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1 **WHICH MOTHERS SMOKE BEFORE, DURING AND AFTER PREGNANCY?**

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1 **ABSTRACT**

2 **Objective**

3 To investigate the sociodemographic factors associated with cigarette smoking in women
4 before, during and after pregnancy.

5 **Study Design**

6 A 12-month longitudinal study.

7 **Method:**

8 All eligible mothers at two public maternity hospitals in Perth, Australia were asked to
9 participate in a study of infant feeding. While in hospital, participating mothers
10 completed a self-administered baseline questionnaire. Follow up telephone interviews
11 were conducted at 4, 10, 16, 22, 32, 40 and 52 weeks. Data collected included socio-
12 demographic, biomedical, hospital-related and psychosocial factors associated with the
13 initiation and duration of breastfeeding.

14 **Results:**

15 A total of 587 (55%) mothers participated in the study. Thirty nine percent of mothers
16 reported smoking pre- pregnancy. Mothers who smoked were more likely to have a
17 partner who smoked, to have consumed alcohol prior to pregnancy and less likely to
18 attend antenatal classes. They were also less likely to have know how they were going to
19 feed their baby before conception and likely to be more inclined to consider stopping
20 breastfeeding before four months postpartum.

21 **Conclusion:**

22 Having a partner (father of the newborn infant) who smoked and maternal alcohol
23 consumption prenatally were factors associated with pre-pregnancy smoking. In addition,

1 if a woman decided how she would feed her infant before the pregnancy occurred and
2 intended to breastfeed for longer than four months she was less likely to smoke in the
3 prenatal period.

4

5 Having a father (of the newborn infant) who smoked during pregnancy continued to be a
6 factor significantly associated with maternal smoking in the antenatal and postnatal
7 period. Not attending antenatal classes and not intending to breastfeed for longer than
8 four months were also factors associated with maternal smoking. At ten weeks
9 postpartum being of Caucasian origin and having a low Iowa Infant Feeding Attitude
10 Score were factors significantly associated with smoking postnatally.

11

12 **KEYWORDS**

13 smoking, pregnancy, breastfeeding

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20 Abstract word count: 292

21 Main text word count: Approximately 2979

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23

1 **INTRODUCTION**

2 Smoking has been shown to negatively effect fecundity and fertility, and evidence shows
3 that cigarette smoking is linked to a variety of adverse pregnancy outcomes including low
4 birth weight, spontaneous abortion, and infant death^[1]. Upon birth, low birth weight
5 babies have been shown to have difficulty breastfeeding due to an ineffective suck
6 correlated with immaturity, which further compromises their early growth and
7 development^[2]. They are disadvantaged in adulthood as evidenced by the association
8 between low birth weight and the development of type 2 diabetes, hypertension and
9 coronary heart diseases^[3].

10

11 Breastfeeding in the postnatal period enables infants to achieve optimal growth and
12 development^[4, 5] however cigarette smoking has been shown to be associated with a
13 decreased initiation and duration of breastfeeding^[6] which further compromises the health
14 and development of an infant already exposed to cigarette smoke. Further to this maternal
15 smoking in the postnatal period poses an indirect threat to the infant through
16 environmental smoke and a direct threat through the transfer of nicotine in the
17 breastmilk^[1].

18

19 The physiological mechanism of nicotine in decreasing breastfeeding initiation has been
20 ascribed to nicotine dependent alterations in prolactin and oxytocin production resulting
21 in a subsequent diminished let-down reflex and decreased breastmilk volume^[1]. However
22 continued research fails to support this theory^[7]. What is supported is that psychosocial
23 factors play an important role in breastfeeding rates among women who smoke^[7].

