
Accuracy of Mothers' Retrospective Reports of Smoking During Pregnancy: Comparison with Twin Sister Informant Ratings

Andrew C. Heath¹, Valerie S. Knopik¹, Pamela A. Madden¹, Rosalind J. Neuman¹, Michael J. Lynskey^{1,2}, Wendy S. Slutske³, Theodore Jacob⁴, and Nicholas G. Martin²

¹ Missouri Alcoholism Research Center, Department of Psychiatry, Washington University School of Medicine, St Louis, Missouri, USA

² Palo Alto Veterans Administration, Palo Alto, California, USA

³ Queensland Institute of Medical Research, Brisbane, Australia

⁴ Missouri Alcoholism Research Center, Department of Psychology, University of Missouri, Columbia, Missouri, USA

Retrospective assessment of maternal smoking or substance use during pregnancy is sometimes unavoidable. The unusually close relationship of twin sister pairs permits comparison of self-report data versus co-twin informant data on substance use during pregnancy. Information about smoking during pregnancy has been gathered from a series of mothers from an Australian volunteer twin panel (576 women reporting on 995 pregnancies), supplemented in many cases by independent ratings of their smoking by twin sister informants (821 pregnancies). Estimates of the proportion of women who had never smoked regularly (56–58%), who had smoked but did not smoke during a particular pregnancy (16–21%), or who smoked throughout the pregnancy (16–18%), were in good agreement whether based on self-report or twin sister informant data. However, informants underreported cases who smoked during the first trimester but then quit (1–3% versus 7–9% by self-report). Women who smoked throughout pregnancy (by informant report) rarely denied a history of regular smoking (< 1%), although a small proportion of apparent false negative cases were identified where they either denied smoking during a pregnancy (9%) or denied smoking beyond the first trimester (10%). We conclude that retrospective smoking data can safely be used to identify potential associations of later child outcomes with maternal smoking during pregnancy.

A growing literature has identified associations between maternal smoking during pregnancy and childhood behavioral disorders. Children whose mothers smoked during pregnancy are significantly more likely to develop conduct disorder and delinquency (Fergusson et al., 1998; Wakschlag et al., 1997, 2002; Wakschlag & Keenan, 2001; Weissman et al., 1999). The consistency of findings in studies to date is striking. This literature, however, has certain important limitations. In particular, despite valiant attempts to control for potential confounding factors, the possibility that smoking during pregnancy is associated with psychopathological features in the mother, with increased risk to the child being genetically transmitted, cannot be excluded. For example, increased rates of ADHD in the offspring of substance abusing parents (Roizen et al., 1996) may be an indirect toxic consequence of maternal substance use during pregnancy or other perinatal risk

factors: maternal smoking and drinking during pregnancy have been linked to lower offspring birthweight (Hay et al., 1997; Secker-Walker et al., 1997) and fetal hypoxia (Abel, 1984; Byrd & Howard, 1995), both of which have been associated with ADHD symptoms (Mick et al., 2002; Toft, 1999); or prenatal exposure to alcohol and/or nicotine may have direct teratogenic effects on the fetus leading to conduct problems or symptoms of inattention or hyperactivity in children. Alternatively, however, these data may represent a spurious association in that women who smoke during pregnancy may have other risk factors that lead to the development of psychiatric morbidity in their children. For example, shared genetic vulnerability between smoking and ADHD would provide an alternative explanation for the increased rate of ADHD and other externalizing behaviors among offspring of smokers.

Studying the offspring of twin mothers has long been recognized as a strategy for controlling for such genetic confounding factors (e.g., Jacob et al., 2001; Nance & Corey, 1976). Thus, assuming appropriate statistical control for assortative mating (i.e., psychopathology in the co-parent), we may compare outcomes in offspring of MZ twin mothers discordant for smoking during pregnancy, who on average will inherit the same genetic risk, but will differ in their prenatal exposure to maternal smoking. The children of twins design, however, usually requires that we rely upon retrospective maternal reports about smoking during pregnancy and other risk-factors: pregnant mothers who are also twins are sufficiently rare as to make prospective data-collection beginning at the time of pregnancy a major hurdle. In a previous paper (Reich et al., 2003), we have documented the acceptable short-term reliability of maternal self-reports about pregnancy risk-factors including smoking, based on data from a study of young twins and their mothers. Here we examine the agreement between

*Address for correspondence: Andrew C. Heath, D.Phil., 40 N. Kingshighway, Suite 2, St Louis MO 63108, USA.
Email: andrew@matlock.wustl.edu*

mother's self-report of smoking during pregnancy, and ratings by her twin sister, as a second approach to establish the utility of such retrospective data.

