

Smoking among pregnant women: epidemiology and health consequences

Kjell Haug

Division for Social Medicine, Department of Public Health and Primary Health Care, University of Bergen

ABSTRACT

Smoking during pregnancy is an important, preventable risk factor for late fetal death and even SIDS. There is a strong dose-response relationship between cigarette smoking and spontaneous abortion, reduction in birth weight, abruptio placentae, placenta previa and bleeding during pregnancy. Ten years ago, the prevalence of smoking among Norwegian pregnant women was between 35 and 40%. During the last 8 years there has been a dramatic change and in 1995 the prevalence seems to be around 20%.

THE EPIDEMIOLOGY OF SMOKING IN PREGNANCY

In Norway 89% of all women are pregnant at least once up to the age of 35 years (1). During the last ten years we have seen a constantly increasing interest for smoking cessation strategies among pregnant women in Norway. The reasons are the following:

- in the middle of the 1980's pregnant women in Norway were among those who had the highest smoking prevalence in the world (Table 1),
- only a small proportion of daily smoking women stopped smoking on their own when they got pregnant (5),
- a majority of daily-smoking pregnant women want to stop smoking (10),
- smoking during pregnancy is probably the single most important threat to a successful pregnancy outcome (2,11),
- a doubling of the risk for a health problem late in life may not prevent many women from continuing to smoke, but a doubling of the risk for early miscarriage probably will (12),
- women as a group never have more frequent contact with the health care system than during pregnancy.

In 1993, the Norwegian Ministry of Health and Social Affairs declared that the prevalence of smoking among pregnant women ought to be 20% or less within the year 1996. This was an ambitious aim, but today it seems to be realistic. In Trondheim (Norway), the smoking prevalence among pregnant women who came to routine ultrasound examination at 18 weeks

of pregnancy decreased from 34% in 1987 to 22% in 1994 (9). A recent multicenter study from Tromsø, Trondheim, Bergen, Lillehammer and Oslo indicates that the results from Trondheim can be generalized to the whole country (unpublished data from 1995, publication in preparation).

Half of pregnant teenagers in Norway and Sweden are daily smokers compared with 25-29% of mothers aged 25 or more (10,11). Adolescent mothers are at risk from biological, social, educational, and economic factors associated with childbearing at a young age. In addition, their infants also risk the complications associated with maternal smoking (17).

Smoking during pregnancy is more common among women whose parents have been smokers, among those whose husbands are smokers, among women who smoked more than 10 cigarettes per day before they became pregnant, and women who started to smoke at an early age (2,10,16). High parity, not living with infant's father, and daily passive smoking at home are also associated with a significantly increased rate for continued smoking during pregnancy, whereas a high level of education and a high age at the onset of smoking decrease the rate (6).

The smoking cessation rate during pregnancy varies considerably between different regions throughout the world. Reports from the USA indicate that more than one third of women smoking before pregnancy quit smoking during pregnancy (13). This is comparable with the most recent results from Norway. In the United States, the smoking prevalence rate among pregnant women and adult women in general has decreased 0.3-0.5% per year since 1969 (14). A remarkable change has occurred among black teenagers

Table 1. Smoking habits in early pregnancy in different studies.

Region	Year	Ref.	Number	Daily smoking at conception	Daily smoking at 6-17 gestational week
Sweden	1986	2	2051	33%	25%
United Kingdom	1987	3	3275	38%	31%
CGDUP*	1987	4	14753	26%	17%
Norway	1987	5	482	43%	35%
Sweden	1987	6	3678	32%	
United States	1990	7			25%
Norway	1989	8	1908		30%
Norway	1987	10	2379	46%	39%
Norway	1987-1994	9	21368		34%, 33%, 31%, 28%, 25%, 26%, 23%, 22%.

* Collaborative Group on Drug Use in Pregnancy, 22 countries.

in Missouri, whose smoking-during-pregnancy rate decreased from 36% in 1978 to 7% in 1990 (15).

