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Transitions in smoking across a pregnancy: new information from the Growing Up in New Zealand longitudinal study

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Key words: smoking, pregnancy, postpartum, longitudinal study

ABSTRACT

Introduction: Maternal smoking remains a modifiable cause of adverse maternal and child health outcomes. This study investigated smoking transitions across pregnancy.

Methods: Data from the contemporary child cohort study *Growing Up in New Zealand* (n – 6,822) were used to analyse smoking status across three points across a pregnancy: pre-pregnancy, during pregnancy and after pregnancy. Odds-ratios (OR) were calculated for maternal, socio-economic and pregnancy-related factors associated with each transition using multivariate logistic regression.

Results: The prevalence of smoking pre-pregnancy was 20.3%. The cessation rate during pregnancy was 48.5%, while the postpartum relapse rate was 36.0%. Heavy smokers were less likely to quit during pregnancy (OR 0.13, 95% Confidence interval (CI): 0.08-0.20), and more likely to relapse at nine months (OR 2.63, CI: 1.60-4.32), relative to light smokers. Women in households with another smoker were less likely to quit during pregnancy (OR 0.35, CI: 0.25-0.48), and more likely to relapse postpartum (OR 2.00, CI: 1.14-3.51), relative to women in a smoke-free household. Women without high school qualifications were less likely to quit during pregnancy than women with bachelor degrees (OR 0.21, CI: 0.11-0.41) but no more likely to relapse. Maori women were less likely to quit during pregnancy than European women (OR 0.35, CI: 0.25-0.49) but no more likely to relapse.

Conclusion: Heavy smokers and those with another smoker in the household are at high risk of smoking during pregnancy or relapsing after pregnancy. Decreasing smoking across a pregnancy therefore requires a focus on cessation in all households with heavy smokers of child-bearing age. The association between smoking and ethnicity may be confounded as it not consistent across the pregnancy.

Key words: smoking, pregnancy, postpartum, longitudinal study

SIGNIFICANCE

What is already known? The covariates associated with smoking and smoking during pregnancy are well-established. Relapse and transitions across a pregnancy are less well-studied. Ethnicity is thought to be consistently associated with smoking behaviours.

What this study adds: Analysis of transitions across a pregnancy, including relapse after pregnancy, using a large (n =6,822), ethnically diverse and contemporary longitudinal dataset. While significantly associated with smoking and smoking during pregnancy, ethnicity and socio-economic status were not significantly associated with relapse. This suggests that the association between smoking and ethnicity may be confounded.

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smoker were less likely to quit during pregnancy (OR 0.35, CI: 0.25-0.48), and more likely to relapse postpartum (OR 2.00, CI: 1.14-3.51), relative to women in a smoke-free household. Women without high school qualifications were less likely to quit during pregnancy than women with bachelor degrees (OR 0.21, CI: 0.11-0.41) but no more likely to relapse. Maori women were less likely to quit during pregnancy than European women (OR 0.35, CI: 0.25-0.49) but no more likely to relapse.

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INTRODUCTION

New Zealand's infant mortality rate of 5.5 per 1,000 live births is worse than all Organization for Economic Cooperation and Development (OECD) countries but Slovakia (5.7) and the United States (6.1) (U.S. Department of Health and Human Services 2014). Maternal smoking remains the most important modifiable cause of adverse pregnancy outcomes (Lumley, Chamberlain et al. 2009). Previous analysis of the *Growing Up in New Zealand* longitudinal survey has established that 10.7% of New Zealand women continue to smoke while pregnant (Morton, Atatoa Carr et al. 2012). In the United States, rates of smoking during pregnancy are estimated at between 9.7 and 10.7% (Centre for Disease Control 2011), while in Australia 7.7% of women reportedly smoked after they knew they were pregnant (AIHW 2011).

