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A longitudinal, observational study of women who persisted in smoking in successive pregnancies

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ABSTRACT

Background This longitudinal study examined the profile and pregnancy-related behaviours of women who reported smoking in two successive pregnancies when they presented for prenatal care in a large maternity hospital.

Methods Using the hospital electronic medical records, women who delivered two successive singleton pregnancies during the years 2011–15 were analyzed. Standardized data were computerized by a midwife at the first prenatal visit, following delivery and before discharge.

Results Over the 5 years, 6647 women delivered twice. Overall 5754 (86.6%) were persistent non-smokers in both pregnancies, 609 (9.2%) were persistent smokers in both pregnancies and between pregnancies 202 (3.0%) quit and 82 (1.2%) started smoking. Compared with persistent non-smokers, persistent smokers had higher rates of reported illicit drug use, alcohol consumption and psychological problems and lower rates of planned pregnancy, folic acid supplementation and breastfeeding in both pregnancies (all $P < 0.001$). In persistent smokers, folic acid supplementation practices deteriorated and illicit drug use increased in the subsequent pregnancy.

Conclusions We found that approximately one in 10 women smoked in two consecutive pregnancies. Furthermore, compared with non-smokers, persistent smokers were more likely to report other health behaviours associated with adverse pregnancy outcomes and may require additional multidisciplinary support.

Keywords breastfeeding, folic acid supplementation, illicit drug use, maternal alcohol consumption, maternal smoking, successive pregnancies

Introduction

Maternal smoking during pregnancy remains a common and important modifiable risk factor for adverse foetal and maternal clinical outcomes.[1,2] Although smoking during pregnancy is decreasing in developed countries, it is increasing in developing countries.[3–5] While smoking cessation interventions are recommended, most women who smoke quit spontaneously without assistance in advance of pregnancy or once they become aware that they are pregnant.[6]

In Ireland, guidelines and policies to reduce maternal smoking are lacking and therefore smoking cessation support for pregnant women is minimal. A national survey of smoking cessation facilities in maternity units found that of all 19 maternity units in Ireland, just six units had all antenatal clinic midwives trained to give smoking cessation advice, eleven units had on-site smoking cessation services, but just over half of these units referred women to the service.[7]

Although there is no pregnancy-specific maternal smoking policy in Ireland, the 'National Maternity Strategy Report for 2016–2026' was launched in January 2016.[8] The Reports publication has prompted several reviews of maternity services which highlighted significant service deficits. The following recommendations were made regarding maternal

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smoking; all midwives and other frontline healthcare professionals' should have formalised and documented training in smoking cessation and all maternity units should have smoke-free campuses and on-site smoking cessation services available by 2026.

In 2009, a review of interventions by the US Preventive Services Task Force strongly recommended that clinicians ask all pregnant women about smoking and provide augmented, pregnancy tailored counselling.[9] This approach was endorsed by the American College of Obstetricians and Gynecologists.[10] Despite recommendations, however, implementation of smoking cessation programmes is poor.[7]

Moreover, studies show that women who have not quit spontaneously before their first prenatal hospital visit rarely stop and may increase smoking during pregnancy and after delivery.[6,11,12] Even smokers who had a previous adverse pregnancy outcome persist in smoking during their next pregnancy.[13]

Cross-sectional research have reported an association between maternal smoking and drug and alcohol use in pregnancy.[5,14] However, no longitudinal studies have demonstrated if associated behaviours persist or change in future pregnancies alongside smoking behaviour. Furthermore, although the benefits of folic acid supplementation and breastfeeding are well established no studies to date have investigated the changes in these advantageous pregnancy-related behaviours over time in persistent smokers.[15,16]

This longitudinal study therefore aimed to examine the profile and behaviours of women who persist in smoking when they presented for prenatal hospital care in successive pregnancies.

