Decreasing Smoking Prevalence during Pregnancy in Sweden: The Effect on Small-for-Gestational-Age Births

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ABSTRACT

Objectives. This study examined whether recent changes in smoking prevalence among pregnant women have affected risks of small-for-gestational-age births.

Methods. With data for all live single births in Sweden from 1983 through 1992 (n = 1 048 139), odds ratios [ORs] and attributable risks of small-for-gestational-age births were calculated for 1983 through 1985, 1986 through 1989, and 1990 through 1992.

Results. Daily smoking decreased from 29.4% in 1983 to 21.8% in 1992. For the three time periods, the odds ratios of small-for-gestational-age births by maternal smoking were almost identical: 1–9 cigarettes/day OR = 2.1 or 2.2; for ≥10 cigarettes/day, OR = 2.8. The attributable risk of smoking for small-for-gestational-age births declined from 26.2% in 1983 through 1985 to 20.9% in 1990 through 1992.

Conclusions. The findings point to a true decrease in tobacco exposure during pregnancy and a reduction in the attributable risk for small-for-gestational-age births. (*Am J Public Health.* 1997;87:410–413)

Introduction

Smoking during pregnancy reduces fetal growth in a dose-dependent manner; this relationship is generally accepted as causal today.[1–3] Because of the high prevalence of smoking in Sweden today, it must be considered the most important preventable risk factor for fetal growth retardation.

Many industrialized countries have reported a general decline in the prevalence of smoking.[4] We are, however, unaware of any previous population-based study of whether changes in smoking habits among pregnant women are reflected in changes in the attributable risk for-small-for-gestational-age births. The aims of our investigation were to report the smoking prevalence in early pregnancy in Sweden over a 10-year period and to investigate whether possible changes in smoking prevalence over time have had any impact on the smoking-related risks of fetal growth retardation.

Methods

Description of Sample

The study, based on the Swedish Birth Register from 1983 through 1992, was restricted to live single births to mothers aged 15 through 44 (n = 1 048 139). This total excludes 0.6% with missing information on birthweight or gestational age.

The Swedish Birth Register, run by the National Board of Health and Welfare, receives information on births from all hospitals. The information is prospectively collected from each woman, starting with the first antenatal visit and ending when the woman and infant are discharged from hospital after delivery. Each year, all births are validated against a population-based register held by Statistics Sweden. The cross-checking is done with the use of the mother's unique personal identification number. The Swedish Birth Register covers more than 99% of all births in Sweden.[5]

Data Analyses

The effect of maternal smoking on the risk of small-for-gestational-age births and low-birthweight births (defined as < 2500 grams) was estimated by multiple logistic regression analysis.[6] Odds ratios were calculated to approximate the relative risk, and the attributable risk was calculated to estimate the small-for-gestational-age and low-birthweight rates that were due to smoking. Separate analyses were done for three time periods: 1983 through 1985, 1986 through 1989, and 1990 through 1992, with the use of SAS software.[7]

Small for gestational age was defined as < −2 SDs below the mean birthweight for the gestational age according to the currently used Swedish birthweight curve.[8] Gestational age was assessed by ultrasonic measurements in 45% of the births and estimated from the date of the last menstrual period in 55%. In Sweden, more than 95% of the pregnant population attend antenatal care before the 15th gestational week.[9]

The following independent variables were categorized and treated as dummy variables in the analyses: maternal age,

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TABLE 1—Number of Births and Small-for-Gestational-Age (SGA) Rates, by Birth and Maternal Characteristics: Live Single Births in Sweden 1983 through 1992

	All Live Single Births %	SGA Births, %
Infant birth year		
1983	8.4	3.4
1984	8.5	2.9
1985	9.1	3.2
1986	9.4	3.4
1987	9.7	3.2
1988	10.3	3.0
1989	10.7	3.0
1990	11.3	3.0
1991	11.4	3.0
1992	11.3	2.8
Maternal age, yrs		
15–19	3.0	4.1
20–24	23.6	3.3
25–29	37.0	2.8
30–34	25.0	2.9
35–39	9.7	3.3
40–44	1.7	3.9
Parity		
0	41.9	4.2
1	35.1	2.2
2	16.1	2.2
3+	6.6	2.4
Missing	0.2	5.8
Nordic citizenship		
No	6.1	4.0
Yes	93.9	3.0
Cigarette smoking		
Nonsmoker	67.9	2.3
1–9 cig/day	15.5	4.6
10 cig/day	9.8	5.7
Missing	6.7	3.6
Total	100.0	3.1

Note. Birthweight for gestational age < −2 SDs. For all live single births, n = 1 048 139; for SGA births, n = 32 090.

