

Five year trends in maternal smoking behaviour reported at the first prenatal appointment

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Abstract

Background Maternal smoking is a key modifiable risk factor in preventing adverse pregnancy outcomes such as intrauterine growth restriction, preterm birth and stillbirth.

Aim This observational study examined annual trends of maternal smoking reported at the first prenatal visit in women who delivered in a large university maternity hospital for the 5 years 2011–2015.

Methods We examined clinical and sociodemographic data computerised routinely for women who presented for prenatal care at the hospital between 2011 and 2015. Multinomial logistic regression was used to determine the maternal characteristics, health behaviours and psychiatric history associated with smoking behaviours.

Results Of the 42,509 women the mean age was 31.4 ± 5.5 years, mean Body Mass Index (BMI) was 25.6 ± 5.1 kg/m², and 39.5% were nulliparas. Overall, 52.6% reported they had never smoked, 34.9% were ex-smokers, 10.5% smoked ≤ 10 cigarettes per day, 1.9% smoked ≥ 11 cigarettes per day and 0.1% smoked e-cigarettes. Between 2011 and 2015 the prevalence of maternal cigarette smoking decreased from 14.3 to 10.9% ($P < 0.001$). Smoking during pregnancy was most strongly associated with younger age, multiparity, unemployment,

unplanned pregnancy, a history of psychiatric problems, alcohol intake and illicit drug usage.

Conclusions The number of women who reported smoking at the first prenatal visit decreased annually. Amongst women who continue to smoke during pregnancy, there is a clustering of adverse lifestyle behaviour and psychological problems that may need to be addressed if smoking cessation interventions are going to succeed in improving fetal programming.

Keywords Maternal smoking · Smoking trends · Health behaviours · Fetal programming

Introduction

Tobacco smoking is a major cause of perinatal morbidity and mortality. It is a modifiable risk factor associated with increased incidence of a number of adverse pregnancy outcomes including preterm birth, intrauterine growth restriction, placental abruption and stillbirth [1, 2]. Preterm birth and low birthweight are two of the leading causes of neonatal morbidity and mortality [3]. The negative impact of low birthweight on clinical outcomes is not confined to the immediate perinatal period. Low birth weight is associated with long-term complications, including increased risk of coronary heart disease, Type 2 diabetes mellitus and adiposity in adult life [4]. ‘Fetal programming’ is an emerging concept, whereby external factors present during pregnancy influence the intrauterine environment and are said to permanently affect future structure, physiology and metabolism. Smoking has been identified as a contributing factor to future health implications, independent of its effects on birthweight [5].

In Ireland, 21% of women report they are current smokers [6]. Ireland was the first country to nationally

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implement legislation banning smoking in all workplaces including indoor public places such as bars and restaurants [7]. Since the ban was introduced in 2004, a 25% decrease risk of preterm births has been reported [8]. The first National Maternity Strategy published in January 2016 recommends that all midwives and frontline healthcare professionals be formally trained to give smoking cessation advice, that all maternity hospitals should be tobacco-free and each should have an on-site smoking cessation service available for pregnant women by 2026 [9].

The most recent national data on maternal smoking was collected as part of the Growing Up in Ireland National Longitudinal Study of Children. This study collected data on 11,134 children aged nine months and their parents between 2007 and 2008, including maternal behaviours in pregnancy. Results showed that 17.6% of women smoked at some point during pregnancy and 12.6% smoked throughout pregnancy [10]. However, information on smoking during pregnancy was collected nine months following birth and was likely to be limited by recall bias [10].

The aim of this observational study was to report contemporary annual trends in self-reported maternal smoking behaviour at the first prenatal appointment in a large maternity hospital from 2011 to 2015, and to identify the sociodemographic characteristics associated with maternal smoking.

