Effect of smoking among Indigenous and non-Indigenous mothers on preterm birth and full-term low birthweight

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ABSTRACT

Objective: To estimate the percentage of preterm (< 37 weeks) and full-term low-birthweight (37–41 weeks, < 2500 g) babies born to mothers who smoke, stratified by Indigenous status and statistically adjusted for the potential confounding effects of social and demographic factors, medical conditions and pregnancy complications.

Design, setting and participants: Population-based study of singleton babies born to mothers resident in Queensland who gave birth in Queensland from 1 July 2005 to 31 December 2006.

Main outcome measures: Adjusted percentages of preterm birth and full-term low birthweight for babies born to Indigenous and non-Indigenous mothers.

Results: Of the 79 803 babies studied, 4228 (5.3%) were born to Indigenous mothers and 16 395 (20.5%) were born to mothers who smoked during pregnancy. The percentage of Indigenous mothers who smoked (54%) was almost triple that for non-Indigenous mothers (risk ratio, 2.90; 95% CI, 2.81–2.99). The adjusted outcomes for babies born to Indigenous non-smokers were similar to those for non-Indigenous non-smokers (preterm, 7.1% v 6.1%; full-term low birthweight, 1.6% v 1.1%). The adjusted percentages for smokers were high regardless of Indigenous status (preterm, Indigenous v non-Indigenous, 8.3% v 7.8%; full-term low birthweight, Indigenous v non-Indigenous, 5.3% v 3.7%).

Conclusions: Antenatal smoking remains an important cause of poor health among both Indigenous and non-Indigenous newborn babies. Most pregnant smokers receive their antenatal care in the public sector. State and federal governments, who directly fund this sector, have a particular responsibility to ensure that interventions are offered to all pregnant smokers to help them quit smoking.

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The poor health of babies of mothers who smoke and babies of mothers of Indigenous origin are two of the most pressing public health problems in Australia. These problems are related — more than 50% of Indigenous mothers smoke during pregnancy; and more than 10% of mothers who smoke during pregnancy are Indigenous, although Indigenous mothers make up only 3%–4% of all mothers in Australia.[1] Across Australia, 16% of non-Indigenous mothers smoke compared with 53% of Indigenous mothers.[1]

There is incontrovertible evidence that smoking harms unborn babies. It increases the risk of spontaneous abortion, fetal death, preterm birth and low birthweight.[2] After birth, it increases the risk of sudden infant death and respiratory problems, and also learning problems, which are possibly associated with in-utero exposure to nicotine.[3] If the hypothesis that the relationship between retarded growth in early life and risk of disease in adulthood is caused by long-term effects on physiology and metabolism of an adverse environment during critical periods of development[4] is true, then the preterm and low-birthweight babies of smoking mothers are at increased risk of diseases like diabetes and acute coronary syndrome in later life.

It is difficult to obtain real-world estimates of the adverse effects of smoking during pregnancy for a particular population, because mothers who smoke might also have a high prevalence of other risk factors for poor pregnancy outcomes, such as diabetes, genitourinary tract infections and psychosocial stress.

In this study, we measured the percentages of preterm births and full-term low-birthweight infants — poor outcomes for which smoking remains one of the most important and potentially preventable risk factors[5] — among Indigenous and non-Indigenous smokers in Queensland, with adjustment for potential confounders. Our aim was to obtain as unbiased an estimate as possible of the adverse effects of smoking for these populations.

METHODS

Data were obtained from the Queensland Perinatal Data Collection (QPDC), which contains records of all births in Queensland of at least 400 g birthweight or 20 weeks' gestation. In addition to demographic variables, the QPDC records information on several antenatal, intrapartum and postpartum variables, including any medical conditions that affect the management of the pregnancy and any complications of the pregnancy itself. The data collection form has tick boxes for pre-existing diabetes and hypertension, gestational diabetes, pregnancy-induced hypertension, pre-eclampsia, antepartum haemorrhage and anaemia, as well as space for reporting all other medical conditions and pregnancy complications. The medical conditions and pregnancy complications included in our analysis were based on a review of the causes of preterm birth and growth restriction in economically disadvantaged populations[5] (Box 1).

