41			
Yes	56.90	37	36.90	24	0.38 (0.17–0.58)		
Weight gain during pregnancy					0.30*		
Substance use during pregnancy (continuous)							
Smoking (number of cigarettes per day)							
During the pregnancy					0.25		
During the first trimester					0.24		
During the second trimester					0.001		
During the third trimester					0.01		
Alcohol (number of alcoholic drinks per month)							
During the pregnancy					-0.09		
During the first trimester					-0.07		
During the second trimester					-0.06		
During the third trimester					-0.07		
Substance use during pregnancy (dichotomized)							
Smoking during pregnancy							
No	70.27	26	75.68	28			
Yes	29.73	11	24.32	9	0.73 (0.48–0.98)		
Smoking during the first trimester							
No	80.00	40	86.00	43			
Yes	20.00	10	14.00	7	0.79 (0.56–1.00)		
Smoking during the second trimester							
No	83.33	30	83.33	30			
Yes	16.67	6	16.67	6	0.80 (0.53–1.00)		
Smoking during the third trimester							
No	80.43	37	82.61	38			
Yes	19.57	9	17.39	8	0.78 (0.55–1.00)		
Alcohol during pregnancy							
No	72.97	27	94.59	35			
Yes	27.03	10	5.41	2	0.08 (-0.18–0.35)		
Alcohol in the first trimester							
No	85.71	42	93.88	43			
Yes	14.29	7	6.12	6	0.13 (-0.22–0.47)		
Alcohol in the second trimester							
No	86.49	32	97.30	36			
Yes	13.51	5	2.70	1	-0.05 (-0.13–0.03)		

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TABLE 1
Continued.

					Mother ($N = 611$)	Twin A ($N = 287$)	Twin B ($N = 287$)
	Medical records (%)	Frequency	Prenatal recall (%)	Frequency	κ (95% CI)/ Pearson correlations	κ (95% CI)/ Pearson correlations	κ (95% CI)/ Pearson correlations
Alcohol in the third trimester							
No	82.98	39	95.74	45			
Yes	17.02	8	4.26	2	-0.073 (-0.16–0.01)		
Vitamins during pregnancy							
Prenatal vitamins							
No	0.82	1	12.30	15			
Yes	99.18	121	87.70	107	0.11 (-0.09–0.31)		
Iron supplement during the pregnancy							
No	1.56	1	37.50	24			
Yes	98.44	63	62.50	40	0.05 (0.05–0.15)		
Folic acid during the pregnancy							
No	16.67	1	66.67	4			
Yes	83.33	5	33.33	2	0.18 (-0.19–0.56)		
Medical procedures/method of delivery							
Method of delivery (Twin A)							
Vaginal	38.20	100	37.80	99			
C-section	61.80	162	62.20	163		0.94 (0.90–0.98)	
Method of delivery (Twin B)							
Vaginal	32.90	85	34.50	89			
C-section	67.10	173	65.50	169			0.97 (0.93–1.00)
Neonatal information							
Birth weight						0.84*	0.82*
Birth length						0.17	0.21*
Meconium (Twin A)							
No	91.40	170	97.80	182			
Yes	8.6	16	2.20	4		0.17 (-0.06–0.4)	
Meconium (Twin B)							
No	91.80	169	98.90	182			
Yes	8.2	15	1.10	2			-0.02 (-0.04—0.00)
Muscle tone (Twin A)							
Limp and some flexion	7.50	12	9.40	15			
Active motion	92.50	147	90.60	144		0.70 (0.51–0.89)	
Muscle tone (Twin B)							
Limp and some flexion	11.9	19	13.1	21			
Active motion	88.1	141	86.9	139			0.26 (0.05–0.46)
Apgar score — Color (Twin A)							
Pale/blue/body pink extra blue	95.55	156	19.39	32			
All pink	5.45	9	80.61	133		-0.04 (-0.08–0.01)	
Apgar score — Color (Twin B)							
Pale/blue/ body pink extra blue	94.71	161	22.35	38			
All pink	5.29	9	77.65	132			-0.03 (-0.08–0.02)
Respiratory distress (Twin A)							
No	67.80	139	83.90	172			
Yes	32.20	66	16.10	33		0.32 (0.18–0.45)	
Respiratory distress (Twin B)							
No	75.50	154	81.40	166			
Yes	24.50	50	18.60	38			0.34 (0.19–0.49)
Post-delivery complications							
Jaundice (Twin A)							
No	60.60	137	79.60	180			
Yes	39.40	89	20.40	46		0.18 (0.06–0.30)	
Jaundice (Twin B)							
No	58.3	127	78.0	170			
Yes	41.7	91	22.0	48			0.28 (0.16–0.40)
NICU (Twin A)							
No	64.50	138	61.70	132			
Yes	35.50	76	38.30	82		0.80 (0.72–0.88)	
NICU (Twin B)							
No	67.90	146	59.10	127			
Yes	32.10	69	40.90	88			0.65 (0.55–0.76)