Methods

Women who delivered two successive singleton babies weighing ≥500 g in the 5 years between January 2011 and December 2015 in a large university maternity hospital were analyzed (Fig. 1). The Coombe Women and Infants University Hospital is a tertiary hospital based in Dublin, Ireland, and is responsible for approximately 8500 deliveries a year. The Hospital accepts women from all socioeconomic backgrounds whether they are privately insured or not.[17]

At the first prenatal clinic visit woman's clinical and sociodemographic details were routinely computerized by a trained midwife using the electronic medical record system 'K2'. The information is used primarily to generate patient records and secondarily for generating standard letters, clinical reports and research.

K2 prompts standardized questions that remained unchanged over the five year period. Data collected on the system includes sociodemographic data, lifestyle information and clinical data. For the purpose of the study, smoking status was initially categorized into 'occasional' (non-daily smoker), 'light' (smoked 1–5 cigarettes per day), 'moderate' (smoked 6–10 cigarettes per day) and 'heavy' (≥11 cigarettes per day). Smoking behaviour between pregnancies were categorized into the following: 'persistent non-smoker' (may have smoked at some point in their life but did not report smoking in either pregnancy at the first prenatal visit), 'quit smoking' (reported as a smoker at the first prenatal visit in the index pregnancy but reported as an ex-smoker at the first prenatal visit in the subsequent pregnancy), 'started smoking' (reported as a non-smoker at the first prenatal visit in the index pregnancy but reported smoking at the first prenatal visit in the subsequent pregnancy) and 'persistent smoker' (reported as a smoker in both the index and subsequent pregnancy at the first prenatal visit).

Current alcohol consumption was categorized into 'no' (no alcohol) or 'weekly alcohol' (consumed an undefined level of alcohol each week). For the purpose of the study, 'binge' was defined as having consumed >5 units of alcohol at one sitting and categorized into 'never' (reported never binging on alcohol) or 'yes' (reported binging on alcohol at least once). Drug use in pregnancy was categorized into 'none' (reported no illicit drugs use) or 'illicit drugs' (reported using any type of illicit drugs, including cannabis). Variables described as 'previous' refer to any behaviour the women reported before pregnancy. Variables described as 'in pregnancy' refer to any behaviour the women reported at least once in pregnancy and/or are ongoing at the first prenatal visit. For the purpose of this study, illicit drugs were defined as the non-medical use of a variety of drugs that are prohibited by international law. Maternal weight and height were measured by a midwife, before body mass index (BMI) was calculated.

The data were pseudonymized on an Excel (Microsoft Corp., Redmond, WA, USA) spreadsheet and exported to the statistical software programme SPSS version 24.0 for analysis (IBM Corp., Armonk, NY, USA). Normality of continuous data was assessed using descriptive statistics for kurtosis and skewness, visual inspection of distribution histograms and the Kolmogorov–Smirnoff statistics. Relevant continuous data were collapsed into categories. Missing data were coded in SPSS and presented in footnotes of tables.

Descriptive statistics were used to describe the sociodemographic characteristics and birth outcomes of the study cohort stratified by smoking category. Normally distributed continuous data were reported as mean and standard deviation and non-normally distributed data as median and interquartile range (IQR). Categorical data were reported as proportions. The test for difference between two

