

# Determining accuracy of self-reported smoking status in pregnant women at maternity booking and second trimester serum screening

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## 1. Summary

**Objective:** To determine what impact the reliance on self-report of smoking status during pregnancy has on both the access to smoking cessation services and the accuracy of smoking prevalence figures in the pregnant population of Scotland.

**Design:** Retrospective, cross-sectional study of cotinine measurements in stored blood samples.

**Participants:** Random sample (n=3475) of all pregnant women in the West of Scotland who opted for second trimester prenatal screening for Down's syndrome and neural tube defects over a one year period.

**Main outcome measure:** Cotinine-validated smoking status by deprivation.

**Results:** Reliance on self-reported smoking status underestimates true smoking prevalence by 6 percentage points (30% by cotinine-validated v 24% by self-report,  $Z=5.59$ ,  $p<0.001$ ). Projected figures suggest that in Scotland over 2500 pregnant smokers go undetected per year, representing over 18% of all validated smokers. A greater proportion of women in the least deprived areas under-report their smoking (39%) compared to the most deprived areas (22%) but because smoking is far more common in the most deprived areas (n=706 (40%) in SIMD5 compared to n=142 (14%) in SIMD1), projected figures suggest that five times as many women in the most deprived areas (n=932) are undetected compared to that in the least deprived areas (n=203).

**Conclusion:** Reliance on self-report for identification significantly underestimates the number of pregnant smokers in Scotland, and underestimates the gap in smoking prevalence between the most and least deprived areas. Reliance on self-report results in a failure to detect over 2500 smokers each year who are therefore not offered smoking cessation services.

## 2. Aims

### Specialist smoking cessation services for pregnant women

To compare self-reported smoking at maternity booking with cotinine-validated smoking, and to determine if under-reporting varies by deprivation or location. In so doing to assess the proportion of pregnant smokers not known and therefore unable to be referred for specialist smoking cessation support during pregnancy.

### Scottish Government to set targets for smoking cessation services

To assess the accuracy of self-report of current smoking at maternity booking as a method for the Scottish Government to set targets. Adjustments to self-reported smoking levels may be needed to gauge the effectiveness of specialist smoking cessation services during pregnancy.

### Congenital anomaly screening programme during pregnancy

To assess the number of women who are true smokers, but are not known to be smokers at congenital anomaly screening at 15 weeks gestation. This is important because smoking changes the metabolism of alpha-fetoprotein, and serum markers of placental origin for example, human chorionic gonadotrophin. Such women may receive sub-optimal advice about amniocentesis to confirm a screening result indicating a possible congenital abnormality such as Down's syndrome.

## 3. Introduction

Although the risks of smoking during pregnancy for both mother and child are well established (Giovino, 2007), smoking during pregnancy is still common with smoking rates varying from 24% in Scotland in 2004 (Information Services Division (ISD) Scotland<sup>1</sup>) to 17% in England (Infant Feeding Survey 2005, Scientific Advisory Committee on Nutrition). Smoking prevalence generally increases with deprivation and this is certainly true of Scotland, where 40% of women in the most deprived areas smoke compared to 13% in the least deprived areas (Scottish Household Survey, 2007). Alarmingly, the gap in smoking prevalence between deprivation areas is larger in the pregnant population where smoking is reduced to 6% in the least deprived areas but remains at 40% in the most deprived (ISD Scotland).

Self-reported smoking is the method most commonly used in antenatal care to determine the smoking status of pregnant women. There is increasing evidence that self-reported smoking in pregnancy is an inaccurate method of identifying smokers (Russell et al, 2004); with studies suggesting up to one quarter of pregnant smokers are missed when self-report is relied upon (Lindqvist et al, 2002, Ford et al, 1997, Klebanoff et al, 2001). The accuracy of self report varies by the setting in which the questions are asked. Routinely collected data, such as in antenatal care, have often been less accurate than data collected in settings perceived as more neutral, such as the research interview (Patrick et al, 1994). With mounting social and medical pressure on women to quit smoking during pregnancy there is a greater likelihood that women will under report their smoking. Inaccurate self-report during pregnancy can affect the reliability of smoking prevalence figures, access to smoking cessation services and accurate assessment of risk for congenital anomalies.