TABLE 2—Smoking during Pregnancy, Sweden 1983 through 1992

Birth Year	1–9 Cig/Day, %	≥10 Cig/Day, %	Nonsmoker, %	Information on Smoking Missing, %
1983	17.8	11.6	64.5	6.1
1984	17.2	11.1	65.4	6.3
1985	17.0	10.8	64.4	7.8
1986	17.0	10.6	65.3	7.0
1987	16.3	10.0	66.9	6.9
1988	15.2	9.7	67.7	7.4
1989	14.6	9.2	68.2	7.9
1990	14.3	8.6	68.2	8.9
1991	14.2	8.8	71.9	5.2
1992	13.3	8.5	73.1	5.1
Total	15.5	9.8	67.8	6.9

parity, citizenship, and maternal smoking habits. Maternal age at delivery was classified into 5-year age groups, except for the reference group (20 through 29 years). Parity was classified into nulliparous (no previous births), one or two previous births (reference group), and at least three previous births. Information about citizenship was dichotomized into citizens of one of the Nordic countries (i.e., Sweden, Denmark, Finland, Iceland, and Norway) and citizens of another country. Self-reported information about maternal smoking habits was collected at the first antenatal visit and was used to classify women as nonsmokers (i.e., nondaily smoker, the reference group), moderate smokers (1 through 9 cigarettes per day), and heavy smokers (at least 10 cigarettes per day).

Results

During the study period (1983 through 1992), the annual number of births ranged from 88 000 through 120 000, and the annual small-for-gestational-age rates ranged from 2.8% through 3.4% (unadjusted rates; Table 1). Smoking increased the small-for-gestational-age rate in a dose-dependent manner; small-for-gestational-age rates were also relatively high for other groups, such as the lowest and highest age groups and nulliparous women.

The prevalence of self-reported smoking in early pregnancy decreased during the study period: in 1983, 29.4% of the pregnant population were daily smokers, while in 1992, 21.8% were daily smokers (Table 2). The prevalence of moderate as well as heavy smoking decreased. The decrease in the prevalence of smoking was not due to varying prevalence rates of women with smoking information missing.

The prevalence of smoking was consistently highest among young women, but so too was the largest reduction in prevalence (Figure 1). In 1983, 40% of nulliparas aged 15 through 24 were recorded as daily smokers, while the corresponding figure for 1992 was 27%. For parous women of the same age, the reduction in smoking prevalence was very similar.

The odds ratios for small-for-gestational-age births by maternal smoking habits for the three time periods studied were almost identical: the odds ratios for moderate smoking were 2.1 or 2.2; while the odds ratios for heavy smoking were 2.8 (Table 3). From the viewpoint of primary prevention, it is of interest that although smoking prevalence rates decreased, the smoking-related odds ratios for small-for-gestational-age births were unchanged. We therefore calculated the risk of small-for-gestational-age births attributable to smoking for the three time periods. This risk measure was used to estimate how much the rates of small-for-gestational-age births would be reduced if smoking were eliminated and the women who gave up smoking faced the same risks of giving birth to small-for-gestational-age infants as their nonsmoking counterparts. In 1983 through 1985, the risk of small-for-gestational-age births attributable to smoking was 26.2%; it was therefore estimated that small-for-gestational-age births would be reduced by 26.2% if smoking could be eliminated from the pregnant population. In 1990 through 1992, the corresponding reduction in rates of small-for-gestational-age births amounted to 20.9%. For the years 1990 through 1992, a reduction of the attributable risk of smoking from 26.2% in 1983 through 1985 to 20.9% for 1990 through 1992 corresponds to 737 fewer small-for-gestational-age infants (from 11 048 to 10 311 small-for-gestational-age infants).