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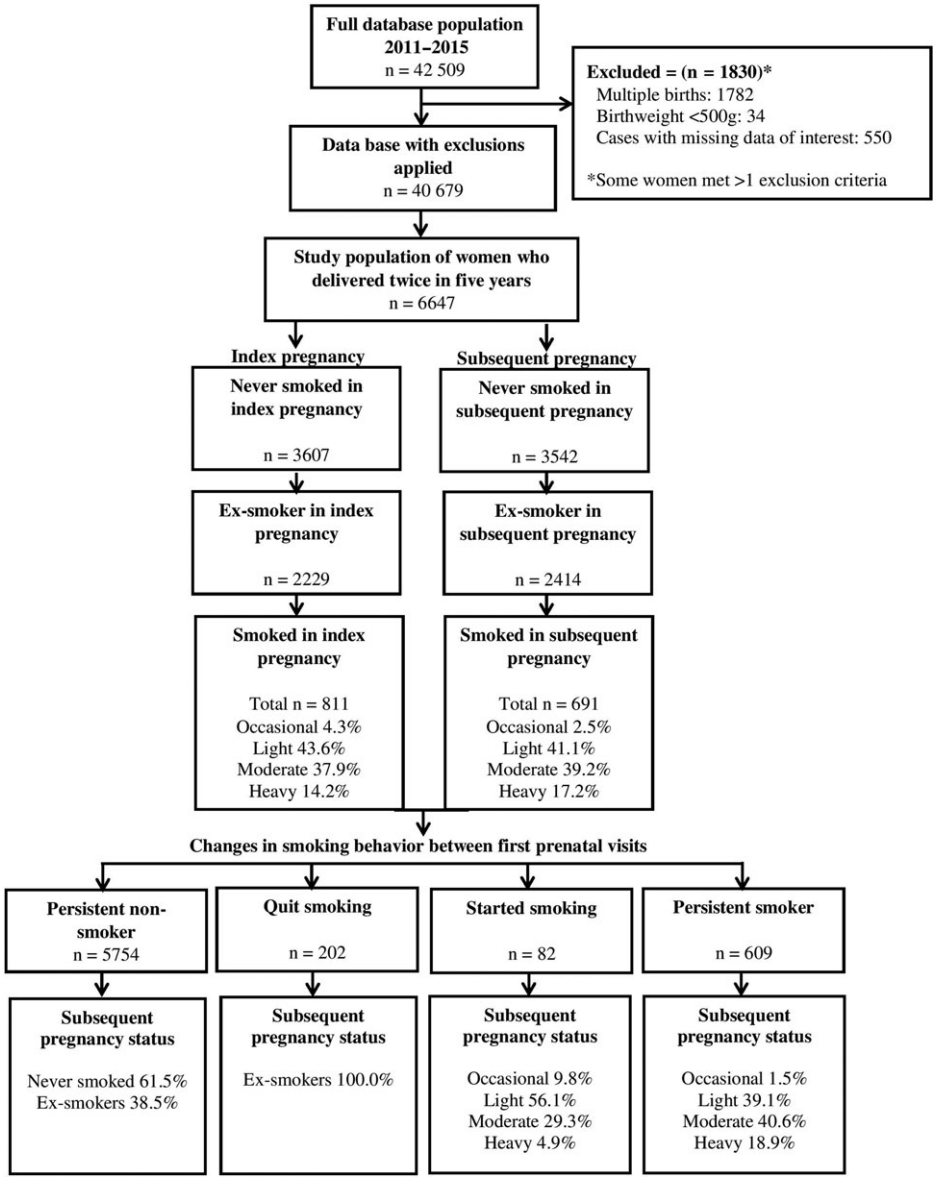

Fig. 1 Flow diagram of the study cohort. This figure shows the selection process for the study population and their smoking behaviour in two successive pregnancies.

independent proportions was used to assess differences in the characteristics and lifestyle behaviours of women who delivered once and women who delivered twice.[18] Results were presented as superscript letters with explanations of these letters provided in the footnotes of the table.

The proportions of characteristics and behaviours in the index and subsequent pregnancies stratified by smoking behaviour were analysed using descriptive statistics. The unadjusted difference between the index and subsequent pregnancies within smoking behaviour categories was then examined using the test for difference between two independent proportions, and results were provided as *P*-values.[18] The unadjusted differences between the index and subsequent pregnancies of persistent smokers and the corresponding pregnancy of all other smoking behaviour groups were also analysed using the test for difference between two independent proportions.[18] Results for this analysis were presented as superscript letters with explanations provided in the footnotes of the table.