Methods

Data were available for all nulli- and multiparas women who presented for prenatal care at the Coombe Women and Infants University Hospital Dublin between January 2011 and December 2015. The Hospital is one of Europe's largest delivering approximately 8000 infants each year accounting for approximately 1 in 8 of all Irish births and cares for women across the socioeconomic gradients [11, 12]. Clinical and sociodemographic information were routinely collected by midwives using a standardised electronic recording system, Euroking K2, at the women's first prenatal visit.

Maternal self-reported smoking behaviour was collected by midwives at the first prenatal appointment (usually 8–18 weeks' gestation). Women were asked if they had smoked cigarettes during the past week and, if so, how many cigarettes they smoke per day. Maternal smoking was categorised into the following: never smoked, ex-smokers, ≤ 10 cigarettes per day, ≥ 11 cigarettes per day and e-cigarette users.

Direct measurements of maternal height and weight were taken and recorded by midwives at the first prenatal clinic appointment and used to calculate BMI. Other data

collected at first prenatal appointment included age, pregnancy intention, maternal occupation, parity, previous miscarriages, nationality, psychiatric history, previous and current alcohol consumption and illicit drug use.

Ex-smokers were defined as women who smoked at any point before pregnancy. Binge drinking was defined as having over 5 units of alcohol in one sitting. Maternal occupation was defined using predetermined definitions according to the occupational classifications employed in the national census [13]. Illicit drugs are defined as the non-medical use of a variety of drugs that are prohibited by international law for the purpose of this study. Women who had delivered more than once over the five years had all pregnancies included.

The data were pseudonymised on an Excel[®] (Microsoft Corp., Redmond, WA, USA) spreadsheet before being exported to the statistical software program SPSS version 20.0.0 for statistical analysis (IBM Corp., Armonk, NY, USA). The normality of continuous data was assessed using descriptive statistics for kurtosis and skewness, visual inspection of distribution histograms and the Kolmogorov-Smirnoff statistics. The relevant continuous data were collapsed into categories. Missing data was coded for in the statistical software program and presented in footnotes of tables.

Descriptive statistics were used to describe the characteristics of the study cohort. Continuous data were reported as mean and standard deviation. Categorical data were reported as proportions. Chi-squared and analysis of variance (ANOVA) were used to assess differences in proportions and means, respectively, between smoking behaviour groups.

The relationships between maternal smoking behaviour and maternal characteristics were assessed using a multinomial regression model, where smoking status was the outcome with 'never smoked' the overall comparison category for the model. Maternal characteristics that are considered to be associated with maternal smoking were investigated using univariate analysis. All variables that were found to be significantly associated with maternal smoking status were then included in the multinomial logistic regression model.

Nine factors were included in the final mutually adjusted model: age (referent: 30–34 years), BMI category (referent: normal), parity (referent: nulliparous), maternal occupation (referent: professional or managerial), nationality (referent: Irish), pregnancy intention (referent: planned) and previous miscarriages (referent: none).

A further two multinomial logistic regressions were conducted to investigate the associations between maternal smoking behaviours and adverse health behaviours and psychiatric disorders. Seven factors were included in the adverse health behaviour model with all reference groups

set to either ‘no’, ‘none’ or ‘never’. The psychiatric disorder model included five factors with all reference groups set to ‘no’. All multinomial logistic regression models were adjusted for age, BMI, parity, maternal occupation, nationality and pregnancy intention. Results from the multinomial logistic models are expressed as odds ratios (OR) and 95% confidence intervals (CI). The study was approved by the Hospital’s Research Ethics committee: Study No. 4-2013.

Results

Of the 42,509 women who attended the Hospital between the years 2011–2015, the average age was 31.4 ± 5.5 years and 39.5% were nulliparas. Maternal characteristics analysed by smoking behaviour are presented in Table 1.

Table 2 shows trends in maternal smoking behaviour over the five year period. From 2011 to 2015 the prevalence of maternal cigarette smoking decreased from 14.3 to 10.9% ($P < 0.001$). Data on e-cigarette usage was only recorded from 2013 onwards and thus it is not possible to comment on any trends. A total of 21 cases between 2013 and 2015 meant the numbers were too small for meaningful analysis.