Self-reported smoking status has been included in the QPDC since 1 July 2005. The questions added were "Did the mother smoke at all during this pregnancy?" and, if the answer is yes, "How many cigarettes were smoked each day on average after 20 weeks' gestation?" (recorded as none, ⩽ 10 or > 10 cigarettes per day). We classified mothers as smokers if they reported smoking at any time during their pregnancy. Based on data from the QPDC, only 7% of non-Indigenous smokers and 3% of Indigenous smokers quit smoking by 20 weeks' gestation, so the results for smoking during pregnancy were similar to those for smoking at 20 weeks' gestation. The results in this article are for smoking during pregnancy to allow comparison with published data from other states.

The study included singleton babies born to mothers resident in Queensland and who gave birth in Queensland during the 18 months 1 July 2005 to 31 December 2006. We used two outcomes: preterm birth (< 37 weeks' gestation) and full-term low birthweight (37–41 weeks' gestation, < 2500 g birthweight).

1 Characteristics of Indigenous and non-Indigenous mothers by smoking status

	Non-Indigenous non-smokers	Non-Indigenous smokers	Indigenous non-smokers	Indigenous smokers
Number of mothers	61 467	14 108	1941	2287
Age group (years)				
< 20	2 127 (3.5%)	1 491 (10.6%)	333 (17.2%)	444 (19.4%)
20–24	8 753 (14.2%)	3 936 (27.9%)	556 (28.6%)	768 (33.6%)
25–34	38 222 (62.2%)	6 876 (48.7%)	853 (43.9%)	887 (38.8%)
⩾ 35	12 365 (20.1%)	1 805 (12.8%)	199 (10.3%)	188 (8.2%)
Parity of mother*				
Primiparous	25 733 (41.9%)	5 014 (35.5%)	623 (32.1%)	576 (25.2%)
Multiparous (1–4)	34 972 (56.9%)	8 597 (60.9%)	1149 (59.2%)	1426 (62.4%)
Multiparous (⩾ 5)	761 (1.2%)	497 (3.5%)	169 (8.7%)	285 (12.5%)
Mean parity	0.9	1.3	1.7	2.1
Remoteness†				
City	34 599 (56.3%)	6 549 (46.4%)	391 (20.1%)	393 (17.2%)
Regional	25 372 (41.3%)	7 184 (50.9%)	1053 (54.3%)	1268 (55.4%)
Remote	1 496 (2.4%)	375 (2.7%)	497 (25.6%)	626 (27.4%)
Socioeconomic status‡				
Most disadvantaged 10%	4 233 (6.9%)	1 990 (14.1%)	439 (22.6%)	648 (28.3%)
Middle 80%	53 388 (86.9%)	11 888 (84.3%)	1482 (76.4%)	1632 (71.4%)
Least disadvantaged 10%	3 846 (6.3%)	230 (1.6%)	20 (1.0%)	7 (0.3%)
Number of antenatal visits§				
< 2	259 (0.4%)	317 (2.2%)	99 (5.1%)	191 (8.4%)
2–4	2 684 (4.4%)	1 691 (12.0%)	250 (12.9%)	539 (23.6%)
5–7	10 149 (16.5%)	3 330 (23.6%)	512 (26.4%)	658 (28.8%)
⩾ 8	48 334 (78.7%)	8 751 (62.1%)	1078 (55.6%)	894 (39.2%)
Type of antenatal care¶				
Public hospital/clinic	18 057 (29.4%)	6 817 (48.3%)	1272 (65.5%)	1601 (70.0%)
Shared care	18 767 (30.5%)	6 073 (43.1%)	531 (27.4%)	592 (25.9%)
Private medical practitioner	24 514 (39.9%)	1 132 (8.0%)	110 (5.7%)	49 (2.1%)
Private midwife/combined private midwife and medical practitioner	75 (0.1%)	6 (0.04%)	2 (0.1%)	0
None	51 (0.1%)	77 (0.5%)	26 (1.3%)	45 (2.0%)
Medical conditions, pregnancy complications				
Pre-existing hypertension	521 (0.8%)	85 (0.6%)	32 (1.6%)	26 (1.1%)
Pregnancy induced hypertension	2 174 (3.5%)	340 (2.4%)	71 (3.7%)	42 (1.8%)
Pre-eclampsia/eclampsia	1 552 (2.5%)	244 (1.7%)	73 (3.8%)	53 (2.3%)
Pre-existing diabetes				
Insulin dependent	205 (0.3%)	37 (0.3%)	14 (0.7%)	9 (0.4%)
Non-insulin dependent	52 (0.1%)	14 (0.1%)	28 (1.4%)	13 (0.6%)
Gestational diabetes				
Insulin dependent	978 (1.6%)	167 (1.2%)	47 (2.4%)	40 (1.7%)
Non-insulin dependent	2 235 (3.6%)	394 (2.8%)	89 (4.6%)	64 (2.8%)
Anaemia	680 (1.1%)	144 (1.0%)	61 (3.1%)	79 (3.5%)
Depression	430 (0.7%)	248 (1.8%)	13 (0.7%)	25 (1.1%)
Genitourinary tract infection	615 (1.0%)	245 (1.7%)	30 (1.5%)	43 (1.9%)
Antepartum haemorrhage ⩾ 20 weeks	1547 (2.5%)	491 (3.5%)	50 (2.6%)	59 (2.6%)