Across child-bearing ages (15-44 years), 19.5% (95% confidence intervals (CI): 16.8%-22.4%) of New Zealand women are current smokers, with higher rates seen in Maori women and women living in lower socio-economic areas : odds ratios for Maori women are 3.03 (CI: 2.71-3.38) versus non-Maori women, and 3.36 (CI: 2.52-4.49) for women from low socio-economic areas versus those from higher socio-economic areas (Ministry of Health 2013). Pregnancy has been shown to provide an opportunity for smoking cessation (Haug, Aarø et al. 1994; Cnattingius 2004), with cessation rates higher than at any other point across the lifetime (Satcher, D., Thompson, T.G., et al. 2002). Internationally, smoking cessation during pregnancy is associated with socio-demographic factors such as age, ethnicity, education and socio-economic status (SES), whether the pregnancy was planned, and smoking factors such as the intensity of smoking prior to pregnancy, partner's smoking status or the presence of a smoker in the household (Flower, Shawe et al. 2013; Smedberg, Lupattelli et al. 2014). In New Zealand, a 2003 study investigated the factors influencing cessation during pregnancy for forty nine women who quit smoking in the first trimester, and found that unemployed women, Maori women, women with previous pregnancies and less socioeconomically advantaged women were all less likely to quit smoking during pregnancy (McLeod, Pullon et al. 2003). A more

recent analysis of 81,821 women enrolled from 2008 to 2010 with a midwife Lead Maternity Carer across New Zealand showed that women under 20 years of age, Maori women and multiparous women were more likely to smoke during pregnancy, although there was no reporting of factors associated with cessation of smoking during pregnancy (Andrews, Dixon et al. 2014). A qualitative study of 60 pregnant Maori self-identified smokers recruited during 2002 and 2003 found all lived with another smoker and identified this as a factor that made it harder to stop smoking (Glover and Kira 2011).

While pregnancy provides an opportunity for smoking cessation, international literature has found that relapse rates at six months postpartum can be as high as 45% to 70% (American College of Obstetricians and Gynecologists 2011; Harmer and Memon 2013). In New Zealand, Craig et al 2012 (Craig, Dell et al. 2012) showed that 16.5% of babies born in 2009-10 had a mother who smoked at two weeks after delivery, however this estimate was thought to be prone to selection bias (omissions were more likely from younger, Pacific or Maori babies from lower socio-economic areas) (Craig, Dell et al. 2012), and no relapse rates were calculated. Andrews et al 2014 (Andrews, Dixon et al. 2014) suggest research is needed to establish relapse rates for New Zealand. Internationally, relapse is associated with a range of socio-demographic, pregnancy and smoking-related factors. Younger, less-educated women and those from lower socio-economic areas; multiparous women and those that do not breastfeed; and those women who smoked heavily prior to cessation during pregnancy, and/or who have a partner or another smoker in the household are more likely to relapse (Simmons, Sutton et al. ; Gyllstrom, Hellerstedt et al. 2012; Harmer and Memon 2013).

Our objective was to provide population relevant rates of smoking, cessation and relapse for contemporary New Zealand women during and after pregnancy. Further, by utilizing a longitudinal data source, we then sought to determine the maternal, household and environmental factors associated with transitions in smoking status across a pregnancy, and in particular those factors that reinforce disadvantage and negative health outcomes by negatively influencing smoking status at

every stage across a pregnancy. Our rationale was that identifying modifiable risk factors could help to improve policies to increase smoking cessation across pregnancy. The current poor child-health outcomes plus ethnic diversity make New Zealand a useful contemporary case study.

METHODS

Growing Up in New Zealand study

We used data from the *Growing Up in New Zealand* longitudinal study of New Zealand families and children. A profile of the cohort has been published previously (Morton, Atatoa Carr et al. 2013). Antenatal recruitment, engagement with an ethnically and socioeconomically diverse sample and inclusion of partners were essential design features (Morton, Grant et al. 2012), and delivered a birth cohort broadly applicable to the current New Zealand births without the need for over-sampling or weighting which become increasingly problematic in longitudinal analyses (Morton, Grant et al. 2012). Alignment of the enrolled cohort with all New Zealand births has subsequently been described after routine birth information for the recruitment period became available (Morton, Ramke et al. 2014).