National targets to improve the nation's health generally include targets to reduce smoking during pregnancy (NHS Scotland<sup>2</sup> and NHS England<sup>3</sup>), often with the explicit aim of reducing inequalities related to deprivation. The Scottish Government uses self-

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<sup>1</sup> <http://www.isd.scotland.org/isd/2911.html>

<sup>2</sup> <http://www.scotland.gov.uk/Publications/2003/10/18432/28416>

<sup>3</sup> <http://www.dh.gov.uk/en/index.htm>

reported smoking at maternity booking to construct targets and to measure the success of services in reaching such targets. These measures need to be robust in order to assess if services are achieving their aim and if money is being well spent in trying to achieve targets. If improvements in self-reported smoking rates are purely due to increased deception then money will not have been well spent and health gains will not be achieved. In order to commission effective smoking cessation services, the Scottish Government needs a robust measure of smoking during pregnancy.

It became clear from the findings of a project examining the provision of specialist smoking cessation services for pregnant women in Scotland (MacAskill et al, 2008) that self-reported smoking at the maternity booking visit is the measure usually used for entry to specialist cessation services during pregnancy in Scotland. Therefore, unless a woman reports being a current smoker at maternity booking she will not be referred to specialist smoking cessation services and will not receive appropriate support, putting her own health and the health of her unborn child at risk.

The assay cut-off for second trimester prenatal screening, used to identify congenital anomalies such as neural tube defects (spina bifida), is known to be affected by products of smoking; either interfering with or enhancing the breakdown of products such as alpha-feto protein by the placenta. This means that if a smoker inaccurately reports about current smoking when asked, she may be offered amniocentesis inappropriately or not be offered amniocentesis when this further investigation is indicated.

This study aimed to provide answers to all three health service issues.

Few studies have looked at the variation in accuracy of self-reported smoking by deprivation, although the education level of pregnant women has been shown to be related to the accuracy of self-report (Parna et al, 2005). We hypothesise that there is greater under-reporting in the most deprived areas, and that this further compounds existing health disparities during pregnancy (D'Souza et al, 2004). For example, greater under-reporting in the more deprived areas would further increase the gap in smoking prevalence between the most and least deprived areas and would disproportionately reduce access to smoking cessation services in the most deprived areas. The study compares routinely collected self-reported smoking status with cotinine-validated smoking to address three objectives: 1) to use the cotinine-validated smoking prevalence in the study population to estimate the true smoking prevalence in Scotland; 2) to identify the number of pregnant women in the study population with no access to smoking cessation services, and thereby to estimate the number of pregnant women in Scotland with no access to such services; and 3) to identify any variation in the level of under-reporting by deprivation and determine what impact this will have on existing health inequalities in pregnancy.

## **4. Methodology**

### **Sample**

The records of all women in the West of Scotland who opted for second trimester prenatal screening for Down's syndrome and neural tube defects between May 2003 and July 2004 (i.e. likely to result in a 2004 birth) were matched with their obstetric records (Scottish Morbidity Records (SMR02), ISD Scotland). The prenatal screening process involves taking a blood sample at 15-20 weeks of gestation. Maternal serum alphafetoprotein (AFP) and human chorionic gonadotrophin (hCG) were assayed in all samples. Excess serum was stored at -20°C. At the time of linking, 2004 was the most recent complete year in the SMR02 dataset. The SMR02 data contain self-reported smoking information collected by the midwife at the maternity booking appointment, usually carried out at 8-12 weeks gestation. Women were asked for their smoking status and were recorded as current, former or never smokers (or 'unknown' if the response was not recorded). Information on

baby's date of birth, mother's date of birth, maternal deprivation (SIMD: Scottish Index of Multiple Deprivation, which is based on postcode of residence), and date of booking was also available in SMR02. At second trimester maternal screening, usually carried out at 15-16 weeks gestation, the date of maternal screening and gestation are recorded, allowing the time between self-reported smoking and collection of blood to be calculated. The records were matched using the mother's Surname, Forename, Date of Birth and Hospital Number using probability matching techniques (Kendrick et al, 1993). After data linkage the database was returned for cotinine and statistical analysis with all patient identifiable information removed.

