Parental Smoking and Infant Respiratory Infection: How Important Is Not Smoking in the Same Room With the Baby?

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Objectives. We sought to quantify the effect of good smoking hygiene on infant risk of respiratory tract infection in the first 12 months of life.

Methods. A cohort of 4486 infants in Tasmania, Australia, was followed from birth to 12 months of age for hospitalization with respiratory infection. Case ascertainment was 98.2%.

Results. Relative to the infants of mothers who smoked postpartum but never in the same room with their infants, risk of hospitalization was 56% (95% confidence interval [CI]=13%, 119%) higher if the mother smoked in the same room with the infant, 73% (95% CI=18%, 157%) higher if the mother smoked when holding the infant, and 95% (95% CI=28%, 298%) higher if the mother smoked while feeding the infant.

Conclusions. Parents who smoke should not smoke with their infants present in the same room. (*Am J Public Health.* 2003;93:482–488)

Postnatal exposure of infants to cigarette smoke is causally associated with an increased risk of lower respiratory tract infections such as bronchitis and pneumonia, increased prevalence of fluid in the middle ear, symptoms of upper respiratory tract irritation, and a small but significant reduction in lung function.[1] This exposure also has been linked with new cases of childhood asthma and with additional episodes and increased severity of symptoms in asthmatic children.[1,2]

Medical authorities therefore recommend that parents provide a smoke-free environment for infants and children. The Committee on Substance Abuse of the American Academy of Pediatrics advocates that caregivers ask parents about tobacco use and smoke exposure at each consultation from the first prenatal visit onward. Parents who smoke should be offered assistance to stop smoking. Those parents who cannot quit should be encouraged to smoke outside the home.[3]

Earlier studies have suggested that the physical distance between the new baby and the smoking parent correlates with the amount of cotinine in the baby's urine,[3,4] that urinary cotinine concentrations are lower when parents refrain from smoking in the same room with the baby,[5–7] and that lower urinary cotinine is associated with reduced risk of respiratory infection in some[8–11] though not all[12] studies of infants. The protective contribution of not smoking in the vicinity of the infant has not been fully evaluated for respiratory tract infection, however.

We undertook the first investigation of whether parents who smoke can nevertheless reduce the increased risk of respiratory infection for their infants by exercising good "smoking hygiene" (i.e., never smoking in the same room with the infant or while holding or feeding the infant). We report the results of a 12-month follow-up on a cohort of 4486 infants conducted with extensive standardized information on parental smoking and near-complete ascertainment of infants hospitalized with respiratory infection in the first 12 months of life.

METHODS

The Cohort Study

The cohort came from the Tasmanian Infant Health Survey (TIHS), conducted from 1988 to 1995 to investigate the etiology of sudden infant death syndrome (SIDS) and other causes of infant mortality and morbidity in Tasmania.[13] Eligibility of singleton infants for inclusion in the TIHS was assessed using a scoring system to identify those at highest risk of SIDS.[14] (Infants from multiple births also were eligible for inclusion but ultimately were excluded from the group in this report; see "Participants and Selection Procedures.") Higher weighting was given for young maternal age, low birthweight (<2500 g), autumn or winter month of birth, male sex, a short duration of second stage of labor, and intention to bottle-feed rather than to breastfeed.[14] The sample of eligible infants represented approximately one-fifth of live births in the state of Tasmania. Infants were excluded if they had severe neonatal disease or major congenital anomalies, if they were intended for adoption, or if they were nonresidents of the main island of Tasmania. From January 1, 1988, to December 31, 1995, 11 070 live-born infants in Tasmania were eligible for inclusion in the survey.

We obtained data on 3 occasions, during the 1st, 5th, and 11th weeks postpartum. The first interview, which was conducted in the hospital, was delayed until 40 weeks postconceptional age for premature infants (those of gestation less than 37 weeks). During this interview we collected information on prenatal smoking, including the number of cigarettes smoked daily by the mother during each trimester of pregnancy and her exposure to smoking by others. The second interview was conducted at a home visit at a median postnatal age of 33 days (interquartile range: 30–40 days). During this interview we collected information on postnatal smoking, including the number of cigarettes smoked daily by the mother and information on smoking hygiene (whether the mother smoked in the same room with the infant or while holding or feeding the infant). We also gathered the same information for other smokers in the household. The third interview was conducted by telephone at a median postnatal age of 80 days (interquartile

range: 73–93 days). We asked no further questions on maternal smoking but did ask mothers about illnesses the infant had suffered, including colds, tonsillitis, and chest infections. The families consented to the data being used to investigate infant morbidity and mortality during the first year of life. We obtained ethical approval from the ethics committee of the University of Tasmania, Hobart.