A total of 6,822 women agreed to their children's participation in the *Growing Up in New Zealand* study for up to 21 years and completed an antenatal interview. The participating women completed a computer-assisted personal interview (CAPI) in the last trimester of their pregnancy and again at nine months postpartum. Women who had enrolled but not completed their interview prior to the arrival of their baby (n=640) were not included in the analysis of the pre and during-pregnancy information to ensure the data for this sub-group was not subject to recall bias. Ethical approval for the study was obtained from the Ministry of Health Northern Regional Ethics Committee. Written informed consent was obtained from all participating women.

Key variables

A description of the key variables included in this analysis is given in Table 1. Self-reported regular smoking status pre-pregnancy (defined as smoking at least one cigarette everyday), smoking cessation during pregnancy (conditional on smoking pre-pregnancy), and smoking relapse at nine months post-pregnancy (conditional on smoking cessation during pregnancy) were the dependent variables for the analyses. Key potential predictors included maternal characteristics such as self-reported ethnicity (European, Maori, Pacific and Asian/Other); socio-economic status as measured by the New Zealand geographical area deprivation quintile (a geographic index of relative socio-economic deprivation derived from Census data – see Salmond et al 2007), age group, and education level (no high school qualifications; completion of high school to grade 11,12 or 13; post-school diploma or trade certificate; Bachelor's degree; or a higher degree). Smoking-related potential predictors included smoking intensity, defined categorically based on self-reported daily cigarettes: 0 = not smoking, 1-5 = light, 5-9 = moderate, 10+ = heavy, similar to Pickett et al (Pickett, Wakschlag et al. 2003), and the presence of a smoker in the household. Pregnancy-related potential predictors included pregnancy planning, previous pregnancy and breastfeeding at nine months. Categorical birth weight (low (<2500g), average (2500-4000g), and high (>4000g)) and categorical child health at nine months (excellent, very good, good, fair and poor) were also considered for analysis of smoking relapse.

Statistical Analyses

We first considered the factors associated with smoking during child-bearing years. We then modelled the factors associated with stopping smoking during pregnancy, conditional on smoking pre-pregnancy, and finally the factors associated with a relapse of smoking during infancy, conditional on smoking cessation during pregnancy. Univariate tests were conducted and adjusted odds-ratios were calculated using multivariate logistic regression. The regression modelling initially considered all variables in the univariate analysis, but was reduced manually by excluding those variables where the p-values were not significant at the 10 per cent level. Unless otherwise stated,

we report results of the multivariate analysis, which adjusts for confounding between available predictors.

RESULTS

Transitions in smoking status

Of the total of 6,822 women recruited antenatally, 6,182 completed their interviews prior to the birth of their child. Of these, 4 did not provide smoking pre or during pregnancy information reducing the initial sample size to 6,178. Of these, 5,758 were contacted again when their infant was nine months of age. This retention rate of 93.2% is the same as for the entire cohort and reflects similar characteristics as previously reported (Morton, Atatoa Carr et al. 2012). The transitions in smoking between these three time points are illustrated below in Figure 1. Overall 1,257 women (20.3%) were smoking pre-pregnancy. Of these, 610 (48.5%) quit during pregnancy. Of those who quit during pregnancy, 220 (36.0%) had relapsed into smoking at nine months post-pregnancy. There was also a reduction in smoking intensity during pregnancy, with the proportion of heavy smokers reducing from 53% pre-pregnancy to 29% during pregnancy, before increasing again post-pregnancy to 38%.

Predictors of smoking pre-pregnancy

The predictors of smoking pre-pregnancy are shown in Table 2. In order of magnitude of adjusted odds-ratio (OR), women with no high school qualifications were more likely to smoke relative to women with post-graduate (OR 10.26, 95% confidence interval (CI): 6.80-15.47) and bachelor degrees respectively (OR 6.27, CI: 4.57-8.62). The presence of another smoker in the household increased the likelihood of smoking (OR 4.68, CI: 3.70-5.93), relative to a smoke-free household. Women under 20 years of age were more likely to smoke than women 35-39 years (OR 3.71, CI: 2.67-5.15). Maori women were more likely to smoke than women that identified within the European ethnic category (OR 1.91, CO: 1.57-2.33). Finally, women from lower SES backgrounds

were more likely to smoke than women from higher SES backgrounds (quintile 1) (quintile 5 OR 1.85, CI: 1.40-2.45; quintiles 2-4 OR 1.35-1.49, CI: 1.01-1.99).