Results from the mutually adjusted multinomial regression model are shown in Table 3. Compared with women who never smoked, women aged 21–24 years were

most associated with smoking ≤ 10 (OR 2.71, 95% CI 2.36–3.12, $P < 0.001$) and ≥ 11 (OR 1.44, 95% CI 1.10–1.88, $P < 0.01$) cigarettes daily during pregnancy. Women who smoked during pregnancy were also more likely to be unemployed than in professional or managerial employment compared to women who never smoked (all $P < 0.001$). Women who smoked e-cigarettes were more likely to be in non-manual or unskilled manual employment (OR 23.16, 95% CI 3.66–146.38, $P < 0.01$) (data not shown). Women who continued to smoke ≤ 10 and ≥ 11 cigarettes daily were more likely to be multiparous and were less likely to have planned their pregnancy (all $P < 0.001$).

Table 4 show the associations between smoking during pregnancy and other adverse maternal health behaviours. Ex-smokers (OR 2.83 95% CI 2.63–3.03, $P < 0.001$) and women that smoked ≤ 10 (OR 2.23 95% CI 2.01–2.47, $P < 0.001$) and ≥ 11 (OR 2.13 95% CI 1.75–2.60, $P < 0.001$) cigarettes daily were more likely to have had a higher level of alcohol intake (> 7 units) and have engaged in binge drinking (OR 1.86 95% CI 1.78–1.96, $P < 0.001$, OR 1.85 95% CI 1.71–2.00, $P < 0.001$ and OR 1.94 95% CI 1.65–2.28, $P < 0.001$, respectively) prior to pregnancy than never smokers. Women who smoked ≤ 10 cigarettes per day were more likely to consume 1–2 units of alcohol per week (OR 3.74 95% CI 2.86–4.90, $P < 0.001$) whereas women who smoked ≥ 11 cigarettes were more likely to continue consuming > 7 units of alcohol a week (OR 36.97 95% CI 23.59–57.93, $P < 0.001$) during pregnancy. All

Table 1 Maternal characteristics of the study population analysed by smoking behaviour 2011–2015

	Never smoked, <i>N</i> = 22,378	Ex-smoker, <i>N</i> = 14,852	≤ 10 cigarettes daily, <i>N</i> = 4454	≥ 11 cigarettes daily, <i>N</i> = 804	Total, <i>N</i> = 42,509
Mean age (years) (SD)	31.9 (5.3)	31.9 (5.3)	27.9 (5.9)	29.5 (5.9)	31.4 (5.5)
Mean BMI ^{a,b} (kg/m ²) (SD)	25.5. (5.1)	25.7 (5.0)	25.5 (5.4)	26.7 (5.9)	25.6 (5.1)
Underweight (%)	1.9	1.5	3.2	2.0	1.9
Normal (%)	52.8	51.7	50.7	43.9	52.0
Overweight (%)	28.1	29.4	28.0	29.0	28.6
Obese (%)	17.2	17.4	18.0	25.1	17.5
Nulliparas (%)	39.7	41.0	37.4	17.5	39.5
Multiple pregnancies (%)	4.1	4.6	3.5	2.0	4.2
Planned pregnancy (%)	75.3	73.2	44.1	35.9	70.5
Unemployed ^c (%)	27.1	23.8	58.9	75.5	30.1

^a BMI body mass index

^b Missing data *N* = 406

^c Missing data *N* = 556

Table 2 Annual trends in daily smoking behaviour of all women who delivered between 2011 and 2015