Validation of Measurements of Smoking Hygiene

The results of a study[7] conducted using urinary cotinine analysis[15,16] in a sample of 100 infants from the TIHS cohort suggest that the maternal reports of smoking hygiene can be relied upon. The cotinine analyses were conducted at the National Poisons Unit, New Cross Hospital, London, England, by gas–liquid chromatography with levels as low as 0.1 ng/mL detectable.[7] Mean urinary cotinine was 4.69 (95% confidence interval [CI] =1.88, 11.72) times higher for infants of mothers who reported they smoked (n=53) than it was for infants of mothers who reported they did not smoke (n=47). Among the infants of mothers who smoked, mean urinary cotinine was 2.18 (95% CI=1.04, 4.60) times higher for infants whose mothers reported they sometimes or always smoked in the same room with the baby (n=32) than for infants whose mothers reported they never smoked in the same room with the baby (n=21). These results are adjusted for breastfeeding (a source of ingested cotinine), for the number of cigarettes smoked per day by the mother, and for whether other household residents were smokers. Smoking hygiene has been related similarly to infant cotinine levels in a smaller sample from this cohort using a less sensitive assay,[17] and also in a study in another population.[5]

Participants and Selection Procedures

The participants for this report were limited to TIHS infants born in the defined geographical region of southern Tasmania. There were 5817 eligible live births in this region during 1988 to 1995, of which 95.4% (n=5552) participated in the hospital interview and 88.3% (n=5134) participated in both the hospital and home interviews. In view of the high proportion (12%) of infants from multiple births in the cohort, the study was limited to the 4486 singletons to increase the generality of results. In the sample of singletons, 21.7% (n=975) were born to teenage mothers, 32.6% (n=1463) were born in March or April (autumn in Tasmania and the birth months given the greatest weighting in the selection criteria for inclusion in the TIHS cohort), 27.9% (n=1244) were born after a 5- to 14-minute second stage of labor, 70% (n=3138) were boys, 22% (n=986) were of low birthweight, and 45.2% (n=2027) were not being breastfed at the time of home interview.

Definition of Respiratory Infection

The respiratory infection category included upper respiratory tract infections (*International Classification of Diseases, Ninth Revision, Clinical Modification*[18] (ICD-9-CM): 460, 462–465, 474); lower respiratory tract infections, including pneumonia (ICD-9-CM: 480–482, 485, 486), bronchitis and bronchiolitis (ICD-9-CM: 466, 490), and pleurisy (ICD-9-CM: 511); and influenza with other respiratory manifestations (ICD-9-CM: 487.1). We found no cases of several other possible types of respiratory infection (ICD-9-CM: 472, 475, 476, 478.21, 478.22, 478.24, 478.29, 478.71, 478.9, 483, 484, 487.0, 491, 494, 510).

Hospital Admission for Respiratory Infection

In southern Tasmania, most pediatric cases with a medical or emergency problem requiring hospitalization are admitted to the Royal Hobart Hospital, a large government-funded teaching hospital. For the period 1988 to 1996, the hospital provided us with paper summaries of discharge diagnoses for pediatric patients aged 12 months or younger when admitted. Those records included 1430 infants diagnosed with a respiratory infection. Using a record linkage method previously employed in a study of infant apnea/cyanosis,[19] we identified 416 infants that were in our study sample. Although 22% (n=90) had repeat admissions, each infant was counted only once as an incident case. The 416 infants included 386 singletons.

There are 3 other hospitals in southern Tasmania, each privately owned. One of those hospitals did not admit any pediatric patients during 1988 to 1996. Another did not admit any infants from our sample. The third hospital admitted pediatric patients, but we did not have access to identifying information. Based on a review of the admission records of this hospital for the 2-year period March 1995 to February 1997 and the percentage of mothers in our sample (27.4%) and in southern Tasmania[20] with private health insurance, we estimate that around 7 of the 77 pediatric patients admitted by this hospital during 1988 to 1996 were infants from our sample. Not having information for these infants reduced case ascertainment by only 1.8% (n=7).