Method

Sample

Participants were women from the 1981 cohort (born before 1965) of the Australian twin panel (Heath et al., 1995), from female like-sex pairs where at least one twin had completed a diagnostic interview during the period 1992–1994, that included an assessment of history of alcohol abuse or dependence (Heath et al., 1997). A high-risk sampling design was used, in which women with a history of *DSM-IV* alcohol abuse or dependence, or with a female twin sister with such a history, were oversampled. Twin mothers were eligible for the study if they had at least one child aged 11–23 at the time of assessment (2000–2003). Mothers reported on a maximum of two births and two offspring (except in the case of twin pregnancies where reporting about a third child was allowed). In addition, to ensure an adequately large number of cases where maternal self-report and co-twin informant rating data could be compared, a subsample of twin sisters of eligible mothers who had no children in the eligible age-range were also assessed. Data presented in this paper are based on data from a total of 522 mothers with eligible children, supplemented by data from an additional 110 twin sister informants. Mothers with eligible children who reported on at least one pregnancy comprised 221 from high-risk families (60 maternal history of alcohol dependence; 83 maternal history of alcohol abuse; 41 unaffected mothers with MZ co-twin with history of alcohol abuse or dependence; 37 unaffected mothers with DZ co-twin with history of alcohol abuse or dependence) and 311 control families. An additional 110 twin sister informants who did not have eligible children reported about their sister's substance use during pregnancy: 26 with a history of alcohol dependence, 24 with a history of alcohol abuse, 9 MZ unaffecteds and 7 DZ unaffecteds with a co-twin with a history of abuse or dependence, and 45 from control pairs. Of these informants, 44 reported about one or more pregnancies of their own.

Assessment

Participants completed a telephone interview, adapted for telephone administration from the DICA (Reich, 2002), which included a series of questions about smoking, drinking and illicit drug use during pregnancy. Mothers and twin sister informants were asked about history of regular smoking, and, on a trimester-by-trimester basis, for each pregnancy, about whether they had smoked cigarettes and how much they had smoked. They were also asked to answer similar questions about their co-twin. Self-report questions preceded questions about co-twin, to ensure that knowledge that co-twin ratings would be obtained did not affect the accuracy of maternal responses. Mothers with children of eligible age were asked to report about no more than two pregnancies that gave birth to children of eligible age; however informant rating data, though limited to no more than two pregnancies, were not restricted to children

of eligible age, yielding a larger number of pregnancies reported about by informant than by self-report.

Analysis

We report, separately for each pregnancy, the prevalence of maternal smoking based on self-report versus informant report. We cross-tabulate self-report and informant data on maternal smoking during pregnancy. For those cases where mother and informant agree that mother smoked throughout pregnancy, we cross-tabulate reports of number of cigarettes per day consumed, separately for each trimester. Finally, we examine the number of available twin pairs, by zygosity, where one twin smoked throughout a pregnancy and the second did not smoke at all.

Results

Table 1 summarizes prevalence of smoking during pregnancy, separately by self-report ($N = 995$ pregnancies) and by informant report ($N = 1130$ pregnancies), for first and second pregnancies. Twenty-seven point three per cent mothers acknowledged smoking during the first pregnancy, 24.0% during the second pregnancy. Estimated prevalence of smoking during pregnancy was lower when based on informant report data (19.4%, 16.7% respectively). There was good consistency between the self-report data and informant report data about the proportion of mothers who had never smoked regularly (56–57%), and about the proportion of mothers who had smoked throughout pregnancy (17–18% by self-report, 16% by informant report). The proportion of mothers who smoked during the first trimester, or first and second trimesters, only, however, was seriously underestimated by informant report (1.1–2.3%) compared to self-report (7.2–9.5%). In approximately 5% of cases, the informant was unable to provide information about whether or not her twin sister had smoked during pregnancy.