1

2 Current Australian and World Health Organisation (WHO) guidelines recommend
3 exclusive breastfeeding for the first six months of life, with continued breastfeeding until
4 two years of age together with complementary foods^[8,9]. Australian breastfeeding
5 initiation rates from the 2001 National Health Survey (NHS) was 83%,^[10] however rates
6 as high as 93.8% have been reported in a more recent longitudinal study conducted in
7 Perth, Western Australia^[11]. Regardless of these high initiation rates, national levels for
8 infants fully breastfed at three months or less, and six months or less had fallen to 54%,
9 and to 32% respectively in the 2001 NHS^[10].

10

11 The 2001 NHS identified approximately 27% of women of childbearing age (18-44
12 years), who are smokers and will potentially smoke during pregnancy and lactation^[12].

13 The National Health and Medical Research Council (NHMRC) sets an Australian target
14 of 80% of infants being breastfed at the age of six months^[9]. As smoking is a known risk
15 factor for the early cessation of breastfeeding and with more than a quarter of Australian
16 women of childbearing age smoking, it has become a significant barrier to achieving
17 national breastfeeding goals.

18

19 The connection between maternal cigarette smoking and breastfeeding duration warrants
20 further investigation into those factors associated with maternal smoking. This paper
21 describes the pre-pregnancy, during pregnancy and postnatal smoking patterns of a
22 sample of women and examines the socio-demographic factors, which may provide

1 information essential for the development of effective strategies to support continued
2 breastfeeding.

3

4 **METHODS**

5 The second Perth Infant Feeding Study (PIFSII) was conducted between mid-September
6 2002 and mid-July 2003 to monitor breastfeeding rates and identify changes in
7 breastfeeding practices and the determinants of breastfeeding. The study was conducted
8 using the same methodology as the first Perth Infant Feeding Study (PIFSI). PIFSII was
9 conducted 10 years previous and results have been reported elsewhere^[13].

10

11 Mothers were contacted within the first three days following the birth of their infant.

12 Women were considered eligible for the study if they had delivered a live infant free of
13 any serious health conditions requiring transfer to the neonatal intensive care unit at
14 Perth's major maternity hospital. Mothers whose infants were admitted to the Special
15 Care Nurseries (SCN) of the participating hospitals were eligible for recruitment.

16

17 Those women agreeing to participate in the study completed the self-administered
18 baseline questionnaire while in hospital or shortly after discharge. Women declining to
19 participate were asked to provide some basic sociodemographic data in order to
20 determine the representativeness of the sample. All women regardless of their chosen
21 infant feeding method were followed up by telephone interview at 4, 10, 16, 22, 32, 40
22 and 52 weeks postpartum. The study instruments used were essentially the same as that

1 used in PIFSI, with only minor improvements and additions being made to the
2 instruments used in the PIFSII.

3
4 Mothers were asked if they had smoked before pregnancy and if they had smoked during
5 pregnancy as part of the baseline questionnaire. Women were classified as smokers or
6 non-smokers during pregnancy according to their self-reported smoking status. At each
7 follow up interview mothers' smoking status was once again confirmed.

8

9 **Statistical analysis**

10 In addition to descriptive analysis, univariate analysis using cross-tabulation and X^2
11 statistics, and multivariate logistic regression modeling using the Statistical Package for
12 Social Sciences, Version 11.0 (SPSS for Windows, SPSS Inc., Chicago, IL, USA) were
13 used to explore variation in factors influencing smoking before, during and after
14 pregnancy.

15

16 We used both findings from the literature and univariate analyses (criterion for inclusion:
17 $p \leq 0.15$) to decide which variables should be entered into the final multivariate logistic
18 model. In the final model all variables were entered simultaneously. All variables were
19 kept in the final model, even those not statistically significant, to illustrate their
20 diminished effect of these factors, which are often considered to be correlated with
21 cigarette smoking (e.g. education and income level).

22

23 Presented P values are two-sided, and a 5% significance level was used.

1

2 **Ethical considerations**

3 The PIFSII was approved by the human ethics committee of Curtin University and the
4 Research Ethics Committees of the two participating hospitals. Signed informed consent
5 was obtained from participants.