Smoking behaviour	Year (%)						P value
	2011, n = 8681	2012, n = 8297	2013, n = 8110	2014, n = 8904	2015, n = 8517	Total, n = 42,509	
Never smoked	52.8	52.1	52.7	53.4	52.2	52.6	NS
Ex-smokers	32.9	34.4	34.4	36.1	36.8	34.9	<0.01
≤10 cigarettes	11.7	11.3	10.9	9.0	9.6	10.5	<0.01
≥11 cigarettes	2.6	2.2	2.0	1.4	1.3	1.9	<0.01

P values compare column 2011 to column 2015

Table 3 Association between self-reported daily smoking status and maternal characteristics

	N	Comparison group: never smoked		
		Ex-smoker N = 14,852 OR (95% CI)	≤10 cigarettes N = 4454 OR (95% CI)	≥11 cigarettes N = 804 OR (95% CI)
Age (years)				
<20	1553	0.77 (0.66–0.89)**	2.76 (2.30–3.30)***	1.17 (0.80–1.72)
21–24	3643	0.80 (0.72–0.88)***	2.71 (2.36–3.12)***	1.44 (1.10–1.88)**
25–29	9136	0.91 (0.85–0.97)**	2.22 (1.97–2.50)	1.31 (1.04–1.65)*
30–34 ^a	15,156	Reference	Reference	Reference
35–39	10,569	0.88 (0.83–0.93)***	1.47 (1.31–1.65)***	1.22 (0.97–1.52)
>40	2452	0.98 (0.89–1.08)	0.77 (0.62–0.97)*	0.87 (0.59–1.28)
BMI category^b				
Underweight	799	0.91 (0.76–1.08)	1.25 (0.99–1.56)	0.97 (0.57–1.65)
Normal ^a	22,123	Reference	Reference	Reference
Overweight	12,154	1.10 (1.05–1.16)***	1.04 (0.95–1.13)	1.13 (0.95–1.35)
Obese	7433	1.05 (0.99–1.11)	0.97 (0.88–1.07)	1.25 (1.03–1.51)*
Parity				
Nulliparas ^a	16,781	Reference	Reference	Reference
Multiparas	25,728	0.98 (0.93–1.03)	1.29 (1.19–1.40)***	2.76 (2.22–3.42)***
Maternal occupation				
Professional or managerial ^a	12,432	Reference	Reference	Reference
Other non-manual or skilled manual	14,960	1.44 (1.36–1.52)***	3.59 (3.13–4.13)***	12.13 (6.37–23.12)***
Semi-skilled or unskilled manual	1919	1.48 (1.32–1.66)***	7.01 (5.76–8.53)***	37.12 (18.35–75.08)***
Unemployed	12,642	1.37 (1.29–1.47)***	9.18 (7.97–10.58)***	61.93 (32.88–116.67)***
Nativity				
Ireland ^a	29,898	Reference	Reference	Reference
EU14 ^c	1750	1.10 (0.99–1.22)	0.78 (0.65–0.93)**	0.69 (0.47–1.01)
EU13 ^d	5403	1.01 (0.94–1.07)	0.54 (0.49–0.61)***	0.23 (0.16–0.32)***
Elsewhere	5323	0.16 (0.14–0.17)***	0.04 (0.03–0.05)***	0.02 (0.01–0.03)***
Pregnancy intention				
Planned ^a	29,983	Reference	Reference	Reference
Unplanned	12,526	1.21 (1.15–1.27)***	2.37 (2.20–2.57)***	3.41 (2.90–4.01)***
Previous miscarriages				
No ^a	30,589	Reference	Reference	Reference
Yes	11,920	1.01 (0.96–1.06)	1.24 (1.14–1.34)*	1.17 (1.00–1.38)

Adjusted for age, BMI, parity, maternal occupation, nativity, pregnancy intention and previous miscarriages

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

Table 4 Association between self-reported daily smoking status and maternal health behaviours