As methods used to estimate gestational age probably changed during the study period, the effect of smoking on low birthweight was also analyzed. From 1983 through 1992, the overall rate of low birthweight was 3.6%, and the odds ratios of low birthweight associated with moderate and heavy smoking was 1.7 (95% confidence interval [CI] = 1.7, 1.8) and 2.2 (95% CI = 2.2, 2.3), respectively. Within the three time periods, the odds ratios of low birthweight associated with moderate smoking ranged from 1.7 to 1.8, and the odds ratios associated with heavy smoking ranged from 2.2 to 2.4. It was

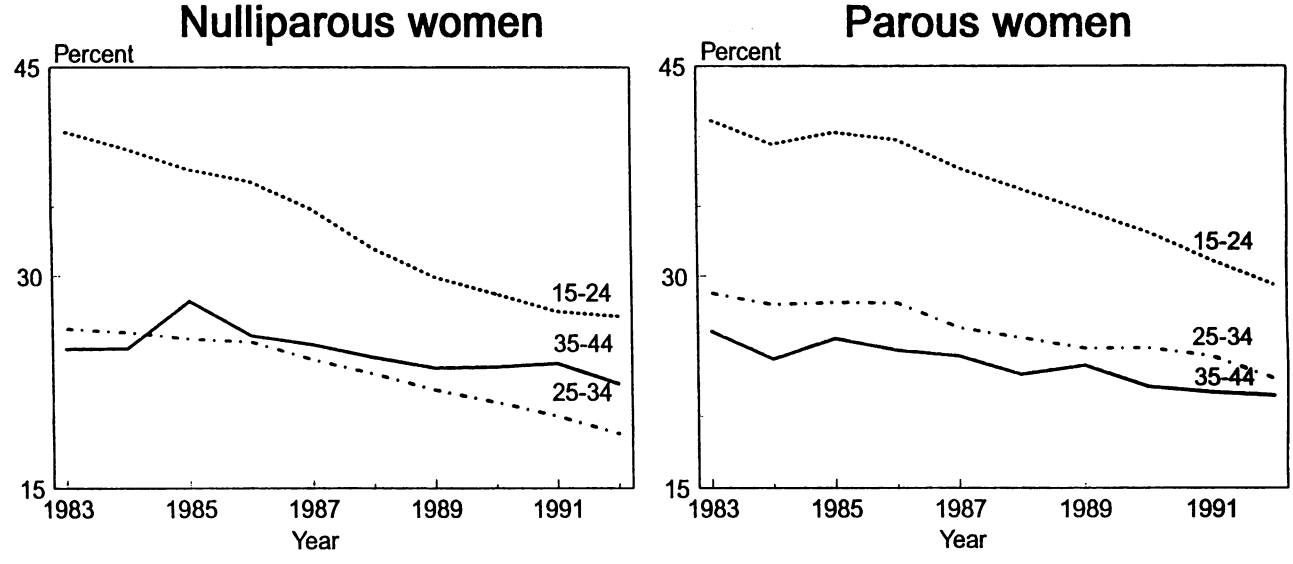

FIGURE 1—Smoking prevalence rates during pregnancy, by maternal age and parity, Sweden 1983 through 1992.

TABLE 3—Adjusted Odds Ratios and Population Attributable Risks of Small-for-Gestational-Age Births for Smoking during Pregnancy in Sweden 1983 through 1992 (n = 1 048 139 Single Live Births)

Birth Year	Odds Ratio (95% Confidence Interval) 1–9 Cig/Day	Odds Ratio (95% Confidence Interval) ≥10 Cig/Day	Attributable Risk, %
1983–1985	2.1 (2.0, 2.2)	2.8 (2.6, 3.0)	26.2
1986–1989	2.2 (2.1, 2.3)	2.8 (2.6, 2.9)	24.2
1990–1992	2.1 (2.0, 2.2)	2.8 (2.6, 2.9)	20.9

Note. These results are based on a logistic regression model, and the estimates are adjusted for the effects of maternal age, parity, and citizenship. Birthweight for gestational age < −2 SDs.

estimated that the risk of low birthweight attributable to smoking amounted to 20.1% in 1983 through 1985, and 15.1% in 1990 through 1992.

Discussion

A reduction in the prevalence of smoking during pregnancy does not necessarily reduce the smoking-related attributable risks of adverse pregnancy outcomes by the same amount. Owing to the strong addictive features of cigarette smoking, heavy smokers are generally less likely than light or moderate smokers to quit, even during pregnancy.[10–12] In Sweden, the overall smoking prevalence in the pregnant population has been reduced by almost 8 percentage points (from 29.4% to 21.8%) during the last decade, and the risk of small-for-gestational-age births attributable to smoking decreased by more than 5% (from 26.2% to 20.9%). This corresponds to a reduction in smoking prevalence by one fourth and a reduction by one fifth in the risk of small-for-gestational-age births attributable to smoking.

We preferred to use small-for-gestational-age births when estimating the possible gains in pregnancy outcomes with reduced smoking prevalence. The causal relationship between smoking and reduced fetal growth has been better established[1–3] than the role of smoking in such pregnancy outcomes as abruptio placenta and late fetal death.[13–15] Furthermore, the current definition of small-for-gestational-age births (< −2 SDs) provided us with outcome rates around 3%, which was high enough to highlight possible gains in pregnancy outcome related to reduced smoking prevalence.