Note: *$p < .05$. κ is not calculated for this dataset because observed concordance is smaller than mean-chance concordance.
NICU = neonatal intensive care unit.
In the prenatal recall record, seven different illnesses were combined into one variable (0 = none, 1 = respiratory infection, 2 = urinary tract infection, 3 = gall bladder inflammation, 4 = measles, 5 = TB, 6 = epilepsy, 7 = asthma). Due to limited data for some diseases, we only kept respiratory infection, urinary tract infection, and asthma when calculating the κ statistic. Two variables in prenatal record, *pre-eclampsia* and *hypertension*, were combined and paired with *pre-eclampsia* in medical records.

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smoking likely reflects the fact that we asked mothers to provide continuous data (e.g., cigarettes per day for overall pregnancy and during each trimester). In contrast to the present study, other studies have generally used dichotomized categories (e.g., 'ever'/'never') when comparing maternal recall data to medical records. Repeating our validity analysis with dichotomous data produced results more in line with the existing evidence with substantial to near perfect agreement for smoking but poor recall of alcohol use.

In addition to poor recall for substance use, we also found very poor recall ($\kappa < 0.20$) for the use of prenatal vitamins, iron supplements, and folic acid during pregnancy. To our knowledge, this is the first study that examines maternal recall for vitamin use, but very poor agreement between records and self-report has been reported for prenatal vitamin use even during pregnancy (κ 0.11; Hessol et al., 2004). Due to low frequency of use for the individual vitamins mothers were asked to report on, answers for prenatal vitamins, iron supplements, and folic acid were all grouped into one category.

Perinatal and Postnatal

Our findings add to the existing evidence that birth weight and the method of delivery are among the most accurately recalled perinatal variables (Olson et al., 1997; Sou et al., 2006; Tomeo et al., 1999; Yawn et al., 1998). An accurate and consistent recall of birth weight may reflect high social value and repetition of information to others (Yawn et al., 1998). The lack of such social value could explain the poor recall for birth length in both our samples. We are aware of only one other study that reports recall of birth length, which showed accurate recall but only 6–10 weeks after delivery (Troude et al., 2008). Birth length has been demonstrated to be an independent predictor for various health outcomes (Maehle et al., 2010; Melve et al., 2000; Sun et al., 2009), and may actually serve as a better indicator of birth size than birth weight (Silva et al., 2008). Thus, while there may be growing interest in obtaining this information, our finding highlights the need for researchers to use caution when relying on maternal reports of birth length.

Recall accuracy was generally poor for neonatal information and post-delivery complications regarding both Twin A and Twin B. Meconium was especially unreliably recalled. Although meconium-stained aminiotic fluid has been associated with higher rates of stillbirths, low Apgar scores, and hypoxic ischemic encephalopathy (Carbonne et al., 1997; Starks, 1980; Steer et al., 1989), outcomes are generally good (Balchin et al., 2011) and may explain the underreporting of this complication by mothers. NICU admission tended to be over reported by mothers of the twin samples, while maternal recall of post-delivery complication factors for both twins was the most accurate. This result is similar to previous findings from the United States (Githens et al., 1993).

Limitations and Implications

Our findings are not without limitations, particularly our use of medical records as the 'gold standard'. These records are not always valid, especially regarding behavioral or lifestyle factors (Hessol et al., 2004; Hewson & Bennett, 1987). Medical records are subject to recording errors and inconsistencies due to varying medical criteria between hospitals (Hewson & Bennett, 1987; Joffe & Grisso, 1985). Recall bias may have also affected our findings and can be caused by factors such as the child's current physical, emotional, mental, or behavioral state. For example, McIntosh et al. (2002) found that the number of obstetric complications recalled by mothers was not related to their own schizophrenic status but was instead related to measures of abnormal child behavior, suggesting that concern for child's behavior may affect retrospective recall. Moreover, it may be possible that pregnancy and related events were more memorable to mothers expecting twins than for those expecting a single child. Additionally, because recall accuracy may be affected by culturally influenced factors, such as the importance of events and awareness and knowledge of conditions (Olson et al., 1997), these findings should be generalized with caution. Furthermore, our sample size is small, which may explain why not all results are significant, specifically regarding more rare medical outcomes. Finally, no information on chorion type was available in the medical birth records.