	N	Comparison group: never smoked		
		Ex-smoker N = 14,852 OR (95% CI)	≤10 cigarettes N = 4454 OR (95% CI)	≥11 cigarettes N = 804 OR (95% CI)
Alcohol ever				
No	11,888	Reference	Reference	Reference
Yes	30,621	2.14 (2.02–2.26)***	1.12 (1.05–1.22)**	1.01 (0.86–1.20)
Alcohol pre-pregnancy				
None	16,145	Reference	Reference	Reference
1–2 units	8600	1.43 (1.34–1.52)***	0.80 (0.72–0.89)***	0.58 (0.46–0.75)***
3–6 units	10,590	1.89 (1.78–2.01)***	1.08 (0.89–1.20)*	0.89 (0.72–1.10)
>7 units	7174	2.83 (2.63–3.03)***	2.23 (2.01–2.47)***	2.13 (1.75–2.60)***
Alcohol binge pre-pregnancy				
Never	28,735	Reference	Reference	Reference
At least once	13,641	1.86 (1.78–1.96)***	1.85 (1.71–2.00)***	1.94 (1.65–2.28)***
Alcohol in pregnancy				
None	41,701	Reference	Reference	Reference
1–2 units	512	1.81 (1.45–2.26)***	3.74 (2.86–4.90)***	5.32 (3.66–7.73)***
3–6 units	124	0	0	0
>7units	172	1.03 (0.64–1.64)	1.95 (1.09–3.49)*	36.97 (23.59–57.93)***
Alcohol binge in pregnancy				
Never	42,248	Reference	Reference	Reference
At least once	128	1.54 (0.85–2.79)	8.02 (4.52–14.2)***	17.40 (8.98–33.70)***
Illicit drugs ever				
Never	39,030	Reference	Reference	Reference
Cannabis only	1634	7.49 (6.33–8.85)***	12.28 (10.15–14.86)***	13.47 (10.07–18.02)***
Other illicit drugs	1845	4.15 (3.60–4.79)***	9.01 (7.67–10.58)***	12.40 (9.84–15.64)***
Illicit drugs in pregnancy				
Never	41,777	Reference	Reference	Reference
Cannabis only	375	8.94 (5.90–13.54)***	19.47 (12.65–30.21)***	20.01 (11.12–35.99)***
Other illicit drugs	357	4.45 (3.06–6.48)***	12.00 (8.13–17.71)***	15.90 (9.74–25.98)***

Adjusted for age, BMI, parity, maternal occupation, nativity and pregnancy intention

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

groups, including ex-smokers and e-cigarette users, were more likely to use illicit drugs before pregnancy (all $P < 0.001$). All groups, excluding e-cigarette users, were more likely to continue using illicit drugs during pregnancy compared to women who never smoked or used illicit drugs (all $P < 0.001$).

Table 5 shows the association between self-reported daily smoking status and self-reported maternal psychiatric history. Ex-smokers and women who smoked during pregnancy were more likely to be currently depressed or have had suffered from depression in the past (all $P < 0.001$). Women who smoked ≥ 11 cigarettes were the most likely to suffer from anxiety (OR 1.79 95% CI 1.43–2.24, $P < 0.001$) and have a history of postnatal depression (OR 1.62 95% CI 1.26–2.07, $P < 0.001$) compared to never smokers. Women who smoked ≥ 11

cigarettes daily were the most likely group to have suffered from a nervous breakdown in the past (OR 7.89 95% CI 2.89–21.53, $P < 0.001$).

Discussion

This observational study in a large maternity hospital found that over five years there has been a decrease in the number of women who report they continue to smoke in early pregnancy. This decrease is consistent with national trends in adults and occurred before improvements in the provision of smoking cessation services were recommended in the 2016 National Maternity Strategy Report from the Department of Health [9]. The women who continue to smoke also reported high levels of alcohol intake and illicit

Table 5 Association between self-reported daily smoking status and self-reported maternal psychiatric history