Data Analysis

We calculated risk of respiratory infection as the proportion of infants hospitalized for respiratory tract infection during the first 12 months of life. To obtain adjusted estimates of ratios of risk and of prevalence, we used log binomial regression[21,22] with binary (0/1) predictors for categories of the study factor other than a reference category. We obtained 95% confidence limits from the likelihood ratio-based confidence limits. We used a single linear predictor for tests of trend. We adjusted in analysis for all cohort selection factors but replaced mothers' intention to breastfeed at time of birth with actual failure to breastfeed after 24 days. We also dropped maternal age from the regression model to estimate the effect of birth order, with which it was correlated (r=0.424). We assessed statistical interaction from the coefficient and standard error of a product term. A probability of type I error of 5% was regarded as sufficiently small. We made no adjustment for multiple testing but report[23] all analyses undertaken to allow readers to make formal adjustments if they desire.

To examine the sensitivity of our results to the nonascertainment of 7 cases, we reestimated the relative risk (RR) of respiratory infection for maternal smoking after reclassifying as diseased (admitted to hospital with a respiratory infection) 7 infants chosen at random from among the nondiseased infants of mothers with private health insurance. The measure of maternal smoking was smoking hygiene (mother not a smoker, mother never

smokes in the same room with the baby, mother sometimes/always smokes in the same room with the baby). We report results for 3 distributions of reclassified infants. These were good smoking hygiene (0–7–0) at one extreme, poor smoking hygiene (0–0–7) at the other, and an intermediate distribution (6–1–2) of 9 diseased infants that quite closely matched the actual distribution (43–7–14) among diseased infants of mothers with private health insurance. We performed this procedure 10 000 times for each distribution and report mean values of the RR estimates and of the 95% confidence limits.

Table 1—Risk and Relative Risk of Hospitalization With Respiratory Infection in the First 12 Months of Life: Tasmanian Infant Health Survey (TIHS), 1988–1995

Factor	Risk		RR (95% CI)[a,b]
	Percentage	(n/N)	
Birth order[c]			
First child	6.1	(122/2014)	1.00
Second child	8.3	(118/1425)	1.41 (1.10, 1.82)
Third child	10.2	(69/677)	1.74 (1.28, 2.33)
Fourth child	12.4	(29/234)	1.92 (1.27, 2.81)
Fifth or subsequent child	11.0	(12/109)	1.58 (0.84, 2.69)
Breastfeeding[d]			
Breastfed ≥ 25 days	5.8	(102/1770)	1.00
Breastfed 1–24 days	9.7	(65/673)	1.74 (1.28, 2.35)
Bottle-fed exclusively	9.1	(184/2021)	1.92 (1.51, 2.47)
Maternal education[e]			
Completed beyond year 10	4.0	(28/692)	1.00
Completed year 10	7.5	(207/2774)	1.66 (1.14, 2.51)
Did not complete year 10	11.7	(116/988)	2.47 (1.65, 3.82)
Maternal smoking in third trimester			
Not a smoker	6.2	(146/2369)	1.00
1–10 cigarettes/day	8.8	(80/907)	1.33 (1.02, 1.73)
11–20 cigarettes/day	10.2	(78/762)	1.49 (1.14, 1.94)
≥ 21 cigarettes/day	10.7	(44/413)	1.54 (1.10, 2.11)
Maternal postnatal smoking[d]			
Not a smoker	5.9	(136/2289)	1.00
1–10 cigarettes/day	9.3	(75/809)	1.46 (1.11, 1.91)
11–20 cigarettes/day	10.9	(101/926)	1.62 (1.26, 2.09)
≥ 21 cigarettes/day	9.0	(39/431)	1.34 (0.93, 1.87)
Smokers in house[d]			
None	5.3	(76/1429)	1.00
1 smoker, not mother	6.5	(49/751)	1.17 (0.82, 1.65)
≥ 2 smokers, not mother	10.2	(11/108)	1.67 (0.86, 2.93)
Mother only	10.4	(72/692)	1.74 (1.27, 2.38)
Mother and 1 other smoker	9.5	(120/1263)	1.59 (1.20, 2.12)
Mother and ≥ 2 other smokers	10.6	(22/207)	1.69 (1.04, 2.63)
Rooms in house per smoker[d]			
No smokers	5.3	(76/1427)	1.00
1–2	10.0	(127/1269)	1.62 (1.22, 2.17)
3	9.5	(62/653)	1.60 (1.15, 2.21)
>3	7.8	(85/1095)	1.37 (1.01, 1.85)