6

7 **RESULTS**

8 In total, 1068 women were eligible to participate in the PIFSII. Of these 870 (68%) were
9 contacted and 587 (55%) completed the baseline questionnaire. There were no significant
10 differences in the age or level of education of participants compared to non-
11 participants^[11]. Table 1 outlines the characteristics of the participants by smoking status.

12 *Insert Table 1 here*

13

14 Tables 2 - 4 present the univariate and multivariate results.

15 *Insert Table 2 here*

16

17 Smoking in pre-pregnancy was significantly associated with maternal alcohol intake and
18 a father (partner) who smoked.

19

20 Mothers who had decided how to feed their baby during or after pregnancy were more
21 likely to be smokers in pre-pregnancy than women who had decided on their feeding
22 method prior to pregnancy. Similarly women who did not attend antenatal classes were

1 twice as likely to smoke before pregnancy. Intending to breastfeed for less than four
2 months was significantly associated with pre-pregnancy smoking.

3

4 Father's smoking status remained significantly associated with a mother's likelihood of
5 smoking during pregnancy. Women who had not attended antenatal classes, and those
6 intending to breastfeed for less than four months were more likely to smoke during
7 pregnancy.

8

9 *Insert Table 3 here*

10

11 Postnatally, mothers were more likely to smoke if the father was a smoker. Mother's
12 country of birth was dichotomised into Caucasian and 'other'. Caucasian women were
13 predominantly from Australia, New Zealand, the UK, North America and Europe, and
14 'other' women comprised all other nations. Caucasian women were between five and six
15 times more likely to be smokers after the birth of their child. (See Table 4)

16 A mother's attitude towards infant feeding was measured by the Iowa Infant Feeding
17 Attitude Scale (IIFAS)^[14]. The IIFAS is a valid and reliable 17 item scale which measures
18 attitudes towards both breast and formula feeding with regards to the health and
19 nutritional benefits, and the cost and convenience of each method^[15]. Mothers with a low
20 Maternal Iowa were more likely to be smoking postnatally.

21

22 *Insert Table 4 here*

23

24

1 **DISCUSSION**

2 In our study 39% of women reported smoking prior to pregnancy. Past studies on pre-
3 pregnancy smoking report prevalence levels ranging from 21.5%-46%^[16-21] In 1998, an
4 Australian study reported a pre-pregnancy smoking level of 45.9%^[19].

5
6 The variability in reported smoking prevalence may be a consequence of self-reported
7 smoking. A limitation of the current study may be our measure of self reported smoking
8 in pre-pregnancy was recalled up to one week after delivery and social desirability may
9 lead to a biased recall of smoking in new mothers. Like other studies of self reported
10 smoking levels in pre-pregnancy, our reports of smoking were not biochemically
11 confirmed^[16, 17, 20]. Some studies have claimed reasonably accurate self reports of
12 smoking, even long after pregnancy,^[22] however others have found that smoking during
13 pregnancy is underreported or undisclosed^[23].

14
15 Smoking prevalence decreased during pregnancy (26%) despite this our level was higher
16 than the most recent national Australian figures reported (18%),^[24] and lower than 31%
17 recorded from 1996-1998 in a previous Australian study^[25].

18
19 Postpartum smoking prevalence further decreased to 23%. Previous research reports
20 values of 26%-28% of women smoking postnatally^[17].

21
22 Maternal age has been shown to be a strong independent indicator of smoking before,<sup>[16-
23 20]</sup> and during pregnancy^[21]. We failed to find a lack association between young age and

1 maternal smoking which may simply be a reflection of current national Australian
2 smoking trends. Nationally female smoking rates peak in the 20-29 and 30-39 age group
3 at 22.9% and 21.8%, respectively^[26].

4

5 Unlike previous studies we were unable to find a significant relationship between
6 smoking before, during and after pregnancy and education level after adjusting for
7 covariates^[16-18, 20, 21]. This may be due to other factors exerting a stronger influence over
8 maternal smoking throughout this emotionally and physically demanding time,
9 particularly after the birth.