	N	Comparison group: never smoked		
		Ex-smoker N = 14,852 OR (95% CI)	≤10 cigarettes N = 4454 OR (95% CI)	≥11 cigarettes N = 804 OR (95% CI)
Depression in past				
No	38,848	Reference	Reference	Reference
Yes	3661	1.72 (1.59–1.87)***	2.26 (2.02–2.52)***	3.03 (2.52–3.65)***
Current depression				
No	41,861	Reference	Reference	Reference
Yes	648	1.43 (1.17–1.74)***	2.50 (1.97–3.16)***	3.82 (2.74–5.33)***
History of postnatal depression				
No	40,641	Reference	Reference	Reference
Yes	1868	1.35 (1.21–1.51)***	1.37 (1.18–1.59)***	1.62 (1.26–2.07)***
Anxiety				
No	39,652	Reference	Reference	Reference
Yes	2857	1.55 (1.42–1.69)***	1.54 (1.36–1.75)***	1.79 (1.43–2.24)***
History of nervous breakdown				
No	41,364	Reference	Reference	Reference
Yes	65	2.45 (1.28–4.72)**	3.61 (1.63–8.01)**	7.89 (2.89–21.53)***

Adjusted for age, BMI, parity, maternal occupation, nativity and pregnancy intention

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

drug usage. Thus, smoking cessation interventions may need to be combined with other interventions if maternal and fetal pregnancy outcomes are to be optimised.

A similar trend in maternal smoking has been reported in Europe, with most countries reporting 10% of women smoking throughout pregnancy [14]. There is a dearth of studies regarding maternal smoking trends during pregnancy worldwide. The most recent maternal smoking data available from the United States of America is from the ‘Pregnancy Risk Assessment Monitoring System’ (PRAMS) in 2011. PRAMS is a state-based surveillance system that monitors self-reported maternal behaviours before, during and after pregnancy using self-administered surveys two to three months following delivery of a live-born infant. Data from 2011 shows that 23% of women smoked in the three months before pregnancy which decreased to 10% in the last three months of pregnancy [15].

Maternal smoking data from the United Kingdom (UK) is available quarterly from the Health and Social Care Information Centre (HSCIC). The data is collected by a number of UK Clinical Commissioning Groups and submitted to the HSCIC for analysis. Between October and December 2015 showed that approximately 11.0% of women reported smoking at the time of delivery, ranging from 25.0% in the NHS Blackpool compared to just 1.3% in National Health Service (NHS) Central London [16]. Blackpool has been ranked as one of the most deprived

areas of England reflecting the current study’s findings that unemployment is associated with cigarette smoking [17].

The numbers of women smoking in the general population of Ireland has decreased over time. In 2007, 27% of women in Ireland reported smoking which decreased to 21% in 2015 [6, 18]. Both local economic and global tobacco trends may have contributed to this marked change in prevalence. First, the cost of a pack of 20 cigarettes rose from 2011 to 2014 by almost 17% and Ireland has one of the highest average cigarette prices in Europe. The high prices are due, most notably, to increased manufacturer costs and excise duty [19]. On December 6th 2011, for example, excise duty on a packet of 20 cigarettes was increased by 25 cents which may have contributed to a drop in cigarette sales was reported from 4.1 billion in 2011 to 3.7 billion in 2012 [20, 21].

Additionally, the growing popularity of e-cigarettes could be contributing to the overall decline in cigarette usage. Between 2012 and 2013 the e-cigarettes market grew considerably in the United States of America including an increase in sales of 320% for disposable e-cigarettes, 72% for starter kits, and 82% for cartridges [22]. In Ireland, 42% of smokers have tried e-cigarettes and 6% currently smoke e-cigarettes [6]. Furthermore, this study has shown that e-cigarettes are starting to be smoked during pregnancy although there is currently no evidence regarding the safety of e-cigarette use during pregnancy. Should popularity increase in the general population in the

coming years, a parallel rise in use during pregnancy is a possible outcome, and should be carefully monitored.

