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

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## ACKNOWLEDGEMENTS

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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). This study aimed to determine the impact that the reliance on self-reporting of smoking status during pregnancy has on both the access to smoking cessation services and the accuracy of smoking prevalence figures of pregnant women in Scotland.

## KEY FINDINGS

Accounting for the difference in the distribution of the Scottish Index of Multiple Deprivation (SIMD) categories between the study population and the pregnant population in Scotland, the number of pregnant smokers in Scotland is estimated at 14,456 (27.8%), compared to official figures of 23%, leaving over 2500 pregnant smokers undetected by self-report each year.

These pregnant smokers are unlikely to be referred to routinely available specialist smoking cessation services and represent 18.2% of all pregnant smokers in Scotland. Other studies in the UK, Scandinavia and New Zealand have shown similar deficiencies with the self-report measure of smoking during pregnancy.

The projected smoking figures for Scotland based on cotinine-validation show a gap of 36 percentage points (46.0% in SIMD5 v. 9.8% in SIMD1) between the most and least deprived quintiles, compared to a gap of 31 percentage points (38.4% in SIMD5 v. 7.7% in SIMD1) when the self-report measure is used.

In our sample 56/142 (39%) pregnant smokers in the least deprived quintiles (SIMD1&2) were not identified by self-report compared with 155/706 (22%) in the most deprived quintiles (SIMD4&5). A greater proportion of less deprived smokers go undetected, but they make up a smaller number of all undetected smokers.

10% of the routinely collected (SMR02) data, used by the Scottish Government for target setting for smoking cessation services, contains no information on smoker status either because women are not asked about smoking/they choose not to answer, or because of known deficiencies in data management systems. This exacerbates maternal under-reporting and affects both target setting and provision of specialist smoking cessation services to pregnant women.

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. In the 5% of women who choose not to disclose their smoking habit prior to congenital abnormality screening, the correction factor will not be applied resulting in the detection rate for Down's syndrome being reduced by 25%.

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# 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 of 24% in Scotland in 2004 (Information Services Division (ISD) Scotland[1]) and 17% in England (Infant Feeding Survey 2005, Scientific Advisory Committee on Nutrition). Smoking prevalence during pregnancy is 6% in the least deprived areas and 40% in the most deprived areas (ISD Scotland).

Self-reported smoking used to identify pregnant smokers is an inaccurate method (Russell et al, 2004). Studies suggest up to one quarter of pregnant smokers are missed (Lindqvist et al, 2002, Ford et al, 1997, Klebanoff et al, 2001). With mounting pressure to quit smoking during pregnancy there is a greater likelihood of under-reporting.

National targets to improve the nation's health generally include targets to reduce smoking during pregnancy (NHS Scotland[2] and NHS England[3]), often with the explicit aim of reducing inequalities related to deprivation. The Scottish Government uses self-reported smoking at maternity booking to construct targets and to measure the success of services in reaching such targets. If improvements in self-reported smoking rates are purely due to increased under-reporting then money will not have been well spent and health gains will not be achieved.

It became clear from a recent project that mapped the provision of specialist smoking cessation services for pregnant women in Scotland (MacAskill et al, 2008) that self-report at maternity booking is used as a trigger for entry to specialist cessation services. Therefore, unless a woman reports being a current smoker she will not be referred 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 to identify congenital anomalies is known to be affected by products of smoking. This means that if a smoker does not report current smoking she may be offered sub-optimal advice about further investigation such as amniocentesis.

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[1] http://www.isdscotland.org/isd/2911.html
[2] http://www.scotland.gov.uk/Publications/2003/10/18432/28416
[3] http://www.dh.gov.uk/en/index.htm

## AIMS AND PURPOSE

### 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 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 smokers, but are not known to be smokers at congenital anomaly screening at 15 weeks gestation. Smoking changes the metabolism of alpha-fetoprotein. Women who are not known to be smokers may receive sub-optimal advice about amniocentesis to confirm an abnormal alpha-fetoprotein result indicating a possible congenital abnormality such as spina bifida.

## APPROACH AND METHODS

### Sample

The records of all women in the West of Scotland with a screening date compatible with a 2004 birth and who opted for second trimester prenatal serum screening for Down's syndrome and neural tube defects were matched with their obstetric records (Scottish Morbidity Records (SMR02), ISD Scotland) using probability matching techniques. SMR02 includes self-reported smoking from maternity booking carried out at 8-12 weeks gestation. Women are asked for their smoking status and are recorded as current, former or never smokers (or 'unknown' if the response is not recorded). Identifiable information was removed and a simple random sample selected for cotinine analysis from births in 2004.