Despite these limitations, this study makes important contributions to the literature on validity of maternal recall for various perinatal factors. The questionnaire developed and used in this study provides data for medical and behavioral factors that are of interest to researchers, due to their associations with important health outcomes, but have not been examined elsewhere in regard to long-term recall validity. For instance, validity for maternal recall of Apgar scores and birth length has been assessed previously but only 6–10 weeks after delivery (Troude et al., 2008). Recent studies have shown associations between low Apgar scores and a high risk for cerebral palsy in term infants born in Sweden (Thorngren-Jerneck & Herbst, 2006). Our findings suggest that researchers using maternal reports to assess Apgar scores should do so with caution because of the low validity of recall. It could be that parents do not understand the medical terminology, and the information may be unclear to parents when they recall, which in turn may affect validity. Additionally, jaundice has recently been associated with disorders of psychological development (Maimburg et al., 2010), and prenatal vitamin use has been linked to outcomes such as childhood cancers (Goh & Koren, 2008). The present study also informs researchers in the development and use of recall questionnaires. The validity of recall for behavioral factors like smoking was low when mothers were asked to report continuous data within a recall period of almost 10 years. Thus, while the frequency of smoking may be a variable

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of interest to researchers due to its association with many long-term outcomes in offspring (Batty et al., 2006; Brook et al., 2006, 2008; Button et al., 2005; Lambe et al., 2006; Liu et al., 2013), it may be more suitable to present mothers with categorical answers, or ask within a more immediate recall period. Furthermore, since maternal knowledge and perception of the event's importance may also affect recall validity (Hewson & Bennett, 1987; Mitchell et al., 1986; Olson et al., 1997), as different pre-, peri-, and postnatal events become increasingly associated as risk factors for offspring health, doctors and nurses should emphasize the importance of this information at or around the time of the delivery event. Healthcare professionals should also improve communication with parents in order to clarify an understanding of how various conditions, procedures, and other factors are defined.

In conclusion, our findings support that maternal recall, even in a twin sample, could be a reliable source for many pregnancy-related variables up to 10 years after the delivery event. However, maternal recall may not be appropriate for obtaining postnatal information, especially regarding twins, aside from the method of delivery, birth weight, and NICU admissions. Furthermore, this study also highlights the need for caution when using maternal report as a sole source of information, especially for information which mothers may not deem socially valuable (e.g., birth length) or events that require little involvement or changes from the mother (e.g., medical problems not requiring medication).

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https://doi.org/10.1017/thg.2013.31 Published online by Cambridge University Press

Appendix

Retrospective pre/peri/post-natal data Questionnaire*

Twin Name A_____B _____

General information

Mother current name _____
Current zip code _____

Mother's full name at the time she gave birth _____
Zip code during the pregnancy____

The name of the Hospital you gave birth _____

Your age when you gave birth to the twins: _____ years

The age of the father when the twin were born____years

Your marital status during the pregnancy:

(1) Married ___ (2) not married but living with partner_____
(3) Separated/divorced_____ (4) single _____

The year of your education during the pregnancy_____

The year of education the father of twins during your pregnancy_____

Your occupation during the pregnancy_____

The occupation of the father of the twins during your pregnancy_____

The total income you and your partner during the pregnancy _____

The family size _____

*This questionnaire was developed by Dr. Jianghong Liu.

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Maternal prenatal information

Pregnancy history **before** the twins:

(1) previous live births _____ (2) abortions _____(3) miscarriages _____
(4) premature_____ (5) birth abnormality _____ (6) other_____

How many antenatal care you received for the twins?