The rates of small-for-gestational-age births may be influenced by the method used to estimate gestational age.[16] Ultrasonic measurement was reported to be the diagnostic tool to estimate gestational age in 45% of cases, but was probably used more often. During the study period, ultrasonic measurements became increasingly widespread, and today, ultrasound is used to estimate gestational age for practically all pregnancies in Sweden. However, it is unlikely that the method of estimating gestational age differed among smoking groups. Moreover, during the three time periods, the relative risks of smoking related to low birthweight was stable, while the risk of low birthweight attributable to smoking was reduced by one fourth (from 20% to 15%). Thus, it is unlikely that changes in routines in estimating gestational age during the study period influenced the results obtained.

The observational study design implies limitations in causation-related conclusions. Smokers differ from nonsmokers in various respects, and our study was able to control only for the effect of maternal age, parity, and citizenship. Brooke et al.[1] examined the effect of more than 40 socioeconomic and psychosocial-stress indicators on birthweight, adjusted for maternal height, parity, baby's gender, and gestational age. In this middle-class population, smoking was the most impor-

tant single factor, and other factors had little or no effect. Similar results have been obtained in a Swedish study.[17] The homogeneity of the Swedish pregnant population and the general use of standardized antenatal and obstetrical care imply a limited influence of possible confounders.

Our information on smoking habits was based on self-reported smoking habits in early pregnancy. When a pregnant woman registers for antenatal care, she spends about 1 hour with a midwife, who stresses the importance of maternal lifestyle factors for pregnancy outcome. Questions about smoking habits are asked in a standardized manner, and women are stratified into three groups: nondaily smoking, moderate smoking, (1 through 9 cigarettes per day), and heavy smoking (at least 10 cigarettes per day). Self-reported smoking habits may, however, underestimate the true prevalence of smoking.[18] The antismoking attitude has increased during the last decade, and this may be especially true for smoking during pregnancy. Thus, the validity of self-reported smoking prevalence may have decreased over time, causing falsely low smoking rates during the last years. In our investigation, the proportions of moderate and heavy smokers were essentially the same over time.

The stratification of smoking habits into three groups is a very crude measure of exposure to tobacco smoke. One may only speculate whether exposure to tobacco smoke among the reported smokers increased or decreased during the study period. For example, the low-nicotine cigarettes have become increasingly popular; however, this may be compensated for by a higher consumption of cigarettes or changes in smoking behavior, such as deeper inhalation. Even though not many women quit smoking after registering for antenatal care,[10,19,20] some may have modified their smoking habits after registration. Yet despite a decrease in smoking prevalence, we observed practically identical relative risks over the three time periods studied. Thus, it is very likely that the reported decrease in smoking prevalence reflects a decrease in exposure to tobacco smoke, leading to a decrease in a smoking-related pregnancy outcome such as small-for-gestational-age births.

General smoking-prevention efforts and smoking interventions during pregnancy are both aimed at reducing smoking prevalence during pregnancy. The results obtained highlight the importance of general smoking-prevention efforts: the prevalence of smoking at the time of registration for antenatal care was equally reduced among nulliparous and parous women. Moreover, the reduction was largest among young women. Young nonsmoking women are more likely than older nonsmoking women to have been never smokers. Our results are consistent with the results obtained in a study from Missouri, where smoking prevalence during pregnancy was reduced from 31.3% in 1978 to 26.5% in 1988; there, too, the decrease was largest among young women.[21]

The general decline in smoking prevalence, more pronounced among men than among women, has been attributed primarily to various public health actions.[4] There is substantial evidence that public health campaigns, anti-tobacco legislation, and the cost of cigarettes are effective tools in reducing the prevalence of smoking.[22,23] If the experience from such successful efforts is used effectively, the rate of smoking prevalence may continue to decline among pregnant women.

Intervention studies during pregnancy have generally achieved modest rates of smoking cessation although quit rates around 30% in the intervention group have been reported.[24] The most effective intervention studies require substantial effort and funds and can hardly be integrated into routine antenatal care. Our study presents substantial evidence that the prevalence of smoking among pregnant women and the smoking-related attributable risk of small-for-gestational-age births have decreased dramatically during the last decade. It is very likely that these improvements in maternal and child health can be attributed to primary smoking-prevention work in society. □

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