### 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.

## Cotinine analysis

Cotinine testing was carried out on thawed serum samples at the West of Scotland Regional Genetics Service laboratories. 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 of 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 self-reported smoking status who had cotinine values greater than 13.7ng/ml, for the whole sample and by SIMD category. 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 West of Scotland (the population from which the sample was drawn) and the population of pregnant women in Scotland. 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. Statistical significance of differences between categorical variables was determined using Pearson's Chi-squared test.

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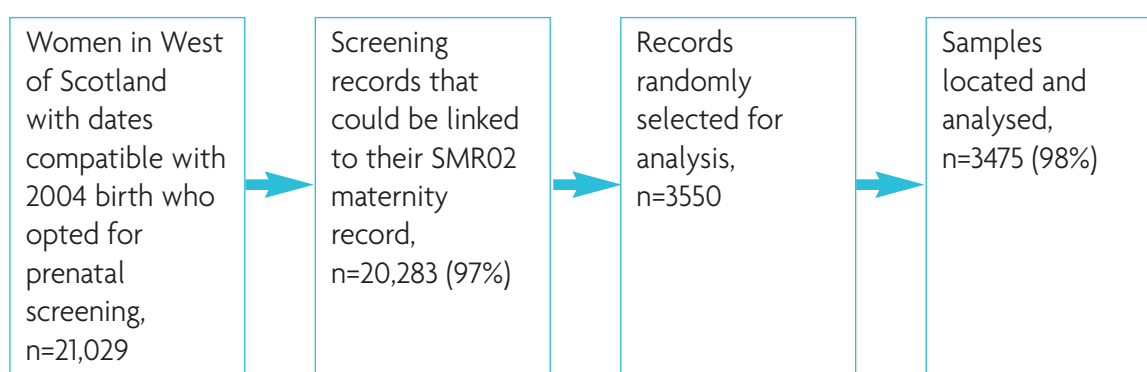
> *"Based on the information provided, we consider the intent of this as outlined in the outcome measures as service evaluation and it should not be managed as research. Therefore it does not require ethical review by a NHS Research Ethics Committee or approval from the NHS R&D office".*

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.

## FINDINGS AND CONCLUSIONS

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 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

| Women in West of Scotland with dates compatible with 2004 birth who opted for prenatal screening, n=21,029 | → | Screening records that could be linked to their SMR02 maternity record, n=20,283 (97%) | → | Records randomly selected for analysis, n=3550 | → | Samples located and analysed, n=3475 (98%) |

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. The profile of maternal age, baby's birth weight and gestation at delivery were all typical of that seen in pregnant populations. The lower socio-economic groups were over-represented in our sample, as in the West of Scotland.

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

| CHARACTERISTIC | | |
|---|---|---|
| **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). The prevalence of smoking among women from more deprived areas was greater than for women from the more affluent, whether using self-report or cotinine validation. However, self-reported smoking prevalence underestimates the difference between the most and least deprived categories.

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

| | SMOKING, n (%) | | Difference (% points) | P value |
|---|---|---|---|---|
| | Self-reported 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 (7%) self-reported smokers had cotinine levels below the cut-off and as such were re-classified as non-smokers. These women could have quit between booking and screening appointment, be light smokers or be subject to recording errors.

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.

The sensitivity (i.e. the proportion of cotinine-validated smokers that are correctly identified by self-report) was 74.4%. Two hundred and sixty eight (25.6%) cotinine-validated smokers were not detected by self-report and were therefore not referred to smoking cessation services. In the more deprived communities the number of undetected smokers was three times that in the more affluent (Table 3). However under-reporting in the more deprived communities represented a smaller proportion of the total number of cotinine-validated smokers than in the more affluent. It appears that proportionally more women in affluent areas inaccurately report their smoking habit.

### 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[1], n (%) | Percentage 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 |

[1] (1 - sensitivity)

### 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%), and 2624 of these would be undetected by self-report; representing 18.2% of all 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 the most deprived quintile is 46% compared to 10% in the least deprived.

## RECOMMENDATIONS

Reliance on self-reported smoking status to measure smoking during pregnancy significantly underestimates the number of pregnant smokers in Scotland, with projected figures estimating that 18.2% of smokers are unrecognised. This translates as over 2500 pregnant smokers per year who will not be referred to specialist smoking cessation services during pregnancy. The routine use of biochemical validation of smoking during pregnancy would improve both the identification of women who can be offered specialist smoking cessation services and the monitoring of targets to reduce smoking during pregnancy. Accurate smoking information also refines the estimation, by prenatal screening, of women's individual risks of having a baby with Down's syndrome since maternal smoking causes changes in the levels of the biochemical markers. Routine carbon monoxide breath testing of all pregnant women at maternity booking could identify 75% of smokers who do not provide correct self-report information at maternity booking (Usmani et al, 2008). This approach should be compared with the cost-effectiveness of screening all maternity booking blood samples for cotinine.

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