Finally, multinomial logistic regression analyses were conducted to examine the relative contribution of persistent smoking on the likelihood of continuing suboptimal behaviours in the subsequent pregnancy compared to persistent non-smoking. Reference groups for all analysis are presented

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in the footnotes of tables. All factors adjusted for within the models were associated with persistent smoking on univariate logistic regression analysis. Model 1 was unadjusted, Model 2 was adjusted for age, Model 3 was adjusted for age and parity and Model 4 was adjusted for age, parity and employment status. Results were reported as odds ratios (ORs) and adjusted ORs (aOR), 95% CI and associated *P*-value. The study was approved by the Hospital's Research Ethics Committee (4-2013).

Results

Over the 5 years 2011–15, there were 42 509 deliveries in which 6647 mothers with singleton pregnancies delivered twice. Figure 1 is a flow diagram of the women studied.

The mean interval between pregnancies was 2.2 ± 0.9 years.

Table 1 compares the maternal and neonatal characteristics of the index and subsequent deliveries of women who delivered twice during the 5 years with women who delivered once. Women who delivered twice were less likely to have an unplanned pregnancy and more likely to be nulliparous in the index pregnancy (all $P < 0.001$).

Of the 811 women who smoked in their index pregnancy, 609 (75.1%) continued to smoke and 202 (24.9%) quit smoking before their subsequent pregnancy (Fig. 1). Eighty-two women began smoking between the first prenatal appointments of the successive pregnancies. The majority (89.0%) of women who started smoking were ex-smokers who relapsed and two-thirds (65.9%) of these women reported as occasional/light smokers at the first prenatal appointment of the subsequent pregnancy. Of the women who had quit smoking by the first prenatal visit of the subsequent pregnancy, 70.3% were occasional/light smokers in their index pregnancy. Just 7.4% of quitters were heavy smokers in their index pregnancy compared to 16.4% of persistent smokers ($P < 0.001$).

Table 2 shows the changes in maternal characteristics and behaviours from the index to the next pregnancy both within and between the categories of persistent smokers, persistent non-smokers and women who quit smoking. The differences between the index and subsequent pregnancies within smoking behaviour categories are displayed in the *P*-value columns. The differences from the index and subsequent pregnancies between smoking behaviour groups are provided as superscript letters.

Between pregnancies the rate of persistent smokers with an unplanned pregnancy increased (53.0 versus 63.9%, $P < 0.001$). The rate of persistent smokers not taking folic acid in the subsequent pregnancy increased (14.3 versus 18.7%, $P < 0.05$), and the rate of pre-conceptional folic acid decreased (14.4 versus 8.5%, $P < 0.001$). The most favourable changes in this group of women were related to alcohol with no increases in alcohol consumed in pregnancy and reductions in prepregnancy weekly alcohol and alcohol binges (60.3 versus 46.3%, $P < 0.001$ and 45.0 versus 29.7%, $P < 0.001$). Persistent smokers who breastfed had lower rates of moderate/heavy smoking than persistent smokers who did not breastfeed (47.8 versus 62.1%, $P < 0.01$). Persistent smokers had the highest rate of unemployment (74.1%) compared to women who quit smoking between pregnancies (50.5%, $P < 0.001$) and persistent non-smokers (25.3%, $P < 0.001$). The rate of unemployment within all smoking groups remained unchanged between pregnancies ($P > 0.05$).

Women who quit smoking between pregnancies had a number of more favourable pregnancy-related behaviours compared to persistent smokers in both pregnancies. Women who quit were less likely to have an unplanned subsequent pregnancy (44.4 versus 63.9%, $P < 0.001$) and more likely to have started folic acid pre-conceptionally (20.3 versus 8.5%, $P < 0.001$). Women who quit were also more likely to initiate breastfeeding (21.3 versus 10.5%, $P < 0.001$) and less likely to engage in illicit drug use (4.5 versus 8.9%, $P < 0.05$) in pregnancy compared to persistent smokers.

Persistent non-smokers in both pregnancies had lower participation rates of suboptimal behaviours than persistent smokers in both pregnancies such as drug and alcohol use. These women, however, had higher levels of a number of suboptimal pregnancy-related behaviours in the subsequent pregnancy compared to the index pregnancy, particularly in terms of family planning and folic acid supplementation.