A multitude of reasons for continued maternal smoking have been reported in literature including lack of social support and post-cessation weight gain [23, 24]. Lower socioeconomic status has been identified as a major risk factor for continued smoking during pregnancy in this study. These women experience greater and more severe stress than that of their more advantaged counterparts and smoking is perceived as a means of relief from anxiety [25]. Furthermore, for some women there is an increase in tobacco use to cope with pregnancy-related pressures and the guilt of being unable to quit smoking [25].

This study found all smoking categories had a higher risk of a number of different psychological problems than women who had never smoked. A link exists between never- or ex-smoking and increased mental health and quality of life compared with light, moderate and heavy smokers [26]. These findings indicate reverse causality as it is difficult to predict whether improved mental health leads to smoking cessation or smoking cessation leads to improved mental health.

Pregnancy intention differed among smoking behaviour groups. Both women who had never smoked and ex-smokers were more likely to have planned their pregnancy than all smoking groups. Women who have not planned their pregnancy frequently continue unhealthy behaviours, such as smoking and illicit drug, use during pregnancy [27]. This study found that the strength of association between alcohol consumption and current drug use increased as smoking behaviour progressed from ex-smokers to smokers of ≥ 11 daily. This clustering of unhealthy behaviours has been found in non-pregnant populations. As cigarette consumption increased, so did the risk of women consuming high amounts of alcohol, having low levels of physical activity and consuming low intakes of fruit and vegetables [28]. Other studies have described tobacco smoking as the 'gateway drug' that leads to the experimentation of illicit drug use [29].

A strength of this study was that it contains a wide range of data from over 42,000 women who presented for prenatal care over a five year period. All sociodemographic data were collected directly from women at the first prenatal visit, thus minimising recall bias [30, 31]. Unlike previous research that relied on information collected by automated procedures or surveys, data in this study were collected by interview with a trained midwife allowing for clarification of answers [30, 31]. All smoking data were collected using standardised questions that were unchanged over the five years. Measurements of height and weight were standardised prior to calculating BMI, rather than based on self-reporting which can lead to underestimations of weight and miscategorisation of BMI in pregnant

women [32]. This study has the most up to date data of maternal smoking habits in Ireland and, to our knowledge, is the first of its kind to have information on the usage of e-cigarettes in an obstetric population.

Like many other larger cohort studies a limitation of the current study is the use of self-reported data [33]. It is possible that percentages of smoking status are underestimated as underreporting is a limitation with self-reported data. However, it was not feasible currently to have biochemical confirmation of smoking status in such a large population over a five year period. Studies which compared biochemically validated smoking status to self-reported measures found that different populations show varying levels of non-disclosure of between 10 and 25% [33–35]. We do not have data on smoking habits of this cohort later in pregnancy, but a previous Irish study within the same hospital showed no difference in the numbers of women reporting smoking or numbers of cigarettes smoked at their first prenatal appointment compared to the third trimester of pregnancy [36].

While smoking during pregnancy has decreased over time, it remains a challenging problem. Smoking during pregnancy increases the proportions of growth restricted and preterm babies, an outcome that is a health and financial cost for families and services [37]. Although the overall downward trends in maternal smoking are positive, smoking during pregnancy remains prevalent and the introduction of e-cigarette usage prompts the need for the safety of e-cigarette usage during pregnancy to be examined. More interventions are needed to assist smoking cessation in pregnancy.

Our study found that women who were most likely to continue smoking during pregnancy were younger, multiparous, unemployed, had an unplanned pregnancy, had a history of psychiatric problems, alcohol intake and were illicit drugs abusers. Due to the clustering of these characteristics and behaviours, women who continue to smoke when presenting for antenatal care should be identified at first visit and given the support that they require to optimise birth outcomes in the short term as well as lifelong health for themselves and their offspring.

Compliance with ethical standards

Sources of funding Friends of the Coombe.

Conflict of interest The authors declare that they have no conflict of interest.

Statement of human rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

Statement on the welfare of animals This article does not contain any studies with animals performed by any of the authors.

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