* Excludes one mother with missing data for parity. † Remoteness was mapped from the statistical local area (SLA) of usual residence of the mother, and defined using the remoteness structure of the Australian Standard Geographical Classification (ASGC) of the Australian Bureau of Statistics (ABS),[6] with remote and very remote designated remote, inner and outer regional designated regional, and major cities designated city. ‡ Socioeconomic status was mapped from the SLA and defined using the Index of Relative Socio-Economic Advantage/Disadvantage at the decile level from the ABS Socio-Economic Indexes for Areas.[7] § Excludes 67 mothers with missing data for number of antenatal visits. ¶ Excludes six mothers with missing data for type of antenatal care. ◆

We analysed full-term low-birthweight babies rather than all low-birthweight babies because birthweight is determined by both the duration of gestation and the rate of fetal growth. Consequently, low birthweight can occur because a baby is born too early (preterm) or is too small for his or her gestational age (growth restriction). We did not further stratify preterm births by whether the baby had growth restriction (was small for gestational age) because there were too few infants with this outcome (24) among Indigenous non-smokers to allow meaningful estimates of the adjusted percentages.

Statistical analysis

We stratified the data into four groups corresponding to each combination of smoking and Indigenous status. Non-smoking, non-Indigenous mothers comprised the reference group. Logistic regression models were used to account statistically for the potential confounding effects of social and demographic factors and medical conditions and pregnancy complications.

The usual outputs from logistic regression are odds ratios, but we present adjusted risk ratios and adjusted percentages (of preterm birth and full-term low birthweight). Adjusted risk ratios can be derived from odds ratios using a simple formula and many people find these measures easier to interpret than odds ratios.[8] Confidence intervals for the adjusted risk ratios were obtained from the *nlcom* command in Stata statistical software, release 10 (StataCorp, College Station, Tex, USA), which uses the delta method to obtain standard errors for non-linear combinations of estimated parameters from a logistic regression.[9]

RESULTS

For the 18 months 1 July 2005 to 31 December 2006, there were 80 735 singleton babies born in Queensland to mothers resident in Queensland. Of these, 385 (0.5%) were excluded because data on maternal smoking status were missing, 32 were excluded because there was a missing value for at least one of Indigenous status, birthweight or gestational age, and a further 515 (0.6%) were excluded because they were born after 41 weeks' gestation.

Of the remaining 79 803 births included in the study, 4228 (5.3%) were born to Indigenous mothers and 16 395 (20.5%) were born to mothers who smoked during their pregnancy. The rate of smoking among Indigenous mothers was 54%, almost triple the rate of 19% among non-Indigenous mothers (risk ratio, 2.90; 95% CI, 2.81–2.99).

Non-Indigenous smokers had a different sociodemographic profile from non-Indigenous non-smokers (Box 1). Specifically, they were younger, more likely to live in regional cities and towns, more likely to be economically disadvantaged, they made fewer antenatal visits and were more likely to receive their antenatal care from a public hospital.