Predictors of cessation during pregnancy

The predictors of smoking cessation during pregnancy, conditional on smoking pre-pregnancy, are shown in Table 3. In order of magnitude of adjusted odds ratio, women who were heavy smokers pre-pregnancy were less likely to quit during pregnancy, relative to being a light smoker (OR 0.13, CI: 0.08-0.20). Women with no high schooling were less likely to quit than women with bachelor degrees (OR 0.21, CI: 0.11-0.41). Living in a household with another smoker, identifying as Maori, being a medium intensity smoker and having previously been pregnant all decreased the likelihood of quitting during pregnancy (OR: 0.25-0.40, CI: 0.23-0.58). Finally, women with unplanned pregnancies were less likely to quit during pregnancy compared to women with planned pregnancies (OR: 0.61, CI: 0.46-0.82). SES and age were not found to be significantly associated with cessation during pregnancy.

Predictors of relapse at nine months postpartum

The predictors of smoking relapse by nine months postpartum, conditional on smoking pre-pregnancy and cessation during pregnancy, are shown in Table 4. In order of magnitude of adjusted odds ratio, women who were medium (OR 2.73, CI: 1.65-4.52) or heavy smokers (OR: 2.63, CI: 1.60-4.32) pre-pregnancy were more likely to relapse, relative to light smokers. Living in a household with another smoker, not breastfeeding at nine months, and having previously been pregnant all increased the likelihood of relapse (OR: 2.00-2.32, CI:1.14-3.51). Women with the lowest SES backgrounds (quintile 5) were more likely to relapse than women from the highest SES backgrounds (quintile 1)(OR: 2.14, CI: 1.07-4.28). Unplanned pregnancy remained weakly associated with relapse, increasing the chance of relapse relative to those women who had a planned pregnancy (OR: 1.46, CI: 0.99-2.15). Ethnicity, age and mother's education were not found to be significantly associated

with relapse at nine months postpartum. Women from lower SES backgrounds (quintiles 2-4) were not statistically more likely to relapse than those from higher SES backgrounds (quintile 1). Child health indicators (birth weight, health at nine months) were not statistically associated with relapse.

DISCUSSION

Key findings

This analysis has demonstrated the typical smoking transitions of New Zealand women in child-bearing age through one pregnancy, and highlighted the factors associated with a change in smoking behavior from pre-natal to the postnatal period. Maternal characteristics such as age, SES and ethnicity were all associated with higher rates of smoking in general, and lower rates of cessation during pregnancy. By contrast, prior heavy smoking and the presence of another smoker in the household, rather than socio-demographic variables such as maternal age, SES and/or ethnicity, are more strongly associated with relapse for those women who have reported successfully quitting during pregnancy.

The prevalence of maternal smoking prior to pregnancy in the *Growing Up in New Zealand* cohort was 20.3%, consistent with the New Zealand rates for women of child bearing age from national surveys of 19.5% (CI: 16.8%-22.4%)(Ministry of Health 2013). Women in the *Growing Up in New Zealand* cohort were more likely to smoke prior to pregnancy if they lived in more poverty-stricken areas, identified as Maori, were young, less educated and lived with another smoker, consistent with earlier studies (Ministry of Health 2013; Andrews, Dixon et al. 2014).