Note. RR = relative risk; CI = confidence interval.
[a]Adjusted for cohort selection factors (maternal age, season of birth, duration of second stage of labor, sex, birthweight, breastfeeding).
[b]For each factor, a test of linear trend gave $P \leq .002$.
[c]The RR estimates for this factor are not adjusted for maternal age.
[d]At time of home interview (for most subjects, during the fifth postnatal week).
[e]Australia requires 10 years of schooling.

RESULTS

Risk of Respiratory Infection

In this cohort of singleton infants, 7.8% were hospitalized for a respiratory tract infection during the first 12 months of life.

Infant, Maternal, and Family Factors Associated With Risk

Risks and adjusted RR of respiratory infection requiring hospitalization are shown in Table 1. The adjustment factors include younger maternal age (linear trend $P=.010$), lower birthweight (trend $P<.001$), male sex (RR=1.29 [95% CI=1.03, 1.62]), March–April (RR=1.29 [95% CI=0.99, 1.66]) or May–July (RR=1.30 [95% CI=1.02, 1.67]) month of birth, and duration of breastfeeding. Other significant predictors were maternal education and birth order.

When interviewed in the fifth postnatal week, 48.6% of the mothers were smoking. Their infants had a 50% greater risk (RR=1.50 [95% CI=1.22, 1.87]) than the infants of nonsmokers of having had a respiratory infection, and risk increased with the number of cigarettes smoked per day (Table 1). Risk also increased with the number of other smokers in the household (trend $P<.001$), apparently more so if the mother was not herself a smoker (Table 1), but this difference in trend was not significant ($P=.132$ for test of interaction). Risk increased with the number of cigarettes smoked daily by the others (trend $P=.036$) and was highest in houses with the fewest rooms per number of smokers in the household (Table 1).

Smoking in the Same Room With the Baby

Of the mothers who smoked, 71.8% reported that they sometimes or usually smoked in the same room with the baby. This type of poor maternal smoking hygiene was

TABLE 2—Prevalence of Poor Smoking Hygiene at 4 Weeks of Postnatal Age Among TIHS Participants: Tasmania, 1988–1995

Factor	Prevalence		RR (95% CI)[a,b]
	Percentage	(n/N)	
Birth order			
First child	66.4	(614/925)	1.00
Second child	73.8	(501/679)	1.11 (1.04, 1.19)
Third child	77.5	(293/378)	1.17 (1.09, 1.25)
Fourth child	76.5	(104/136)	1.15 (1.03, 1.27)
Fifth or subsequent child	83.6	(46/55)	1.26 (1.08, 1.40)
Breastfeeding[b]			
Breastfed ≥ 25 days	57.9	(366/632)	1.00
Breastfed 1–24 days	71.5	(251/351)	1.23 (1.12, 1.36)
Bottle-fed exclusively	79.1	(943/1192)	1.37 (1.27, 1.47)
Maternal education[c]			
Completed beyond year 10	51.2	(88/172)	1.00
Completed year 10	70.7	(951/1346)	1.37 (1.19, 1.61)
Did not complete year 10	79.4	(519/654)	1.53 (1.33, 1.80)
Maternal smoking in third trimester			
Not a smoker	46.0	(75/163)	0.74 (0.61, 0.87)
1–10 cigarettes/day	62.4	(528/846)	1.00
11–20 cigarettes/day	78.3	(587/750)	1.25 (1.18, 1.34)
≥ 21 cigarettes/day	89.5	(365/408)	1.43 (1.35, 1.53)
Maternal postnatal smoking[b]			
1–10 cigarettes/day	53.6	(435/811)	1.00
11–20 cigarettes/day	78.9	(735/932)	1.47 (1.37, 1.58)
≥ 21 cigarettes/day	90.3	(390/432)	1.68 (1.57, 1.81)
Other smokers in house[b]			
No other smoker	67.1	(468/697)	1.00
1 other smoker	73.0	(924/1266)	1.09 (1.02, 1.16)
≥ 2 other smokers	79.8	(166/208)	1.19 (1.09, 1.29)
Other adult smokes in same room[b]			
No other smoker in house	48.8	(186/381)	2.56 (2.05, 3.26)
Never	19.0	(72/378)	1.00
Sometimes/usually	92.0	(1299/1412)	4.83 (3.96, 6.01)
Rooms in house per smoker[b]			
1–2	81.2	(991/1221)	1.71 (1.54, 1.92)
3	67.2	(388/577)	1.41 (1.26, 1.60)
>3	47.6	(176/370)	1.00