A simple random sample of linked records was selected for cotinine analysis from the births in the 2004 calendar year.

### **Sample size**

A sample size of 3200 allowed a 3% difference in the proportion of cotinine-confirmed and self-reported smoking to be detected in the sample as a whole and a difference of 3% to be detected when comparing the combined SIMD categories SIMD1&2 with the combined SIMD categories SIMD4&5. The *a priori* decision was made to compare SIMD1&2 with SIMD4&5, and not individual SIMD categories, to give greater power with the chosen sample size. To allow for technical difficulties (e.g. insufficient serum etc) 3550 women were randomly selected from the linked dataset for cotinine analysis.

### **Cotinine analysis**

As cotinine is derived only from nicotine metabolism, its measurement in maternal serum is a good indicator of recent nicotine exposure during pregnancy. Cotinine testing was carried out on thawed serum samples at the West of Scotland Regional Genetics Service laboratories using commercially available kits (Cozart STD Micro-Plate Cotinine EIA) and was blind to smoking status. Samples were assayed in singletons. Samples with cotinine levels between 10 and 30 ng/ml (close to the cut-off) were re-assayed and the mean of the two values taken as the final cotinine concentration. Cotinine levels above 13.7ng/ml were taken to indicate current smoking (Jarvis et al, 1987).

### **Statistical analysis**

The prevalence of cotinine-validated current smoking (cotinine > 13.7ng/ml) and self-reported current smoking were determined for the whole sample, and by deprivation category. The Z-test was used to determine statistical significance between cotinine-validated and self-reported smoking.

The number of cotinine-validated smokers not captured by self-report (referred to as *undetected smokers*) was determined by identifying women with never, former, or unknown smoking status who had cotinine values greater than 13.7ng/ml, for the whole sample and by SIMD category. This was usually presented as a proportion of the total number of smokers.

The degree to which the study sample represents the population of pregnant women in Scotland was determined by comparing the distribution of maternal age and deprivation (SIMD) in the study sample with the same data for the West of Scotland (the population from which the sample was drawn) and the population of pregnant women in Scotland as a whole. Cotinine-validated smoking prevalence in the study sample was used to estimate the true smoking prevalence in the population of pregnant women in Scotland, accounting for differences in the distribution of SIMD and/or maternal age using standardisation techniques. For example, the estimated number of cotinine-validated pregnant smokers in SIMD1 in Scotland would be calculated by multiplying the proportion of cotinine-validated smokers in SIMD1 in the sample by the number of pregnant women in SIMD1 in the Scottish pregnant population. Similarly, estimated cotinine-validated smokers would be calculated for the other four SIMD categories and summed to estimate the total number of

cotinine-validated smokers in the population of pregnant women in Scotland. Thus, differences in the distribution of SIMD between the study population and the Scottish population would be accounted for. The number of undetected pregnant smokers in Scotland was estimated, also accounting for differences in deprivation between the study population and the Scottish population. Statistical significance of differences between categorical variables was determined using Pearson’s Chi-squared test. The sensitivity of the finding to the level of cotinine used to denote a smoker was also explored.