The cessation rate during pregnancy was 48.5%, higher than those reported from the United States (23-43%) and the United Kingdom (27-47%)(Schneider, Huy et al. 2010). There has been a concerted effort in New Zealand to reduce smoking during pregnancy and smoking more generally that may explain some of this impressive result. In 2011, the Government set the ambitious target of making New Zealand smoke-free by 2025, and implemented a wide range of policies including directing all

health care workers in contact with smokers to discuss smoking and provide cessation options, and providing monetary incentives for Maori and Pacific women to quit smoking during pregnancy (see smokefree.org.nz for full details). However there is also the possibility that the self-reported smoking status is overestimating cessation; a Scottish study found that this bias can be as much as 25% in pregnancy (Shipton, Tappin et al. 2009). A cessation rate of less than one in two is still poor in absolute terms. New Zealand has around 60,000 births each year (Statistics New Zealand 2014), which means that of the estimated 12,300 women who smoke prior to pregnancy, around 6,300 women continue to smoke during pregnancy. We found that those women who continue to smoke during pregnancy were more likely to be from lower SES backgrounds and living with other smokers in the household, be multiparous (so likely to have older children in their homes), identify as Maori, have low levels of education, smoke heavily and to have had an unplanned pregnancy. This is consistent with a recent systematic review that found increased nicotine dependence, multiparity and having a partner that smoked were all negatively associated with cessation during pregnancy (Schneider, Huy et al. 2010). Our results are also similar in both predictor and magnitude to the smaller 2003 New Zealand study, which found Maori women, women whose partners smoked and women who had been previously pregnant were all two to three times less likely to quit smoking during pregnancy (McLeod, Pullon et al. 2003).

The smoking relapse rate at nine months after pregnancy was 36.0%, lower than reported international rates of between 47% and 63% by six months postpartum (Harmer and Memon 2013). A surprising finding from this study is that relapse was a function of pregnancy and smoking-related factors rather than socio-demographic factors such as ethnicity and SES. This is unusual in New Zealand, where ethnicity and SES are typically significantly associated with smoking-related behaviours (McLeod, Pullon et al. 2003; Ministry of Health 2013; Andrews, Dixon et al. 2014). We note that maternal ethnicity was highly correlated with the other associated factors: Maori women were more likely to smoke heavily, to have the presence of another smoker in the household, to have had an unplanned pregnancy and to have been previously pregnant, all significant predictors of

relapse. However there was no additional ethnicity effect associated with relapse at nine months after pregnancy. These results suggest that the association between smoking and ethnicity may be confounded as it not consistent across the pregnancy. Previous New Zealand research has shown that statistically significant associations between health and ethnicity might be largely explained by inequalities, discrimination and other typically unobserved factors correlated with ethnicity (Harris, Tobias et al. 2006). There is evidence of differential access to health services, and differential treatment and effectiveness of the health system, based on ethnicity within New Zealand (Harris, Cormack et al. 2013; Came 2014; Makowharemahihi, Lawton et al. 2014). Depending on the level of interaction with the health system across a pregnancy, such factors could therefore confound ethnicity associations with cessation and relapse to varying degrees. Similarly, other socio-demographic factors such as mother's education level and SES were either not associated or only weakly associated with relapse. This is inconsistent with international literature which showed that non-smoking related socio-demographic factors remain important in relapse (Allen, Prince et al. 2009; Harmer and Memon 2013).

Finally, pregnancy-related factors such as pregnancy planning and parity were also significantly associated with transitions in smoking status. Pregnancy planning has positive impacts on both quitting during pregnancy, and on withstanding relapse at nine months. Previous pregnancy decreases the probability of quitting during pregnancy and increases the chances of relapsing at nine months. This is consistent with international findings (Schneider, Huy et al. 2010; Harmer and Memon 2013).

Implications for policy

From a policy perspective, we sought to identify modifiable risk factors that could increase both the probability of smoking cessation during pregnancy and decrease the chance of relapse after pregnancy. We found that women who are heavy smokers are least likely to quit smoking should

they fall pregnant. Targeting policy at the pregnancy period may be too late for a large number of at-risk women.

The presence of another smoker in the household was both strongly associated with a lack of quitting, and relapse at nine months. This is a consistent theme in the literature (Schneider, Huy et al. 2010; Gyllstrom, Hellerstedt et al. 2012; Harmer and Memon 2013; Simmons, Sutton et al. 2014), and suggests that interventions need to consider the household environment and include mother, partner and other adults in the household.