Note. PR = prevalence risk; CI = confidence interval.
[a]For each factor, a test of linear trend gave $P < .001$.
[b]At time of home interview (for most subjects, during fifth postnatal week).
[c]PRs for maternal education have been adjusted for maternal age.

more frequent among younger mothers (trend $P=.004$) and mothers who smoked more cigarettes daily. Other factors associated with poor smoking hygiene are shown in Table 2.

The infants of mothers with poor smoking hygiene had a 56% greater risk of hospitalization with respiratory infection than the mothers who smoked but never in the same room with the baby (Table 3). Relative to the risk of infants of nonsmokers, never smoking in the same room with the baby eliminated 70.6% of the excess risk predicted to occur if the mother sometimes or usually smoked in the same room. The RR estimates are adjusted for daily cigarettes smoked by the mother (trend $P=.280$) and the significant predictors for maternal age, month of birth, infant sex, birthweight, and duration of breastfeeding. Additionally adjusting for the number of other smokers in the household (trend $P=.606$) or maternal education resulted in only minor changes (Table 3). The same was true of adjusting for birth order, whether other adults smoked near the baby (trend $P=.824$), and rooms per smoker (trend $P=.558$).

Upper vs Lower Respiratory Tract Infections

The respiratory infection cases included 121 infants with an upper respiratory tract infection (URTI) and 258 infants with a lower respiratory tract infection (LRTI). Whereas the risk increase for any postnatal maternal smoking was less for URTI (RR = 1.09 [95% CI = 0.76, 1.57]) than for LRTI (RR = 1.69 [95% CI = 1.31, 2.18]), the elevation in risk for maternal poor smoking hygiene was similar. The adjusted RRs were 1.68 (95% CI = 0.92, 3.26) for URTI and 1.49 (95% CI = 1.04, 2.20) for LRTI.

Prenatal vs Postnatal Smoking

Of the mothers who smoked in the postnatal period, 97.0% also had smoked during pregnancy. Prenatal smoking in each trimester of pregnancy was associated with higher risk of respiratory infection among the infants, with the strongest dose response for smoking in the third trimester (Table 1). Just as had been the case when the effect of postnatal daily cigarettes was adjusted for postnatal smoking hygiene, the number of cigarettes smoked daily by the mother during the third trimester was no longer a significant predictor (trend $P=.824$) after adjustment for smoking hygiene.

To further examine this issue, we identified all 65 mothers who had smoked in the postnatal period but not during pregnancy. The risk (10.7%) of respiratory infection for their infants was greater than the risk (6.0%) for infants of mothers who did not smoke at either time. Adjusted for the cohort selection factors, the RR estimate for this postnatal-only smoking was 1.58 (95% CI = 0.69, 3.00). Adjusting also for the number of other smokers in the household (RR = 1.51 [95%

TABLE 3—Risk and Relative Risk of Hospitalization With Respiratory Infection in the First 12 Months of Life, by Maternal Smoking Hygiene: Tasmania, 1988–1995

Smoking Hygiene	Risk		RR[a,b]		
	Percentage	(n/N)	Adjusted for Cigarettes Smoked Daily by Mother RR (95% CI)	Also Adjusted for Smoking by Others[c] RR (95% CI)	Also Adjusted for Maternal Education RR (95% CI)
Mother smokes in the same room					
Not a smoker	5.9	(136/2289)	0.77 (0.51, 1.18)	0.78 (0.52, 1.20)	0.78 (0.52, 1.19)
Never	7.4	(45/610)	1.00	1.00	1.00
Sometimes/usually	10.9	(170/1553)	1.56 (1.13, 2.19)	1.53 (1.11, 2.15)	1.51 (1.10, 2.12)
Mother smokes when holding baby					
Not a smoker	5.9	(136/2289)	0.74 (0.49, 1.14)	0.77 (0.51, 1.18)	0.76 (0.50, 1.16)
Never smokes in same room	7.4	(45/610)	1.00	1.00	1.00
Never smokes when holding baby	10.6	(103/976)	1.48 (1.06, 2.10)	1.47 (1.05, 2.09)	1.44 (1.03, 2.05)
Sometimes/usually	11.6	(67/578)	1.74 (1.18, 2.58)	1.68 (1.14, 2.50)	1.65 (1.12, 2.45)
Mother smokes when feeding baby					
Not a smoker	5.9	(136/2289)	0.72 (0.48, 1.11)	0.74 (0.49, 1.13)	0.74 (0.49, 1.14)
Never smokes in same room	7.4	(45/610)	1.00	1.00	1.00
Never smokes when feeding baby	10.4	(123/1179)	1.48 (1.06, 2.09)	1.45 (1.04, 2.05)	1.43 (1.03, 2.02)
Sometimes/usually	12.6	(47/374)	1.97 (1.28, 3.01)	1.94 (1.27, 2.97)	1.87 (1.23, 2.85)