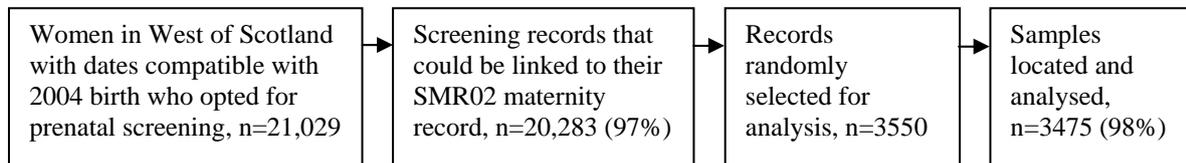
Because of the emphasis on service evaluation of this piece of work the multicentre research ethics committee [corec.org.uk] was approached. We were advised that “*Based on the information provided, we consider the intent of this as outlined in the outcome measures as service evaluation and it should not be managed as research. Therefore it does not require ethical review by an NHS Research Ethics Committee or approval from the NHS R&D office*”.

Data protection issues were discussed with the data protection officer at the University of Glasgow and a ‘Confidentiality Statement for use of NHS patient data’ was completed. ISD Scotland approved the study for linkage with their routinely collected data.

## 5. Results

Of the 21,029 second trimester screening records in the chosen time period 97% could be linked to their obstetric SMR02 data. Of these 3550 were randomly selected for cotinine analysis and 98% of samples were located and assayed (Figure 1). Seventy-one samples with cotinine values between 10-30ng/ml (close to the cut-off of 13.7ng/ml), were re-analysed.

**Figure 1: Selection of study sample**



Over half of the women in the sample reported being non-smokers, and just under one quarter reported being current smokers. For a sizable minority the self-reported smoking status was unknown (Table 1). The profiles of maternal age, baby’s birth weight and gestation at delivery were all typical of those seen in pregnant populations (Table 1). The lower socioeconomic groups were over-represented in this sample, as in the West of Scotland (Table 1).

**Table 1: Basic characteristics of the study population**

<b>Characteristic</b>		
Self-reported smoking status, n (%)		
Current smoker	839	( 24.1)
Former smoker	367	( 10.6)
Never smoker	1971	( 56.7)
Unknown	298	( 8.6)
Maternal age, mean (SD)	29.4	( 6.0)
Gestation, mean (SD)	39.21	( 2.0)
Birth weight, mean (SD)	3390.8	(600.0)
Scottish Index of Multiple Deprivation (SIMD), n (%)		
1	440	( 12.7)
2	545	( 15.7)
3	733	( 21.1)
4	730	( 21.0)
5	1023	(29.4)

## Under-reporting of smoking in the sampled population

Using smoking figures derived from self-report, 24% of pregnant women were recorded as smokers. This figure is significantly lower than the cotinine-validated estimate of 30% (Table 2). As expected, the prevalence of smoking in the more deprived categories was greater than in the more affluent categories, using either self-report and cotinine-validation. However, smoking prevalence based on self-report underestimates the difference between the most and least deprived categories.

**Table 2: Prevalence of self-reported smoking at booking appointment (8-12 weeks of gestation) and cotinine-validated smoking at approximately 15 weeks of gestation.**

	Smoking, n (%)		Difference (% points)	P value
	SR current smoking, n (%)	Cotinine-val. smoking, n (%)		
All sample	839 (24.1)	1046 (30.1)	6.0	Z=5.59, p<0.001
SIMD1&2	101 (10.3)	142 (14.4)	4.1	Z=2.81, p=0.005
SIMD4&5	587 (33.5)	706 (40.3)	6.8	Z=4.17, p<0.0001

Cotinine-validated smoking: cotinine>13.7ng/ml

Sixty-one women (7% of self-reported smokers) had cotinine levels below the cut-off and as such were classified as non-smokers. These women could have quit between booking and screening appointment, be light smokers or be subject to recording errors.

Using cotinine-validation as the gold standard, the sensitivity (i.e. the proportion of cotinine-validated smokers that are correctly identified by self-report) was 74.4%. This means that 268 (25.6%) of cotinine-validated smokers were not detected by self-report and consequently were not actively referred to smoking cessation services. In the more deprived categories the number of undetected smokers (i.e. cotinine-validated smokers not captured by self-report) was approximately three times greater than in the more affluent categories (Table 3). However, in the more deprived categories this represented a smaller proportion of the total number of cotinine-validated smokers than in the more affluent categories; it appears that proportionally more women in affluent areas inaccurately report their smoking than women in the deprived areas.