Table 2 cross-classifies respondent self-report data by co-twin informant report, for 821 pregnancies where both self-report and informant report data were available. For only 35 pregnancies (4.3%) was the informant unable to give information about the respondent's smoking history. In cases where the respondent reported that she had never smoked regularly, this was usually confirmed by co-twin report (95.6%), with only a single case where a self-described never regular smoker was reported to have smoked during pregnancy. Conversely, 91.8% of those reported by the twin sister informant as having never smoked regularly confirmed this by self-report, with only a single case of a woman who reported smoking beyond the first trimester but who was believed by her sister to have never smoked regularly.

It does appear that there are indeed some false negative cases where mothers denied smoking during pregnancy. Out of 125 pregnancies where a woman was reported by her twin sister to have smoked throughout her pregnancy, while 80% acknowledged this by self-report, in 8.8% of the pregnancies smoking during pregnancy was denied, and in 10.4% of cases smoking beyond the first trimester was denied. Once again, twin sister informant reports were also imperfect. In those cases where the respondent reported

Table 1

Prevalence of Smoking During Pregnancy, by Self-report Versus Co-twin Informant Report

	First Pregnancy		Second Pregnancy	
	Self-report (%) (<i>N</i> = 579)	Co-twin report (%) (<i>N</i> = 591)	Self-report (%) (<i>N</i> = 416)	Co-twin report (%) (<i>N</i> = 539)
Never smoked regularly	56.3	56.2	57.7	57.3
Smoked regularly				
not during pregnancy	16.4	19.0	18.3	21.2
during first trimester only	8.3	0.8	6.7	0.4
during first and second trimesters	1.2	2.2	0.5	0.7
during all 3 trimesters	17.8	16.4	16.8	15.6
Unknown	—	5.4	—	4.8

Table 2

Confirmation by Co-twin Informant of Self-report Smoking During Pregnancy (Summed Over Pregnancies)

Self-report: (<i>N</i> = 821 pregnancies)	<i>N</i>	I	Report by Co-twin Informant (%)					Unknown
			II	III	IV	V		
I. Never smoked regularly	468	95.7	4.1	0.0	0.2	0.0	0.0	
II. Smoked regularly — not during pregnancy	147	21.1	64.0	0.7	2.7	7.5	4.1	
III. During first trimester only	59	13.6	42.4	1.7	10.2	22.0	10.2	
IV. During first and second trimester	7	14.3	14.3	0.0	0.0	14.3	57.1	
V. During all 3 trimesters	140	0.0	10.7	1.4	2.9	71.4	13.6	

smoking throughout her pregnancy, while 71.4% of informant cases confirmed this, in 10.7% of cases the informant reported that her sister had not smoked during the pregnancy, and in additional 13.6% of cases the informant did not know whether her sister had smoked.

It is of course possible that some disagreements between respondent and informant report will arise because the twin sister informant (or the respondent, or even an interviewer) was confusing two different pregnancies, during only one of which the respondent smoked. Since data were gathered about only two pregnancies, this possibility cannot in all cases be ruled out. However, this interpretation is rendered less plausible by the small number of cases in which a mother reported smoking during one pregnancy, but not during a second. Thus, among mothers reporting on two pregnancies, 141 pregnancies where a mother reported smoking throughout the pregnancy were accounted for by 66 women who smoked throughout both pregnancies, 1 woman who smoked throughout her first pregnancy but not at all during her second, 2 women who did not smoke during their first pregnancy but did not during the second, and 6 women who smoked throughout one pregnancy but during only the first trimester of another. Thus the 11 cases that we observed where a mother who was reported by her twin sister to have smoked throughout her pregnancy denied smoking during the pregnancy seem to provide clear evidence for underreporting of smoking during pregnancy. Overall, out of 147 women who reported a history of

regular smoking but denied smoking during pregnancy, 16 (10.9%) were reported by their sister informant to have smoked during the pregnancy.