Table 3 shows the unadjusted (ORs) and adjusted odds ratios (aORs) of persistent smokers and suboptimal behaviours in the subsequent pregnancy. Periconceptionally, persistent smokers were less likely to plan the pregnancy and supplement with folic acid. Persistent smokers were more likely prenatally to consume weekly alcohol, alcohol in binges and use illicit drugs. Postnatally, these women were more likely to exclusively artificially feed their infant. Models 2 and three adjusted for age and parity as these factors were significantly related to all behaviours on univariate analysis. Furthermore, persistent smokers and persistent non-smokers differed significantly in terms of both age and parity. However, the associations identified between persistent smoking and maternal behaviours in the unadjusted model (Model 1) remained.

Finally, Model 4 in the table adjusted for maternal age and parity but also included maternal occupation. The predictive ability of persistent smoking strengthened in this

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Table 1 Maternal and neonatal characteristics of women who delivered in total over the five years, those who delivered once and those who delivered twice

	Delivered once n = *26 713*	*Delivered twice index pregnancy* n = *6647*	*Delivered twice subsequent pregnancy* n = *6647*
Age (years) (mean, SD)	31.3 (5.7)	30.2 (5.1)[a]	32.4 (5.1)[a]
Irish nativity (%)	75.0	74.7	74.7
Nulliparas (%)	44.2	61.7[a]	0.0
Body mass index (kg/m^2) (mean, SD)	25.6 (5.1)	25.2 (4.9)[a]	25.7 (5.1)[a]
Obese (%)	17.8	14.5[a]	17.4[a]
Employed (%)	70.8	69.0[b]	69.0[b]
Unplanned pregnancy (%)	31.5	22.9[a]	30.3[a]
Anxiety (%)	7.0	5.2[a]	7.3[a]
Current depression (%)	1.7	1.0[a]	1.5[a]
Prepregnancy folic acid (%)	42.6	52.5[a]	44.3[a]
Exclusively breastfed on discharge (%)	35.6	38.5[a]	39.9[a]
Smoked in pregnancy (%)	13.1	12.2[c]	10.4[a]
Alcohol in pregnancy (%)	1.8	2.2[c]	2.0
Drugs in pregnancy (%)	2.2	0.6[a]	1.4[a]
Birth weight (grams) (mean, SD)	3415.3 (566.0)	3424.3 (564.2)	3493.1 (541.6)
Gestation (weeks) (mean, SD)	39.5 (1.9)	39.6 (1.9)[a]	39.4 (1.7)[a]
Small for gestational age (%)[a]	13.2	12.3[c]	11.4[a]
Preterm birth (%)	5.6	5.2	4.9[c]
Low birth weight (%)	5.2	4.8	3.7[a]

P-values compare women who delivered once and women who delivered twice over the 5 years. Superscript letters ([a]$P < 0.001$, [b]$P < 0.01$ and [c]$P < 0.05$) indicate significance between index and subsequent pregnancies of women who delivered twice with the respective pregnancies of women who delivered once.

model for no folic acid use and postconceptional folic acid use, despite all other associations remaining unchanged.

Discussion

Main finding of this study

In this longitudinal study of successive pregnancies, we found that approximately one in 10 women smoked in two consecutive pregnancies. Three quarters of women who reported smoking in their index pregnancy also reported smoking in their next pregnancy. Compared with non-smokers, persistent smokers had higher rates of reported psychological problems, illicit drug use and alcohol binges in both pregnancies. They also had lower rates of planned pregnancy, preconceptional folic acid supplementation and breastfeeding. Folic acid supplementation and family planning practices deteriorated between pregnancies in persistent non-smokers. The incidence of depression increased between pregnancies in persistent smokers whereas the incidence of anxiety increased in persistent non-smokers. Compared with quitters, more persistent smokers smoked ≥11 cigarettes per day in their index pregnancy.