**Table 3: Cotinine-validated smokers not identified as smokers by self-report in the whole study sample and by deprivation category**

	Total n	Cotinine validated smokers, n	Undetected smokers: cotinine- validated smokers that are not captured by self-report <sup>1</sup> , n (%)	Undetected smokers as % of all pregnant women
All sample	3475	1046	268 (25.6)	7.7
SIMD1&2	985	142	56 (39.4)	5.7
SIMD4&5	1753	706	155 (22.0)	8.8

<sup>1</sup> (1-sensitivity)

With the aim of using these data to estimate the number of pregnant women in Scotland with no access to smoking cessation services, the degree to which this sample represents the West of Scotland (the population from which it was drawn) and the Scottish population, was determined (Table 4). There were no significant differences in maternal age between the sampled population and the population of pregnant women in the West of Scotland. There was a significant difference in the distribution across SIMD categories between the sample population and the West of Scotland, although this was driven by differences in only SIMD3. These data suggest that the sampled population is fairly representative of the population from which it was drawn. There were significant differences by SIMD between pregnant women in the sampled and Scotland populations.

**Table 4: Distribution of maternal age, SIMD and self-reported smoking in the study sample, population of pregnant women in West of Scotland and All Scotland.**

	Pregnant women							
	Study sample (2004)		West of Scotland (2005) <sup>1</sup>			All Scotland (2005)		
	N	(%)	N	(%)	p <sup>1</sup>	N	(%)	p <sup>2</sup>
<b>All</b>	3474	(100)	29977	(100)		52657	(100)	
<b>Mat Age<sup>2</sup></b>								
<20	274	(8)	2446	(8)		4146	(8)	
20-24	621	(18)	5705	(19)		9700	(18)	
25-29	874	(25)	7307	(24)		12866	(24)	
30-34	1032	(30)	8864	(30)		16035	(30)	
35-39	580	(17)	4807	(16)		8388	(16)	
40-44	91	(3)	825	(3)		1482	(3)	
45+	2	(0.1)	23	(0.1)		40	(0.1)	
					>0.2			>0.2
<b>SIMD<sup>2</sup></b>								
1	440	(13)	3756	(13)		9465	(18)	
2	545	(16)	4515	(15)		9922	(19)	
3	733	(21)	5482	(18)		9715	(19)	
4	730	(21)	6567	(22)		10546	(20)	
5	1023	(30)	9344	(31)		12344	(24)	
					<0.0			<0.001

Home births and births at non-NHS hospitals excluded from all populations

1. Made up of Argyll & Clyde, Ayrshire & Arran, Dumfries & Galloway, Forth Valley, Greater Glasgow, Highland, Lanarkshire, Western Isles

2. 1 record with missing maternal age, 4 records with missing SIMD

p: Pearson Chi squared test between the sampled population and the West of Scotland population (p1), and the whole of Scotland (p2)

## Projected smoking figures for Scotland

Accounting for the difference in the distribution of SIMD between the study population and the pregnant population in Scotland, the number of pregnant smokers in Scotland is estimated at 14,456 (27.8% of pregnant women). 2624 of these would be undetected by self-report, representing 18.2% of pregnant smokers or 5.0% of the total population of pregnant women in Scotland. The number of undetected smokers in the most deprived category (n=932, SIMD5) is nearly 5 times that in the least deprived category (n=203, SIMD1). Using the projected figures for Scotland, the prevalence of smoking in pregnancy in the most deprived quintile is 46% compared to 10% in the least deprived quintile.