Note. RR = relative risk; CI = confidence interval.
[a]All RR estimates are adjusted for the cohort selection factors (maternal age, season of birth, duration of second stage of labor, sex, birthweight, breastfeeding).
[b]In each analysis, a test of linear trend gave $P < .001$.
[c]Number of other smokers in household.

CI=0.66, 2.89]) or maternal education (RR=1.57 [95% CI=0.69, 2.98]) resulted in only minor changes.

Sensitivity of Results to Incomplete Ascertainment

Around 7 infants in this sample may have been admitted with respiratory infection to a fee-charging private hospital. The adjusted RR estimates for poor smoking hygiene would have been 1.36 (95% CI=1.00, 1.87) if each mother smoked but never in the same room with the baby and 1.63 (95% CI=1.18, 2.29) if each mother smoked in the same room with the baby. Those are the extreme possibilities; if most of the 7 mothers were nonsmokers, as expected from the actual proportion of smokers among mothers with health insurance, the revised estimate would have been almost unchanged at RR=1.55 (95% CI=1.13, 2.17). Alternatively, restricting the analyses to the infants of mothers without private health insurance also produced an elevated RR estimate for poor smoking hygiene (RR=1.46 [95% CI=1.04, 2.11]).

Smoking When Holding or Feeding the Infant

Of postnatal smokers, 27.0% reported smoking when holding the infant, and 17.5% reported smoking when feeding the infant. The RR estimates for these more proximal types of poor smoking hygiene showed even greater elevation in risk (Table 3).

Smoking Hygiene and Respiratory Infection Reported by Mothers

We examined parental reports of respiratory infection to determine whether poor smoking hygiene also was associated with elevated risk of infections not requiring hospitalization. The parents had reported in the telephone interview during the 11th postnatal week whether their infants had suffered colds, tonsillitis, or chest infections. Those reports had predictive validity because subsequent hospitalization with respiratory infection was 5.78 (95% CI=3.16, 11.85) times more likely for infants with at least 1 reported episode than for infants with no reported episode. Elevated risk of respiratory infection for poor smoking hygiene was not limited to infants admitted to the hospital; poor smoking hygiene at 1 month was significantly associated with reported respiratory infection for infants who had not been hospitalized in the first 10 weeks (Table 4).

DISCUSSION

In this study, we followed a cohort of 4486 infants with information on *in utero* and postnatal exposure to tobacco smoke for admission to the hospital with respiratory tract infection during the first 12 months of life. The infants of mothers who smoked at the end of the first postnatal month had a 50% higher risk of hospitalization with respiratory infection than did the infants of nonsmokers. Among infants of mothers who smoked, however, risk was significantly lower for those whose mothers exercised good smoking hygiene by never smoking in the same room with the infant.

If these associations are causal, mothers who find it difficult to give up smoking can at least reduce the susceptibility of their infants to serious respiratory infection. Exercising

TABLE 4—Risk and Relative Risk of Parental Report of Respiratory Illness[a]: Tasmania, 1988–1995

Smoking Hygiene	Risk		RR (95% CI)[b,c]
	Percentage	(n/N)	
Not a smoker	55.3	(1210/2172)	1.00 (0.90, 1.20)
Never smokes in same room	54.9	(314/572)	1.00
Sometimes/usually smokes in same room	63.6	(898/1411)	1.10 (1.01, 1.20)

Note. RR = relative risk; CI = confidence interval.
[a]Cold, tonsillitis, or chest infection contracted by the infant in the first 10 weeks postpartum for infants who had not been hospitalized with a respiratory infection in that time.
[b]Adjusted for cohort selection factors (maternal age, season of birth, duration of second stage of labor, sex, birthweight, breastfeeding).
[c]A test of linear test gave $P = .048$

good smoking hygiene—not smoking in the same room with the baby—eliminated more than 70% of the excess risk of hospitalization with respiratory infection associated with maternal postnatal smoking.