10

11 Our finding that pre-pregnant smokers were almost three times as likely to drink alcohol
12 as non-smokers is supported by the literature^[17, 18]. Alcohol has also been shown to be a
13 factor strongly associated with relapse in women who quit smoking prior to pregnancy^[18].

14

15 The lack of association between alcohol and smoking during pregnancy is most likely
16 attributable to the public health awareness of reducing alcohol intake during pregnancy
17 that exists today. Postnatally women may find they no longer desire the taste of alcohol
18 due to their abstinence during pregnancy or they may find a lack of social occasions to
19 drink alcohol in their new mothering role.

20

21 A strong relationship was confirmed between smoking pre-pregnancy, during pregnancy
22 and postnatally, and the father's smoking status. This effect has been documented prior
23 to pregnancy,^[17, 18] during pregnancy,^[18, 21] and postnatally,^[17-19] in previous research.

1

2 In our study, we assumed the father of the child to be the mother's partner as
3 approximately 90% of smoking mother's responded that the only (other) smoker in the
4 household was the father. Given this information we found that if the father smoked the
5 mother was between five and seven times more likely to smoke herself, prior to falling
6 pregnant, during pregnancy and after the birth. Research has shown this relationship
7 extends beyond the partner, in that women who cohabitat with a smoker are less likely to
8 quit smoking during pregnancy and more likely to relapse if they have quit^[17, 18].

9

10 Infants exposed to Environmental Tobacco Smoke (ETS) are at increased risk of
11 respiratory illness, and a continuation of both parents smoking poses a health risk for the
12 newborn infant^[1]. Having a father who smokes makes it difficult for the mother not to
13 smoke as the presence of another smoker within the household automatically provides for
14 the availability of cigarettes and therefore the opportunity to smoke as well as the
15 temptation to smoke.

16

17 Women who decided how they were going to feed their baby before becoming pregnant
18 were less likely to be smokers prior to pregnancy. When adjusted for, this association
19 only existed with smoking prior to pregnancy and to date no other study has investigated
20 this variable as a factor in maternal smoking.

21

22 Intending to breastfeed for less than four months was significantly associated with
23 smoking prior to pregnancy and during pregnancy. This is akin to O'Campo and Faden^[16]

1 who found that women intending to breastfeed were less likely to smoke prior to
2 pregnancy and more likely to quit during pregnancy than women intending to formula
3 feed.

4

5 Antenatal classes aim to prepare expectant parents for childbirth and their new family
6 life. Our finding that mothers not attending antenatal classes was significantly associated
7 with smoking before and during pregnancy agrees with the literature^[27]. Women who are
8 smoking and not attending antenatal classes may not be receiving information related to
9 exposure of their infant to nicotine and ETS further amplifying the hazards of smoking
10 and may not be provided with opportunities for education on smoking cessation.

11

12 It is possible that together the attendance at antenatal classes, intended duration of
13 breastfeeding, timing of both the pregnancy and the decision of how to feed the baby may
14 signify the preparedness of the mother for the oncoming pregnancy. A lack of readiness
15 for this major life event may be enacted through a continuation of smoking whereas those
16 women enthusiastically anticipating this event have had time to contemplate and quit
17 smoking before conception.

18

19 Unlike previous studies^[17, 19, 24, 25] we failed to find a significant relationship between
20 smoking and income level or social group. This discrepancy between our study and those
21 before us may be due to power differences between their investigations and the current
22 one. In addition, education and age are considered to be highly correlated with income.

1 Women who are older are often more educated and more aware of the dangers of
2 smoking before, during and after pregnancy and therefore less likely to smoke.