The sociodemographic profile of Indigenous mothers was very different from that of non-Indigenous mothers; however, within the population of Indigenous mothers there were few differences by smoking status (Box 1). Specifically, nearly one in five Indigenous mothers were teenagers (regardless of smoking status), compared with one in 10 non-Indigenous mothers who smoked and one in 30 non-Indigenous mothers who did not smoke. More than one in four Indigenous mothers lived in remote areas (regardless of smoking status) compared with less than one in 40 non-Indigenous mothers. Indigenous mothers were much more likely to be economically disadvantaged, have higher parity, make fewer antenatal visits and receive their antenatal care from a public hospital, regardless of smoking status (Box 1).

Pregnancy complications and medical conditions were more frequent among Indigenous mothers and mothers who smoked, although mothers who smoked were less likely to have pregnancy-induced hypertension and pre-eclampsia, and this was not unexpected.[10,11]

Preterm birth and full-term low birthweight infants

Box 2 shows that, after adjusting for potential confounders in the multivariate ana-

2 Unadjusted and adjusted percentages and risk ratios for preterm birth and full-term low birthweight*

	Non-Indigenous non-smokers	Non-Indigenous smokers	Indigenous non-smokers	Indigenous smokers
Preterm birth				
Number of babies	3756	1312	199	301
Unadjusted percentage (95% CI)	6.1% (5.9%–6.3%)	9.3% (8.8%–9.8%)	10.3% (8.9%–11.7%)	13.2% (11.8%–14.7%)
Adjusted percentage (95% CI)	6.1% (5.9%–6.3%)	7.8% (7.3%–8.3%)	7.1% (6.0%–8.4%)	8.3% (7.2%–9.5%)
Unadjusted risk ratio (95% CI)	1.00	1.52 (1.43–1.62)	1.67 (1.46–1.91)	2.15 (1.92–2.40)
Adjusted risk ratio (95% CI)	1.00	1.28 (1.19–1.37)	1.17 (0.98–1.36)	1.37 (1.18–1.55)
Area under ROC curve†		0.74		
Full-term low birthweight				
Number of babies	626	474	31	116
Unadjusted percentage (95% CI)	1.1% (1.0%–1.2%)	3.7% (3.4%–4.0%)	1.8% (1.2%–2.5%)	5.8% (4.9%–7.0%)
Adjusted percentage (95% CI)	1.1% (1.0%–1.2%)	3.7% (3.2%–4.2%)	1.6% (1.1%–2.3%)	5.3% (4.2%–6.7%)
Unadjusted risk ratio (95% CI)	1.00	3.41 (3.04–3.84)	1.64 (1.15–2.35)	5.38 (4.44–6.53)
Adjusted risk ratio (95% CI)	1.00	3.38 (2.95–3.81)	1.47 (0.92–2.02)	4.91 (3.80–6.03)
Area under ROC curve†		0.70		

ROC = receiver-operating characteristic.

* Adjusted for maternal age, parity, remoteness, socioeconomic status, number of antenatal visits, type of antenatal care and all pregnancy complications and medical conditions listed in Box 1. Variables were used in categorical form as outlined in Box 1, with all pregnancy complications and medical conditions included as individual indicator variables. † Areas under the ROC curve of ⩾ 7 show acceptable fit.[12] ◆

lysis, the percentage of preterm births was highest among babies born to Indigenous smokers (8.3%) and non-Indigenous smokers (7.8%). A lower adjusted percentage of preterm births was seen among babies born to Indigenous non-smokers (7.1%), although this was not quite as low as that for babies born to non-Indigenous non-smokers (6.1%).

The adjusted percentage of full-term low-birthweight babies born to Indigenous non-smokers (1.6%) was only 0.5% higher than the percentage born to non-Indigenous non-smokers (1.1%). For babies of both Indigenous and non-Indigenous mothers who smoked, the adjusted risk of full-term low birthweight was more than three times higher than that of babies born to non-smoking Indigenous and non-Indigenous mothers (Box 2).

DISCUSSION

Smoking during pregnancy is more common among young, Indigenous and economically-disadvantaged mothers. After adjusting for other risk factors, Indigenous mothers who did not smoke had adjusted pregnancy outcomes that were nearly as good as those for non-Indigenous mothers who did not smoke. This suggests that an important part of the extra risk of Indigenous babies being born too early or too small results from the higher prevalence of smoking among Indigenous mothers compared with non-Indigenous mothers.