Consideration of cigarette consumption per day during pregnancy was limited to those 100 pregnancies where respondent and her twin sister informant agreed that she had smoked throughout a given pregnancy. There was too little variation in frequency of smoking to permit separate examination of this variable: in 93–96% of cases, varying by trimester, maternal self-report frequency of smoking was at least 3–4 days per week. Informants tended to give lower estimates of the quantity smoked per day during pregnancy, by their twin sisters. Thus respondents indicated that they smoked 16 or more cigarettes per day during the first trimester of 53% of pregnancies, and during the second and third trimesters of 45% of pregnancies, with corresponding figures of 41%, 38% and 37% reported by sister informants. It did not appear that respondents who acknowledged smoking systematically underreported how much they smoked during their pregnancies.

There was a total of 135 MZ twin pairs where both twins reported on at least one pregnancy, and 77 pairs where both twins had had two pregnancies, from which 42 cross-pair pregnancy comparisons could be identified where one twin reported smoking throughout the pregnancy, the second reported no smoking at all. Corresponding numbers for DZ pairs were 78 and 45 pairs, with 26 informative cross-pair pregnancy comparisons.

Discussion

Our results suggest that most women who have smoked during pregnancy will acknowledge this in response to a retrospective health interview, and almost none will deny that they have ever been regular smokers (we observed only one such case). A substantial minority, however, of mothers reported by an informant to have smoked throughout a pregnancy will either deny smoking during that pregnancy (8.8%) or deny smoking beyond the first trimester (10.4%). For those mothers who acknowledged smoking during pregnancy, there did not seem to be any systematic tendency to under-report numbers of cigarettes smoked per day, compared to what was reported by informants. Informants were relatively good reporters for those cases where a woman smoked throughout her pregnancy, or not at all, but performed more poorly in cases where mothers did not smoke beyond the first trimester. There were too few cases of mothers who quit successfully during the second trimester to allow us to assess the accuracy of informant data for this group. Overall, we may conclude that supplementing retrospective self-report data on smoking during pregnancy with informant ratings may serve a useful purpose to confirm cases of those who have never smoked regularly; of those who have smoked, but not during pregnancy; and of those who have smoked throughout their pregnancy. Twin sister informants underestimated the proportion of cases where the respondent smoked during the first trimester but then quit.

A number of limitations of this study must be considered. First, we relied upon twin sisters, rather than co-parents (i.e., spouse or partner), to obtain ratings of smoking during pregnancy. A partner who was present throughout the pregnancy might be expected to give more accurate data about smoking and other substance use during pregnancy. However, in high-risk families (e.g., where there is a parental history of alcoholism), the co-parent will often be absent or unavailable because divorced, deceased or uncooperative, so the value of such co-parent informants must remain uncertain. We would also miss cases in which the twin was secretive about her smoking, or where the twin and her sister colluded in false reporting, although the latter seems unlikely. Second, because we over-sampled families where a woman or her twin sister had previously reported a history of alcohol abuse or dependence, and because our families were drawn from a volunteer twin panel (Heath et al., 1997), our estimates of the prevalence of maternal smoking during pregnancy cannot be generalized to the general population. Overall, however, our results confirm the utility of using retrospective reports about smoking during pregnancy, with the caveat that a subset of those reporting a history of regular smoking but not during pregnancy (approximately 11%) will likely be false negatives.

Twin pair discordance in timing of pregnancy, even in MZ pairs, is likely to limit the practical utility of comparisons of outcomes of offspring of MZ twin pair mothers discordant for smoking during pregnancy, and essentially limits the feasibility of conducting prospective studies that begin with prenatal assessment. Much larger sample sizes

would be required than those in the present study to ensure adequate numbers of discordant twin mother pairs were available. Ensuring adequate control for psychopathology in the biological co-parent will also be challenging. The informativeness of the children-of-twins design for identifying cases where an apparent effect of pre-natal exposure may in fact be confounded with genetic transmission of risk, however, suggests that greater use should be made of the children-of-twins design for investigating claims about offspring outcomes of prenatal exposures such as maternal smoking that can be assessed with reasonable accuracy in retrospective data.

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