The distribution of cotinine values produced two quite distinct populations, suggesting that the findings were robust to the chosen cotinine cut-off of 13.7ng/ml. Using this cut-off, 30.1% of women were classified as smokers. Using an alternative cut-off (Boyd et al, 1998) of 24ng/ml, produced a cotinine-validated smoking prevalence of 29.3% (n=1018), very similar to that produced using the 13.7ng/ml cut-off.

## 6. Discussion

Use of self-reported smoking status as the primary measure greatly underestimated the prevalence of smoking in pregnancy, with estimates of 24% using self-reported smoking and 30% when cotinine-validation was used. The projected true smoking prevalence for pregnant women in Scotland, taking into account the different deprivation profile of the study population, is 28%, notably higher than the 23% prevalence calculated from self-report (ISD Scotland). Projected figures suggest that in Scotland over 2500 of nearly 15,000 pregnant smokers per year are not identified as such and therefore are not actively referred to smoking cessation services.

Smoking also impacts on the interpretation of maternal serum marker concentrations in screening for congenital abnormalities e.g. Down's syndrome. If a correction factor is not applied for each marker, a lower proportion of women who smoke will be classified as having pregnancies at increased risk. This will reduce the detection rate for Down's syndrome in these women by 25% (Crossley et al, 2002).

There was a striking difference in smoking prevalence in pregnant women between deprivation categories reflecting that seen elsewhere (Owen et al, 2001). Comparing cotinine-validated and self-reported smoking by deprivation category shows that a greater *proportion* of the smokers in the more affluent areas go unreported when self-report is relied upon: nearly 40% of smokers in the more affluent categories under-reported their smoking status compared to only 22% in the more deprived categories. This possibly reflects a greater expectation that women from more affluent areas will quit during pregnancy. However, because of the larger *number* of smokers in the more deprived areas, in absolute terms, there are three times as many undetected smokers in the more deprived categories compared to the more affluent categories in the sample population. This results in a wider gap in the validated smoking prevalence between deprivation categories; projected cotinine-validated smoking figures for the whole of Scotland suggest there is gap of 36 percentage points (9.8% in SIMD1 v. 46.0% in SIMD5) between the most and least deprived quintiles, compared to a gap of only 31 percentage points (7.7% in SIMD1 v. 38.4 % in SIMD5 (ISD Scotland, 2005)) when self-report is used.

In this study sample, approximately one quarter of cotinine validated smokers were undetected. This is similar to that seen in some other studies of pregnant women in the UK (Jarvis et al, 1987) and elsewhere (Lindqvist et al, 2002, Ford et al, 1997, Klebanoff et al, 2001, England et al, 2007). Higher proportions of undetected smokers have also been seen: in one US study over 50% of cotinine-validated smokers were undetected by self-report (Webb et al, 2003). Higher proportions of undetected smokers (i.e. the proportion of true smokers that are unreported by self-report) are commonly seen in pregnant populations involved in cessation programs (Kendrick et al, 1995, Windsor et al, 1993), as might be expected. Other studies have reported lower proportion of undetected smokers (McDonald et al, 2005, Owen et al, 2001); some as low as 1% (George et al, 2006). The variation in the proportion of undetected smokers can be largely explained by the different populations and settings in which the self-reported smoking data were collected. The study by George *et al* (2006) that reported 1% undetected smokers was based on a Swedish population in which only 8% of the pregnant population were smokers, and the study reporting over 50% undetected smokers was based on a predominantly ethnic minority population in America with a smoking prevalence of 35%.

There is general agreement that serum cotinine is the gold standard for measuring smoking status because of its long half life and optimised sensitivity and specificity (Russell et al, 2004, Jarvis et al, 1987). There is little variation in the cotinine level used to define a pregnant smoker, with some studies using the lower cut-off of 10ng/ml (Klebanoff, 2001, McDonald et al, 2005) and others using values up to 24ng/ml (Lindqvist et al, 2002, Boyd et al, 1998). Cotinine analysis in the current study produced two distinct populations with little overlap; there were very few cotinine values close to the chosen cut-off of 13.7ng/ml (Jarvis et al, 1987, Hegaard et al, 2007). The results of this study are robust to the chosen cut-off of as sensitivity analysis showed.