What is already known on this topic

Previous research from Sweden found similar, high rates of continued smoking in successive pregnancies. Even women who experienced an adverse outcome in a previous pregnancy continued to smoke in their next pregnancy, with heavy smoking the greatest predictor of persistent smoking in future pregnancies.[13] Our study's rate of continued smoking in successive pregnancies (75.1%) was higher and initiation of smoking rate (1.2%) lower than that reported in studies from other countries.

It is not surprising that continued smoking is high in this study given that Ireland currently has no national guidelines or policies for smoking cessation in pregnancy. Although all women receive verbal smoking cessation advice, this has been reported to last as little as ten seconds in duration.[7] Even if routine antenatal cessation interventions were implemented the effectiveness of these may be limited in

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Table 2 Changes in the maternal characteristics and behaviours between pregnancies of persistent smokers, persistent smokers and women who quit smoking between pregnancies

	Persistent smokers			*Quit smoking*			*Persistent non-smoker*		
	Index pregnancy (n = 609)	*Subsequent pregnancy (n = 609)*	P-*value*	*Index pregnancy (n = 202)*	*Subsequent pregnancy (n = 202)*	P-*value*	*Index pregnancy (n = 5754)*	*Subsequent pregnancy (n = 5754)*	P-*value*
BMI (kg/m^2) (mean, SD)	25.5 (5.6)	26.0 (5.8)	**<0.001**	25.9 (5.4)	26.9 (5.2)	**<0.001**	25.2 (4.8)	25.6 (5.0)	**<0.001**
Obese (%)	17.7	20.4	0.121	20.0	23.8	0.200	14.0[b]	16.8[c]	**<0.001**
Unemployment (%)	74.1	74.1	0.500	50.5[a]	50.5[a]	0.500	25.3[a]	25.3[a]	0.500
History of depression (%)	16.6	20.0	0.059	14.4	18.8	0.114	6.1[a]	7.4[a]	**0.003**
Current depression (%)	2.1	4.1	**0.024**	4.5[c]	5.0	0.407	0.8[a]	1.1[a]	0.051
Anxiety (%)	10.7	13.6	0.057	4.5[b]	9.4	**0.025**	4.5[a]	6.4[a]	**<0.001**
Postnatal depression (%)	5.1	13.6	**<0.001**	5.4	16.8	**<0.001**	2.1[a]	5.9[a]	**<0.001**
Suicide attempts (%)	2.8	3.0	0.432	0.5	1.5	–	0.3[a]	0.4[a]	0.228
Unplanned pregnancy (%)	53.0	63.9	**<0.001**	44.1[b]	44.1[a]	0.500	18.6[a]	25.7[a]	**<0.001**
No folic acid (%)	14.3	18.7	**0.018**	4.5[a]	7.4[a]	0.103	3.9[a]	4.6[a]	**0.026**
Folic acid preconception (%)	14.4	8.5	**<0.001**	21.7[a]	20.3[a]	0.357	58.0[a]	49.4[a]	**<0.001**
Folic acid postconceptional (%)	81.4	79.1	**0.002**	89.1[b]	85.7[c]	0.147	82.0	84.7[a]	**<0.001**
Exclusive breastfeeding (%)	11.5	10.5	0.292	16.3[c]	21.3[a]	0.101	42.6[a]	44.1[a]	0.053
Heavy smoker (%)	16.4	18.9	0.129	7.4[a]	0.0	–	0.0	0.0	–
Weekly alcohol before pregnancy (%)	60.3	46.3	**<0.001**	61.4	53.0[c]	**0.044**	67.5[a]	59.9[a]	**<0.001**
Weekly alcohol during pregnancy (%)	5.7	4.6	0.183	4.0	1.5	–	1.8[a]	1.7[a]	0.308
Alcohol binges before pregnancy (%)	45.0	29.7	**<0.001**	40.1	38.1	0.342	38.1[a]	22.5[a]	**<0.001**
Alcohol binges in pregnancy (%)	1.8	1.6	0.413	1.5	0.0	–	0.2[a]	0.1[a]	0.404
Illicit drugs prepregnancy (%)	24.1	25.9	0.234	22.3	23.3	0.406	5.6[a]	5.3[a]	0.230
Illicit drugs during pregnancy (%)	3.9	8.9	**<0.001**	1.5	4.5[c]	–	0.2[a]	0.5[a]	**0.011**