3

4 Kahn, Certain and Whittaker^[17] found that Caucasian race was a significant predictor of
5 smoking in the 12 months before pregnancy. Likewise in our study Caucasian women
6 were four times more likely to smoke before pregnancy than 'other' women. The most
7 recent national Australian data,^[24] and Australian study,^[25] also found that women from
8 English speaking countries or predominantly Caucasian women had a higher smoking
9 level during pregnancy than 'other' women.

10

11 A low IIFAS is indicative of negative maternal breastfeeding attitudes and previous
12 studies have indicated that positive maternal breastfeeding attitudes are strongly
13 correlated with maternal age, level of education, income, and marital status^[14]. In our
14 study a low IIFAS score was significantly associated with smoking postnatally. As a high
15 score indicates willingness to breastfeed, a low IIFAS score may also be a proxy for the
16 lack of anticipation of the approaching birth.

17

18 This study is the first Australian study to assess the relationship between smoking before,
19 during and after pregnancy with sociodemographic factors predictive of smoking, but it
20 needs to be replicated to verify our results and to investigate further other factors that
21 may play a role in predicting maternal smoking habits. In addition several limitations of
22 this study exist.

23

1 All smoking behaviours were self-reported and cigarette smoking may have been
2 underreported particularly during the antenatal period when there is increased stigma
3 associated with smoking, as opposed to smoking before and after pregnancy. However
4 self-reported smoking status is considered to be reasonably accurate^[22]. Future studies
5 should consider the inclusion of alternative measures of cigarette smoking.

6
7 The relatively small sample size, and the fact that all women came from government
8 hospitals is a limitation of this study. Thus, the results may not be generalisable to the rest
9 of Australia or to other cultures. Future studies in other countries that use larger, more
10 representative samples and that investigate sociodemographic factors indicative of
11 maternal smoking should be conducted to confirm our findings.

12
13 In summary this study further substantiates a number of factors independently associated
14 with smoking prior to pregnancy, during pregnancy and postnatally. Foremost is the
15 impact partner's (father's) smoking status has on all stages of pregnancy. This potentially
16 modifiable risk factor^[28] is paramount in promoting positive breastfeeding outcomes and
17 optimum health of the baby.

18
19 Alcohol intake is a health risk behaviour known to cluster with cigarette smoking and in
20 this study maternal alcohol intake was associated with smoking prior to pregnancy^[29].

21 Being emotionally prepared for the pregnancy and making important choices for the care
22 of the baby (e.g., feeding method) is possibly another factor in the conundrum of
23 maternal smoking and an important area for education.

1

2 Smoking cessation interventions targeted at women of child bearing age need to consider
3 the likelihood of women conceiving a baby and the harmful effect of smoking on the
4 unborn foetus and newborn baby. Factors predictive of pre-pregnancy, antenatal and
5 postnatal smoking highlighted in this and previous research are essential in tailoring
6 client interventions. Most importantly since a smoker's partner often smokes as well, the
7 anti-smoking efforts in antenatal care must be complementary to the general preventive
8 work in the community and inclusive of the partner.

9

1 **ACKNOWLEDGMENTS**

2 Roslyn Giglia is supported by a Public Health Postgraduate Research Scholarship from
3 the National Health and Medical Research Council.

4

5 **COMPETING INTERESTS**

6 The authors have no financial or other competing interests to disclose.

7

8

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1 **Table 1. Characteristics of the participants prior to, and during pregnancy (%)**

	Pre-Pregnancy				Pregnancy			
	Non-smoker		Smoker		Non-smoker		Smoker	
	(n=358)		(n= 228)		(n=427)		(n=153)	
	n	%	n	%	n	%	n	%
Maternal age (yr)								
<20	11	3.1	21	9.2	16	3.7	16	10.5
20 – 24	63	17.6	59	25.9	89	20.8	31	20.3
25 – 29	106	29.6	64	28.1	123	28.8	45	29.4
30 – 35	116	32.4	61	26.8	129	30.2	46	30.1
35+	62	17.3	23	10.1	70	16.4	15	9.8
Maternal education level								
did not complete secondary school	100	27.9	111	48.7	126	29.5	83	54.2
completed secondary school/trade	198	55.3	108	47.4	234	54.8	68	44.4
bachelor degree or higher	60	16.8	9	3.9	67	15.7	2	1.3
Income								
<\$25 000	175	48.9	140	61.4	213	49.9	99	64.7
>\$25 000	175	48.9	83	36.4	204	47.8	51	33.3