The recording of self-reported smoking at the antenatal clinic booking visit usually took place around 3 weeks before the collection of blood used for cotinine analysis. It was possible, therefore, for women to quit and correctly report being a former smoker at the booking appointment but to return to smoking before the blood was collected. Therefore, it should be acknowledged that a number of unreported smokers may be former smokers who relapsed after giving their self-reported smoking status and not smokers deliberately under-reporting their smoking status. This distinction may not be so important for the objective of determining the true prevalence of smoking in the pregnant population. It may be that, within reason, the later in pregnancy that smoking is measured the more accurate it will be in terms of recording the true number of pregnant smokers - in that it will capture more of those that relapse (England et al, 2007). As a result, these data will slightly overestimate the number of smokers who were not offered smoking cessation services because at the time of asking the to-be relapsers were in fact not smoking, although they are arguably in need of such services.

Another weakness relates to differences between the study population and the Scottish population that have not been accounted for. Unaccounted for differences may introduce some inaccuracy in the projected figures for the Scottish population. Some errors in the recording of self-reported smoking status at the booking appointment will inevitably have happened. It is not likely that these recording errors would be systematic i.e. by deprivation or smoking status; therefore such errors are unlikely to bias these findings. The recording of self-reported smokers with a cotinine below the cut-off value as non-smokers may slightly underestimate the true prevalence of smokers.

For 9% of the routinely collected data used for this study there was no valid smoking status data, i.e. the self-reported smoking status was not asked or recorded, compounding the problem of inaccurate self-report data. Similar data quality problems have also been highlighted with routinely collected data in other regions (O’Gorman et al, 2008). The impact of poor quality routinely collected self-reported smoking data in pregnant women demonstrated in this study and elsewhere (O’Gorman et al, 2008) calls for better methods of routinely identifying smokers during pregnancy, namely biochemical validation of smoking status. The routine use of a biochemical validation of smoking during pregnancy would improve both the monitoring of targets to reduce smoking during pregnancy and the identification of women for smoking cessation services. Accurate smoking information also refines the estimation of women’s individual risks of Down’s syndrome by prenatal screening, since maternal smoking causes changes in the levels of the biochemical markers used in the screening test. Analyte levels can be corrected for maternal smoking status to provide a more accurate risk.

## **7. Conclusions**

In conclusion, reliance on self-report to measure smoking during pregnancy significantly underestimates the number of pregnant smokers in Scotland, with projected figures estimating that 18% of true smokers are unrecognised, which translates as over 2500 unrecognised pregnant smokers per year who will not be referred to smoking cessation services. The use of self-report also underestimates the gap in smoking prevalence between the most and least deprived areas. Overall, these figures call for the introduction of routine biochemical validation of smoking during antenatal care, especially when such routine data are used to inform policy and patient care.

## **8. Importance to NHS and possible implementation**

In approximately 10% of the routinely collected data used for this study there was no valid information on smoking status, compounding the problem of inaccurate self-report data. This complete lack of smoking data must be considered alongside the lack of accuracy of the routinely collected self-reported smoking data in pregnant women demonstrated in this study and elsewhere (O’Gorman et al, 2008). It calls for better methods of routinely identifying smoking during pregnancy, namely biochemical validation of smoking status. The routine use of a biochemical validation of smoking during pregnancy would improve the monitoring of targets to reduce smoking during pregnancy and identify all current pregnant smokers who can then be offered the specialist smoking cessation support they are entitled to expect and would benefit from.

## 9. Future research

Further research is required to find out patient and care worker views of routine biochemical estimation of smoker status at, for example, maternity booking where blood sampling already takes place routinely on all women. Cost and benefit needs to be assessed in a formal manner to be sure that extra money spent on identifying smokers is met with a gain in the number of women who quit smoking during pregnancy.

## 10. Research workers

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