P-values compare the columns of the index pregnancy to the subsequent pregnancy. Superscript letters ([a]$P < 0.001$, [b]$P < 0.01$, [c]$P < 0.05$) indicate significance between index and subsequent pregnancies of persistent smokers with the respective pregnancies of women who quit smoking or were persistent non-smokers. –, numbers were too small for statistical analysis. Bold text indicates significance between the index and subsequent pregnancy within smoking categories.

persistent smokers with clustered psychosocial problems.[19] Therefore, more intensive and targeted interventions that continue in the postpartum period and include relapse prevention may be required.

Initiation rates of smoking between pregnancies are variable and generally higher than our study.[20–22] A Kansas-based study reported a rate of 4.8%, an Australian study reported a rate of 3.9% and a Swedish study reported a rate of 3.0%.[20–22] More recently, an Ohio population-based study that investigated smoking behaviour change between the years 2007 and 2013 found that 4.6% of women began smoking between pregnancies; however, the overall smoking rate in the first pregnancy was 6.9% higher than the smoking rate in our study.[23] Overall, in Ireland, the rate of maternal smoking decreased from 28.1% in 1997/98 to 10.9% in 2015 which may also, in part, explain the low initiation rate we found between pregnancies.[5,24]

Our findings are consistent with cross-sectional studies, which have shown an association between maternal smoking and the use of illicit drugs, alcohol consumption, depression and unplanned pregnancy.[14,25,26] In a sample of 215 urban pregnant smokers living in the USA, persistent heavy smokers reported higher numbers of alcohol drinks per day and higher levels of anxiety and depression compared with light smokers.[27]

Best practice guidelines recommend folic acid supplementation of 400 μg before and in the first 12 weeks of pregnancy to prevent neural tube defects.[28] Breastfeeding is recommended to promote immunity and support optimum child growth and development.[29,30] In general, maternal smokers have suboptimal nutritional intakes, particularly in terms of micronutrient intakes.[31] One study found a dose-dependant relationship between intakes of micronutrients and cigarette consumption.[32] Another found that not only were smokers less likely to take

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Table 3 Unadjusted and adjusted odds ratios of persistent smoking and suboptimal health behaviours in the subsequent pregnancy

	Model 1		*Model 2*		*Model 3*		*Model 4*	
	OR (95% CI)	P-*value*	*aOR (95% CI)*	P-*value*	*aOR (95% CI)*	P-*value*	*aOR (95% CI)*	P-*value*
Unplanned pregnancy	5.1 (4.3–6.1)	**<0.001**	3.4 (2.8–4.1)	**<0.001**	2.6 (2.2–3.2)	**<0.001**	2.5 (2.1–3.1)	**<0.001**
No folic acid	20.0 (11.0–36.1)	**<0.001**	11.3 (7.6–16.9)	**<0.001**	6.2 (4.1–9.3)	**<0.001**	19.9 (11.1–36.1)	**<0.001**
Folic acid postconceptional	7.8 (4.5–13.6)	**<0.001**	5.9 (4.2–8.2)	**<0.001**	4.4 (3.1–6.2)	**<0.001**	7.8 (4.5–13.6)	**<0.001**
Exclusive artificially feeding	9.6 (7.4–12.5)	**<0.001**	6.6 (5.0–8.6)	**<0.001**	5.1 (3.9–6.8)	**<0.001**	9.8 (7.5–12.9)	**<0.001**
Weekly alcohol during pregnancy	2.9 (1.9–4.4)	**<0.001**	3.2 (2.0–5.2)	**<0.001**	3.2 (1.9–5.2)	**<0.001**	3.2 (1.9–5.2)	**<0.001**
Alcohol binges during pregnancy	12.0 (4.7–30.6)	**<0.001**	15.7 (5.3–46.0)	**<0.001**	10.3 (3.1–33.8)	**<0.001**	10.6 (3.2–35.3)	**<0.001**
Illicit drugs during pregnancy	19.2 (12.1–30.4)	**<0.001**	14.1 (8.5–23.3)	**<0.001**	14.3 (8.5–23.9)	**<0.001**	14.3 (8.5–24.0)	**<0.001**