One of the strengths of this study is that information was collected in a standardized way over time. Selection bias due to nonresponse[24] is unlikely to be a major problem because of the high response rates. Nearly all hospital admissions for respiratory infection were ascertained, and the small number of cases not ascertained did not unduly influence the results. Although there is potential for admission rate bias[24] if some infants were admitted to the hospital by clinicians to provide respite from unfavorable home environments, we found that poor smoking hygiene also increased the risk of parent-reported colds, tonsillitis, and chest infections for nonhospitalized infants. Parental reports of those infections were strongly associated with hospitalization with respiratory infection in the full sample, indicating that these reports had validity and further suggesting that the differences in risk due to smoking hygiene are real.

Although the smoking data are based on self-report, reporting bias is an unlikely explanation of these findings. The results of a validation study[7] conducted using urinary cotinine analysis in a sample of 100 infants from the cohort suggest that the maternal reports of smoking hygiene are reliable.[7] In addition, an examination of the cluster of maternal factors associated with the reports of smoking hygiene revealed some evidence of construct validity for the hygiene data. The mothers with good smoking hygiene at 4 weeks of infant age were generally older, breastfeeding, and better educated. They smoked fewer cigarettes per day and less often lived with other smokers; the smokers they did live with more often also practiced good hygiene. These mothers more often lived in households with more rooms per smoker, plausibly offering more opportunity to provide a smoke-free area for the infant. Furthermore, adding to the confidence that can be placed in these results, respiratory outcomes have been directly related to higher (later) birth order,[25,26] parental smoking,[27,28] male sex,[29] and short duration of breastfeeding[30] in previous studies.

This cohort comprised one-fifth of live births in the defined geographical area, but weighting in selection of individual infants was given to risk factors for SIDS. The cohort is not representative of the general infant population of Australia, but it does not need to be for inferences about disease causation to be valid.[23,31] What matters in a study to test causal hypotheses is that the sample contains a wide distribution of the study factor and its effect modifiers.[31] A particular advantage of this study base, given that maternal postnatal smoking was the principal study factor, was the high proportion of mothers who smoked. The confounding effects of the maternal and infant factors used in selection were always taken into account in the multivariate analyses.

Consistent with previous findings for this cohort,[17] poor postnatal smoking hygiene was associated with prenatal smoking. We cannot discount the possibility that the higher risk of respiratory infection for infants of mothers with poor smoking hygiene was due in part to exposure *in utero*, but our results and other findings suggest that postnatal smoking hygiene itself presents a relevant exposure. In this study, adjusting for prenatal smoking did not diminish the estimated effect of poor postnatal smoking hygiene. Furthermore, postnatal-only exposure was associated with an elevation in risk similar to postnatal-plus-prenatal exposure, and in households of mothers who did not smoke, smoking by others was associated with increased risk in a dose–response fashion. There have been similar findings in other studies of nonsmoking mothers.[27]

In conclusion, the risk of respiratory tract infection requiring hospitalization in the first year of life for the infants of mothers who smoked in the postnatal period was least for those whose mothers did not smoke in the same room with them. Not smoking at all is the safest option, but mothers who find it difficult not to smoke postpartum can at least reduce 1 of the deleterious effects of their smoking on the respiratory health of their infants. This first report of a protective effect of good smoking hygiene on respiratory tract infection provides quantitative evidence to support the current recommendations[3] that infants should not be exposed to tobacco smoke. ■

About the Authors

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Contributors

L. Blizzard contributed to planning this study, undertook the data analysis, and drafted the manuscript. A.-L. Ponsonby contributed to planning the main cohort study, and devised and planned this study. T. Dwyer devised and planned the main cohort study. J.A. Cochrane undertook the data linkage. All authors participated in data interpretation and in revising the manuscript.

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Human Participant Protection

The ethics committee of the University of Tasmania approved this project.

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