Pregnancy planning proved important in smoking transitions suggesting there is merit in promoting planning across the child-bearing age population. Similarly, while our results do not show a causal relationship, an intention not to breastfeed could be used to identify women who may benefit from more intensive smoking cessation and support services (Harmer and Memon 2013).

Women who continue to smoke during pregnancy are a particularly at-risk group with attributes that predict a low probability of cessation. This means that the marginal rate of cessation during pregnancy is likely to be much lower than the average rate achieved across the population to date, and therefore that increased effort will be required to further reduce smoking during pregnancy in New Zealand. Finally, we also highlighted that ethnicity and SES were not consistently associated with smoking across the pregnancy, indicating the possibility of confounding on health service inequalities or discrimination. This should encourage policy makers and analysts to continue to look for modifiable factors captured by the ethnicity variable that are leading to unequal outcomes.

Limitations

There were some methodological limitations to this study. First, the analysis was restricted to those who had fully answered the questions on smoking during pregnancy. This omitted some participants in wider the study who had delivered their children before they completed the antenatal questionnaire, often prematurely. However it is believed this bias is minimal as all of the

characteristics of the group used in this data are consistent with those of the whole cohort reported in Morton et al (Morton, Atatoa Carr et al. 2010).

Second, accurate measurement of smoking during the pregnancy period was difficult. The smoking variables used in this analysis are based on self-reported smoking status, which is likely to overestimate cessation (Dietz, Homa et al. 2011) and thereby underestimate the prevalence of this critical population health risk factor. In addition, the smoking during pregnancy measurement was obtained in the early third trimester and specific information was not provided as to exactly when in pregnancy cessation occurred.

Thirdly, there was a difference in the 'presence of another smoker in the household' variable across the pregnancy periods. At the antenatal interview the question asked was '*Does anyone currently smoke in the same room as you?*' and if the answer was yes then the frequency was established (Rarely – less than once a week; Occasionally – a few times a week; Often – almost or every day of the week). At the 9 month interview the question was '*How many people who live in your household smoke cigarettes?*', as this question was targeted at the child's environment rather than the direct effect on the pregnant mother. There were no follow-up questions on where they smoked or the frequency. However both questions did provide an indication as to the contact the mother had with other smokers on a daily basis and this how the finding that living in a house with another smoker reduced the likelihood of cessation and increased the likelihood of relapse should be interpreted.

Conclusion

Our research suggests that New Zealand has relatively high rates of cessation during pregnancy, and avoidance of relapse at nine months, when compared internationally. However maintaining and improving on these outcomes in the future is likely to prove harder to achieve, as many of the factors associated with smoking prior to pregnancy also adversely impact on the probability of cessation during pregnancy. We found that heavy smoking prior to pregnancy had the largest

negative effect on cessation during and on relapse after pregnancy, and the presence of another smoker in the household was also statistically and economically significant. This highlights the importance of general smoking interventions across the child-bearing age population for further reducing smoking during pregnancy and subsequently improving New Zealand birth outcomes. Finally, we also highlighted that ethnicity was not consistently associated with smoking across the pregnancy, indicating the possibility of confounding on health service inequalities or discrimination.

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DECLARATION OF INTERESTS

We have no conflicts to declare.

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Table 1: Descriptive statistics