2

3

1 **Table 2. Relationship between pre-pregnancy smoking and explanatory variables**

	Smoker before pregnancy % (n= 228)	Multivariate Odds Ratio (95% CI)	<i>p</i>
Maternal alcohol intake			0.010
drank alcohol pre-pregnancy	77.0	2.9 (1.3-6.5)	
did not drink alcohol pre-pregnancy	23.0	1	
Father's smoking status pre-pregnancy			0.000
smoker	75.2	7.0 (3.7-13.2)	
non-smoker	24.8	1	
When first decided how to feed baby			0.001
during/after pregnancy			
before pregnancy	53.5	3.1 (1.6-6.1)	
	46.5	1	
Attend antenatal			0.026
No, never	46.3	2.1 (1.1-4.1)	
Yes, this and/or previous	53.7	1	
Intended duration			0.048
<4months	26.2	2.2 (1.0-4.8)	
4 months+	73.8	1	

2 Variables in full models included maternal age (<25 years, >25 years), maternal

3 education level (did not complete secondary education, completed secondary

1 school/trade, bachelor degree or higher), timing of pregnancy (actively trying,
2 mistimed, unplanned), income (<\$25 000, >\$25 000), Mother's country of birth
3 (Caucasian, other), Maternal Iowa Score(IIFAS) (low score, high score).

4

5

6

7

1 **Table 3. Relationship between smoking during pregnancy and explanatory variables**

	Smoking in pregnancy (%) (n=153)	Multivariate Odds Ratio (95% CI)	<i>p</i>
Father's smoking status during pregnancy			0.000
smoker	74.8	5.7 (2.9-11.3)	
non-smoker	25.2	1	
Attend antenatal			0.001
No, never	52.0	3.2 (1.6-6.2)	
Yes, this and/or previous	48.0	1	
Intended duration			0.012
<4months	27.5	2.7 (1.2-5.9)	
4 months+	72.5		

2 All significant results are shown in bold

3 Variables in full models included maternal education level (did not complete
 4 secondary education, completed secondary school/trade, bachelor degree or higher),
 5 when first decided how to feed baby (during/after pregnancy, before pregnancy),
 6 timing of pregnancy (actively trying, mistimed, unplanned), income
 7 (<\$25 000, >\$25 000), Mother's country of birth (Caucasian, other), Maternal Iowa
 8 Score(IIFAS), (low score, high score).

9

10

11

12

1 **Table 4. Relationship between postnatal smoking (week 10) and explanatory**
 2 **variables**

	Smoking postnatal (%) (n=123)	Multivariate Odds Ratio (95% CI)	<i>p</i>
Father's smoking status during pregnancy			0.000
smoker	31.6	6.7 (3.0-15.2)	
non-smoker	68.4	1	
Mother's country of birth			0.044
Caucasian	96.7	5.2 (1.0-25.7)	
Other	3.3	1	
Maternal Iowa Score(IIFAS)			0.009
low score	67.5	2.9 (1.3-6.6)	
high score	32.5	1	

3 All significant results are shown in bold

4 Variables in full models included maternal education level (did not complete secondary
 5 education, completed secondary school/trade, bachelor degree or higher), maternal age
 6 (<25 years, > 25 years), when first decided how to feed baby (during/after pregnancy,
 7 before pregnancy), timing of pregnancy (actively trying, mistimed, unplanned), attend
 8 antenatal classes (No, never, Yes, this and/or previous pregnancy), Intended duration of
 9 breastfeeding (>4 months, >4 months).

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