(1) 0 (2) 1-3 (3) 4-6 (4) 7-9 (5) 10+

Did you take prenatal vitamins during the pregnancy? (1) None ___ (2) Yes____

Did you take Folic Acid Supplement? (1) None ___ (2) Yes ___

How much you weighed before pregnancy? _____(LB)

Did you suffer chronic renal disease before the pregnancy? (1) None__ (2) yes__

Did you suffer chronic cardiac disease before the pregnancy? (1) None___ (2) yes___

Did you suffer hepatitis before the pregnancy? (1) None___ (2) yes____

Did you have Diabetes before the pregnancy?

(1) None__ (2) insulin dependent __ (3) Non-insulin dependent__

Did you experience STD (sexual transmitted disease) before the pregnancy?

(1) None___ (2) gonorrhea__ (3) syphilis __ (4) other___

Did you experience/ develop the following illness **during pregnancy**?

Resp infection (1) None __ (2) yes___

Asthma (1) None __ (2) yes___

Urine infection (1) None __ (2) yes___

Hepatitis (1) None __ (2) yes___

Vulvo infection (1) None __ (2) yes___

Gall bladder (1) None __ (2) yes___

Measles (1) None __ (2) yes___

TB (1) None __ (2) yes___

Epilepsy (1) None __ (2) yes___

Anemia: (1) None __ (2) yes___

Hg level if you remember___ 1st; 2nd___ 3rd____

Pregnancy Induced Hypertension: (1) None __ (2) yes___

BP if you remember 1st _____2nd _____3rd_____

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Edema: (1) None __ (2) yes___

Protein in urine: (1) None __ (2) yes___

Gestational Diabetics: (1) None __ (2) yes___

Blood Glucose level if you remember____1st ____2nd ___3rd

Did you receive insulin treatment? (1) None __ (2) yes___

Pernicious vomiting: (1) None __ (2) 1st trimester___ (3) 2nd ___ (4) 3rd___

Rubella: (1) None___ (2) 1st trimester____ (3) 2nd ___(4) 3rd___

Measles: (1) None___ (2) 1st trimester____(3)2nd ___ (4) 3rd___

Flu during pregnancy: (1) None___ (2) 1st trimester___ (3)2nd ___ (4) 3rd___

Fever: (1) None___ (2) 1st trimester___(3) 2nd ____(4) 3rd___

Did you experience abnormal bleeding during the pregnancy?

(1) None___ (2) 1st trimester____ (3) 2nd _____ (4) 3rd___

Did you experience polyhydramnios (a lot of amniotic fluid)? (1) None __ (2) yes___

Did you experience oligohydramnios (lack of amniotic fluid)? (1) None __ (2) yes___

Any Placental problems (e.g. low position of placenta, placenta rupture) occurred in you pregnancy?

(1) None __ (2) yes___

Did you experience Rh incomparability? (1) None __ (2) yes___

Other than above, did you experience any other complications? (1) None __ (2) yes___

Did you smoke during the pregnancy? How many cigarettes per day?

(1) None (2) ____/day during 1st trimester (3) ____/day during 2nd (4) ___/day during 3rd

Were you exposure to smoking (partner, co-workers, friends etc)

(1) 0____ (2) 0-1 hr/day ____(3) 1-2hr/day _____ (4)2-4hr/day____(5)4+hr/day

Did you use any drugs during the pregnancy?

(1) None___(2) Marijuana____(3) cocaine_____(4) other____

How much Alcohol did you consume during the pregnancy?

(1) None__; (2) 1-2 drink/week__; (3) 3-4wk__; (4) 1 drink/day__; (5) 2+ drink/day__

Did you take any Medication during the pregnancy?

(1) None__ (2) antibiotics__(3) antihypertension___(4) other___

Did you experience any accidents?

(1) None___; (2) fall__ (3) slipped disc; ___(4) hit in abdomen ___(5) other___

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Labor /deliver information

Abnormal Fetal heart Rate/rhythm (1) none ____(2) yes___ (999) don't know____

Fetal Presentation (which body part came first):

(1) head____ (2) bottom____(3) foot___(4) shoulder___(999) don't know ___

Premature rupture of membrane (1) none ____(2) yes___ (999) don't know ___

Induced labor (use medication such as pitocion) (1) none ____(2) yes___(999) don't know___

How many hours it took from starting labour (contraction) to birth? _____Hours (999) don't know___

Fever during labor (1) none ____(2) yes___ (999) don't know ___

Meconium (baby stool) in amniotic fluid: (1) none ____(2) yes___ (999) don't know ___

Mother given oxygen: (1) none ____(2) yes___ (999) don't know ___

Did you receive any pain medication?