Reference group for overall models: women who were persistent non-smokers in both pregnancies. Reference categories for each variable are as follows: unplanned pregnancy reference category planned pregnancy; no folic acid and postconceptional folic acid reference category preconceptional folic acid; exclusive artificially feeding reference category exclusively breastfeeding; weekly alcohol and alcohol binges during pregnancy reference category no alcohol during pregnancy; illicit drugs during pregnancy reference category no illicit drugs during pregnancy. Model 1: unadjusted. Model 2: adjusted for maternal age. Model 3: adjusted for maternal age and parity. Model 4: adjusted for maternal age, parity and employment status. Bold text indicates significance between the index and subsequent pregnancy within smoking categories.

folic acid supplements compared to non-smokers, they also consumed lower amounts of dietary folate, placing them at an even higher risk of having an NTD effected birth.[31] Furthermore, a higher prevalence of non-compliance to folic acid supplementation has been found in lower social class maternal smokers.[33] To our knowledge, however, this is the first study to demonstrate that folic acid supplementation practices in smokers deteriorate from one pregnancy to the next.

Similar to our findings, previous research has reported that not only are maternal smokers less likely to breastfeed, maternal smokers that do breastfeed do so for a shorter duration than non-smokers.[34,35] Despite breastfeeding eliciting protective effects on neonatal health, one study found that smokers believed breastfeeding would put their baby at risk of the toxic, harmful and addictive effects of smoking and received little encouragement to breastfeed.[36,37]

Limitations of this study

A limitation of the study is that the information on smoking and other lifestyle behaviours were self-reported. Studies which compared biochemically-validated smoking status to self-reported measures found that different populations have varying levels of non-disclosure, some as low as 7% whilst the highest currently reported is 73%.[38,39] Although the rate of smoking reported in this study is potentially an underestimation, there is no evidence that self-reporting of behaviour changes over time.[40]

Sociodemographic data such as education and health insurance cover were unavailable in this study. This information should be collected and included in the analysis of future studies, in particular their associations with behaviours of persistent smokers in pregnancy.

A strength of this study is that it used detailed clinical and sociodemographic data that were computerized at the first prenatal visits, avoiding post-pregnancy recall bias. Furthermore, the details were computerized by a midwife using a standardized electronic record system, which remained unchanged over the 5 years. Many longitudinal studies to date have concentrated on changes in weight, BMI and smoking in successive pregnancies.[13–44] However, to our knowledge, no studies have examined changes in pregnancy-related behaviours such as folic acid supplementation and breastfeeding.

What this study adds

We believe that there are key learning points for future women's healthcare services and research from this study. In view of the high number of women who continue to smoke or relapse after pregnancy, resources need to be invested in community-based cessation interventions soon after delivery and before any future pregnancies. This is likely to be challenging, not least with compliance, and may require a sustained, multidisciplinary approach combining pharmacological as well as behavioural modifications interventions. It may also be necessary to tackle several addictions concurrently.

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The benefits of positive pregnancy-related behaviours such as folic acid supplementation and breastfeeding need to be addressed and encouraged in first time and persistent maternal smokers. Unless there is an integrated approach in primary care to support these high risk mothers, it is probable that the risks of these adverse behaviours will continue in future pregnancies and beyond, placing each pregnancy at a higher risk than the previous.

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