These percentages (54% v 19%) are similar to smoking percentages in 2005 for the other states and territories of Australia that collect such data, showing that 53% of Indigenous and 16% of non-Indigenous mothers smoke,[1] although some states (eg, New South Wales) have smoking rates among non-Indigenous mothers as low as 14%.[1]

Although smoking is an important risk factor for preterm birth, it has been known for some time that it is a much stronger risk factor for growth restriction.[13] The results of our study are consistent with this: smoking multiplied the risk of having full-term low-birthweight babies more than threefold (ie, > 200% increase), but multiplied the risk of preterm birth by about 1.3 times (ie, 30% increase).

Also, Indigenous non-smoking mothers had a statistically significantly lower adjusted risk of having full-term low-birthweight babies than Indigenous mothers who smoked. For preterm birth, the difference was not statistically significant, although the point estimates of the adjusted percentages were in the same direction as for full-term low-birthweight outcomes. These findings also reflect the stronger association between smoking and growth restriction than between smoking and preterm birth.

Mothers who are able to quit smoking early in pregnancy reduce their risk of having a preterm or low-birthweight baby to nearly that of mothers who did not smoke at all.[14,15] However, in our data from Queensland, of pregnant women who smoked, only 7% of non-Indigenous women and 3% of Indigenous women were able to quit by 20 weeks' gestation.

Interventions based on cognitive behaviour therapy (CBT), such as brief counselling sessions (5–10 minutes) offered with pregnancy self-help materials, produce modest but important reductions in the percentage of pregnant women who smoke[16] (relative risk reductions of the order of 6%[17]).

For non-pregnant smokers, the addition of pharmacotherapy (eg, nicotine replacement therapy [NRT], bupropion or varenicline) to CBT has been shown to multiply quit rates by about 1.5 to 2.0 times.[18] For pregnant women who smoke, CBT is usually provided without pharmacotherapy because of concerns that the drug might harm the fetus. Such caution might not be valid for NRT.[19] The argument is that babies of smokers will be exposed to nicotine anyway, so if NRT is used instead of cigarettes, then exposure to the other harmful chemicals in cigarette smoke might be avoided with overall net benefits for the fetus, but there are differing views in this debate.[19]

A feature of our Queensland data was that, of the pregnant women who smoked, 91.4% of non-Indigenous and 95.9% of Indigenous women received their antenatal care in the public sector (ie, public hospital, or shared public hospital and general practitioner care). Consequently, the state and federal governments, who directly fund this antenatal care, have a particular responsibility to ensure that all pregnant smokers are offered culturally appropriate interventions to help them quit smoking,[20,21] especially as many of them are young or Indigenous or economically disadvantaged (or all three). Tobacco control strategies that discourage teenagers from taking up smoking are also important, because the earlier a teenager starts smoking, the less likely it is that she will be able to quit during pregnancy.[22]

It is easier to help mothers quit smoking if they attend antenatal care. Based on our data, one in 50 Indigenous smokers (1.9%) had no antenatal care and one in 12 (8.3%) had fewer than two antenatal visits (Box 1). The corresponding figures for non-Indigenous smokers were one in 200 (0.5%) with no antenatal care and one in 45 (2.2%) with fewer than two antenatal visits. However, the attendance of Indigenous mothers at antenatal care can be improved, as has been demonstrated in the "Mums and Babies" program.[23]

Our study has two main limitations. First, some smokers might have been incorrectly classified as non-smokers because some mothers might not have wanted to disclose that they smoked.[24] This misclassification is most likely to have influenced the results for the Indigenous, non-smoking group because the non-Indigenous non-smoking group was large and any effects of misclassification in that group would have been diluted. In any case, if there were smokers in the non-smoking group, this would mean that our findings underestimated the effects of smoking.

Second, we did not have data on all factors that might affect preterm birth and growth restriction. For example, we adjusted for depression, but could not adjust for psychosocial stress, which might be more prevalent among Indigenous mothers.

Antenatal smoking remains an important cause of poor health in both Indigenous and non-Indigenous babies. More attention to smoking during pregnancy would be an important step in giving prevention a more central role in health care.

COMPETING INTERESTS

None identified.

AUTHOR DETAILS

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