Characteristic	Pre-pregnancy	During pregnancy (third trimester)	Post-pregnancy (nine months)
Observations	6,178	6,178	5,758
Ethnicity	54%	54%	56%
European	14%	14%	13%
Maori	14%	14%	13%
Pacific	18%	18%	18%
Asian/Other	54%	54%	56%
SES quintile			
1 (Highest)	16%	16%	16%
2	18%	18%	19%
3	17%	17%	18%
4	21%	21%	21%
5 (Lowest)	28%	28%	26%
Age group at pregnancy			
< 20 years	5%	5%	5%
20-24 years	15%	15%	14%
25-29 years	24%	24%	24%
30-34 years	31%	31%	32%
35-39 years	21%	21%	21%
40+	4%	4%	4%
Mother's education level			
No high school	7%	7%	6%
High school completion	24%	24%	23%
Diploma/Trade certificate	30%	30%	31%
Bachelor's degree	23%	23%	23%
Higher degree	16%	16%	16%
Smoking			
Yes	20%	10%	14%
Smoking intensity			
Light (1-5 per day)	16%	38%	24%
Moderate (6-10 per day)	30%	32%	37%
Heavy (10+ per day)	53%	29%	38%
Smoking in household			
Yes	7%	7%	7%
Previous pregnancy			
Yes	70%	70%	70%
Pregnancy planning			
Yes	60%	60%	62%
Breastfeeding at nine months			
Yes	N/A	N/A	47%
Birthweight			
Low (<2500g)	N/A	N/A	5%
Average (2500-4000g)			79%
High (>4000g)			16%
Child health at nine months			
Excellent	N/A	N/A	60%
Very good			28%
Good			9%

Fair *Poor*			3% 0%

Table 2: Smoking during child-bearing (15-44 years)

Risk factor		Univariate analysis				Multivariate (final model)			
		p value	OR	95% C.I.		p value	OR	95% C.I.	
Ethnicity	*European*								
	Maori	<0.001	4.77	4.08	5.58	<0.001	1.91	1.57	2.33
	Pacific	<0.001	2.51	2.14	2.95	0.428	1.09	0.88	1.35
	Asian/Other	<0.001	0.30	0.23	0.39	<0.001	0.26	0.20	0.35
SES	*1 (Highest)*								
	2	0.001	1.55	1.20	2.00	0.008	1.49	1.11	1.99
	3	<0.001	1.73	1.34	2.23	0.045	1.35	1.01	1.82
	4	<0.001	2.33	1.84	2.96	0.021	1.40	1.05	1.86
	5 (Lowest)	<0.001	4.82	3.86	6.02	<0.001	1.85	1.40	2.45
Age group	*<20*								
	20-24	<0.001	0.47	0.37	0.61	0.014	0.69	0.51	0.93
	25-29	<0.001	0.20	0.16	0.26	<0.001	0.50	0.38	0.68
	30-34	<0.001	0.10	0.08	0.13	<0.001	0.34	0.25	0.46
	35-39	<0.001	0.09	0.06	0.11	<0.001	0.27	0.19	0.37
	>=40	<0.001	0.10	0.07	0.15	<0.001	0.26	0.16	0.42
Mother's education level	*No high school*								
	High school completion	<0.001	0.26	0.21	0.32	<0.001	0.44	0.34	0.56
	Diploma/Trade certificate	<0.001	0.25	0.20	0.31	<0.001	0.49	0.38	0.63
	Bachelor's degree	<0.001	0.05	0.04	0.07	<0.001	0.16	0.12	0.22
	Higher degree	<0.001	0.03	0.02	0.04	<0.001	0.10	0.06	0.15
Other household smoking	*No*								
	Yes	<0.001	10.18	8.26	12.55	<0.001	4.68	3.70	5.93