(1) None____(2) pain shot____(3) epidural____(999) don't know

Did you receive any Anesthesia during birth?

(1) None____(2) epidural___ (3) spinal____ (4) general_____

(5) Cervical____(999) don't know

Did you give birth through vaginal delivery?

(1) None___(2) Spontaneous_____ (3) forceps_____

(4) Vacuum extraction_____(5) rotation____

Did you give birth through C-section?

(1) None___ (2) planned __ (3) emergency ___

Any Abnormal bleeding during labor and delivery? (1) None ____(2) yes___ (999) don't know ___

Were there any placenta infarcts? (1) None ____(2) yes___ (999) don't know ___

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Newborn information (use separate sheet for each child)

Twin A: name_____

Sex: (1) Male___ (2) female____

Born at ____weeks.

Minutes apart from twin B_____

Birth weight_____gram or _____Ib _____oz

Length _____cm or _____inches; HC_____cm;

Did you child have umbilical cord knotted or wrapped around neck upon birth?

(1) None (2) one round__ (3) two rounds____ (999)____

Did you child cry loud/weak at birth (first minutes?

(1) Good/vigorous cry___ (2) weak/grimace cry (3) no cry ___

What color did your child have at birth (first 1-5 minutes)?

(1) Whole body Pink__ (2) hands/feet blue only_____ (3) face blue ___

(4) not blue but face or body pale___

Did you child have active/limp muscle tone at birth (first 1-5 minutes)?

(1) Active___ (2) limp (soft)____ (999) don't know

Did you child experience breathing difficulties at birth (first 1-5 minutes)?

(1) No breathing problem ___(2) breathing difficult and gave oxgency___

(3) intubation ____(999) Don't know__

Did you child have Meconium aspiration (baby stool in mouth and nose)?

(1) None ___ (2) yes___ (999) don't know___

Did you child experience Hypoglycemia (low sugar in blood) at birth?

(1) None____ (2) yes__ (999) don't know____

Did you child have birth injury?

(1) None___ (2) clavicle or brachial born/never injury___ (3) fracture of long born__

(4) Head hemotoma ___ (5) other ___

Did you child have any of the following birth defects?

(1) None____ (2) hydrocephalus____ (3) cleft lip/palate (4) imperforate anus___

(5) Tracheoesophageal___ (6) bowel obstruction (7) others____

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Was your child sent to NICU (neonatal intensive care unit) after birth?

(1) None (2) yes, due to premature reason___ (3) yes, due to breathing difficulties ___

(4) Yes, due to fever___ (5) yes, due to hypogleciam ___ (6) yes, due to other reason____

How long was your child in NICU?

_____Days

During the first 6 months did your child have any of the following disorders?

(1) None___ (2) Pneumonia_____ (3) Sepsis (infection in blood) ____ (4) Fever____

(5) Jaundice____ (6) seizure_____ (7) other_____

During the first 18 months of life, for how many days was this child spend in hospital/institutions?

_____days

Feeding information:

What type of feeding method did you chose?

(1) Breast only ____ (2) fumula only ____ (3) mix___

For how many months did you breast feed this child?

_____months

For how many months did you formula feed this child?

_____months

What type of formula did you use?

(1) Iron-Fortified Formula ____(2) Soy Formula _____(3) Hypoallergenic Formula___

(4) Other _____

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Childhood illness:

Has your child experienced any of the following illness up to present time?

Asthma (1) none _____ (2) mild _____ (3) moderate (4) severe _____

Other allergy (1) none _____ (2) mild _____ (3) moderate (4) severe _____

Anemia (1) none _____ (2) mild _____ (3) moderate (4) severe _____

Diabetics (1) none _____ (2) mild _____ (3) moderate (4) severe _____

Cardiac disorder (1) none _____ (2) mild _____ (3) moderate (4) severe _____

Rheumatic fever (1) none _____ (2) mild _____ (3) moderate (4) severe _____

Renal disorder (1) none _____ (2) mild _____ (3) moderate (4) severe _____

Hemophilia (1) none _____ (2) mild _____ (3) moderate (4) severe _____

Cyst fibrosis (1) none _____ (2) mild _____ (3) moderate (4) severe _____

Measles (1) none _____ (2) yes___

Rubella (1) none_____ (2) yes___

Chicken Pocks (1) none ____ (3) yes____

Other _____

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