Table 3: Smoking cessation during pregnancy

Risk factor		Univariate analysis				Multivariate (final model)			
		p value	OR	95% C.I.		p value	OR	95% C.I.	
Ethnicity	*European*								
	Maori	<0.001	0.30	0.22	0.39	<0.001	0.35	0.25	0.49
	Pacific	0.476	0.90	0.67	1.20	0.306	0.84	0.59	1.18
	Asian/Other	0.002	2.72	1.44	5.16	0.304	1.46	0.71	3.02
SES	*1 (Highest)*								
	2	0.275	0.74	0.44	1.27				
	3	0.285	0.75	0.44	1.27				
	4	0.009	0.52	0.31	0.85				
	5 (Lowest)	<0.001	0.39	0.24	0.61				
Age group	*<20*								
	20-24	0.343	0.84	0.59	1.20				
	25-29	0.784	1.05	0.73	1.52				
	30-34	0.539	1.13	0.76	1.67				
	35-39	0.504	1.17	0.74	1.84				
	>=40	0.119	0.52	0.23	1.18				
Mother's education level	*No high school*								
	High school completion	<0.001	2.80	1.99	3.95	0.002	1.86	1.26	2.74
	Diploma/Trade certificate	<0.001	2.41	1.73	3.34	<0.001	1.95	1.34	2.83
	Bachelor's degree	<0.001	8.67	4.96	15.17	<0.001	4.70	2.44	9.06
	Higher degree	<0.001	4.67	2.25	9.68	0.093	2.09	0.88	4.94
Other household smoking	*No*								
	Yes	<0.001	0.30	0.22	0.39	<0.001	0.35	0.25	0.48
Smoking intensity prenatal	*Light (1-4/day)*	Reference							
	Medium(5-9/day)	<0.001	0.32	0.22	0.49	<0.001	0.37	0.23	0.58
	Heavy (10+/day)	<0.001	0.12	0.08	0.18	<0.001	0.13	0.08	0.20
Pregnancy planning	*No*								
	Yes	<0.001	2.20	1.72	2.81	0.001	1.63	1.21	2.18
Previous pregnancy	*No*								
	Yes	<0.001	0.44	0.34	0.56	<0.001	0.40	0.30	0.54

Table 4: Smoking relapse at nine months after pregnancy

Risk factor		Univariate analysis				Multivariate (final model)			
		p value	OR	95% C.I.		p value	OR	95% C.I.	
Ethnicity	*European*								
	Maori	0.061	1.55	0.98	2.46				
	Pacific	0.427	1.18	0.78	1.80				
	Asian/Other	0.196	0.62	0.30	1.28				
SES	*1 (Highest)*								
	2	0.503	1.28	0.63	2.60	0.352	1.44	0.67	3.11
	3	0.972	1.01	0.49	2.11	0.810	1.10	0.50	2.42
	4	0.621	1.19	0.60	2.37	0.541	1.26	0.60	2.68
	5 (Lowest)	0.032	2.00	1.06	3.77	0.032	2.14	1.07	4.28
Age group	*<20*								
	20-24	0.989	1.00	0.58	1.74				
	25-29	0.217	0.70	0.40	1.23				
	30-34	0.199	0.68	0.38	1.22				
	35-39	0.165	0.61	0.31	1.22				
	>=40	0.771	0.82	0.21	3.13				
Mother's education level	*No high school*								
	High school completion	0.745	0.91	0.50	1.64				
	Diploma/Trade certificate	0.322	0.74	0.41	1.34				
	Bachelor's degree	0.004	0.33	0.15	0.71				
	Higher degree	0.013	0.22	0.07	0.73				
Other household smoking	*No*								
	Yes	<0.001	2.13	1.50	3.00	0.016	2.00	1.14	3.51
Smoking intensity prenatal	*Light (1-4/day)*								
	Medium(5-9/day)	<0.001	2.76	1.72	4.43	<0.001	2.73	1.65	4.52
	Heavy (10+/day)	<0.001	2.64	1.66	4.21	<0.001	2.63	1.60	4.32
Pregnancy planning	*No*								
	Yes	0.046	0.70	0.49	0.99	0.054	0.68	0.47	1.01
Previous pregnancy	*No*								
	Yes	0.001	1.82	1.27	2.60	<0.001	2.18	1.48	3.23
Breast feeding at 9 months	*No*								
	Yes	<0.001	0.41	0.29	0.60	<0.001	0.43	0.29	0.64
Birth weight	*Average*								
	Low (<2500g)	0.330	0.64	0.26	1.57				
	High (>4000g)	0.054	1.49	0.99	2.25				
Child health at 9 months	*Excellent*								
	Very good	0.963	0.99	0.66	1.48				
	Good	0.804	0.93	0.54	1.61				
	Fair	0.406	1.53	0.56	4.18				
	Poor	0.828	0.77	0.07	8.53				

Figure 1: Smoking transitions