The relapse rates in women who quit in pregnancy appear to be somewhat lower than those among quitters in the general population. Fingerhut et al reported a one-year postpartum relapse rate of 66% among women who had quit in early pregnancy compared with a one-year relapse rate of 80% in the general population (18). In a German study, smoking cessation rates resulting in long-term abstinence were about three times higher during the year after childbirth and the year before than in other years (19). However, childbirth led to long-term abstinence from smoking in only a small minority of smoking mothers and fathers (19).

EFFECTS OF NICOTINE AND CARBON MONOXIDE

Nicotine rapidly crosses the placenta to affect the fetus (20). Fetal hypertension due to blood vessel contraction and bradycardia due to stimulation of the carotid and aortic bodies has been demonstrated in rhesus monkeys (21). Placental intervillous blood flow decreases with as much as one fourth during smoking (22) and the fetal heart rate increases after smoking one cigarette (23). Although CO diffuses across the placenta relatively slowly, the fetal CO-Hgb levels reflects that of the mother and is 10% *higher* than maternal levels (24).

Polycyclic aromatic hydrocarbons (PAHs, known as mutagens and carcinogens), such as benzopyrene, reach the placenta and fetus. The placental concentra-

tion is highly correlated with the number of cigarettes smoked (25).

BIRTH WEIGHT

Babies born to women who have smoked during pregnancy are, on average, 170 grams (5%) lighter than babies born to non-smoking women (8,26-29). There is a dose-response relationship; the more the woman smokes during pregnancy, the greater the reduction in birth weight (27). Mothers who smoke around the time of conception, nearly double their risk of small-for-gestational age (SGA) birth (30). In an American study, the risk of having a low-birth-weight baby under 2,500 grams was 49 per thousand for non-smokers, 76 per thousand for smokers of less than twenty cigarettes per day and 114 per thousand for smokers of twenty cigarettes or more per day (31). Women older than 30 years who smoke, enter pregnancy underweight and have a previous low-birthweight delivery are at greatest risk of delivering a SGA baby (30,32). Smokers' babies are smaller than non-smokers' in all dimensions: length and head, chest and shoulder circumference (33,34). However, if a woman gives up smoking within her fourth month in pregnancy, her risk of delivering a SGA baby is almost similar to that of non-smokers (35).

ABORTION AND PERINATAL MORTALITY

Some studies have demonstrated a strong dose-response relationship between maternal cigarette

smoking and the risk of spontaneous abortion (36). The increased risk for spontaneous abortion ranges from 1.1 to 1.8 (37,38). The underlying mechanism seems to be due to complications of pregnancy rather than to any fetal abnormality (39). The relative increase in risk associated with maternal smoking is highest (1.7 times that of non-smokers) at the youngest maternal ages (40).

A strong dose-dependent relationship between cigarette smoking and abruptio placentae, placenta previa, bleeding during pregnancy, and risk of perinatal mortality has also been demonstrated (11,41,42).

Smoking seems to be the most important preventable risk factor for late fetal death (11). Smokers aged under 35 face a relative risk of late fetal death ranging from 1.1 to 1.6, while the risk is doubled if the mother is aged 35 years or more and smoke (11).

SUDDEN INFANT DEATH SYNDROME (SIDS)

In a prospective, Swedish study based on 279,938 infants, elevated relative risks of SIDS were associated with low maternal age, multiparity, maternal smoking, and male infants (43). Smoking doubled the risk and a clear dose-response relationship with maternal smoking was observed after controlling for sociodemographic variables. Maternal smoking also seemed to influence the time of death, as infants of smokers died at an earlier age. The authors conclude that smoking may be the single most important preventable risk factor for SIDS in Sweden.

CHILDHOOD CANCER

Benzopyrene from tobacco smoke is known to pass the placenta (25). The relationship of maternal smoking during pregnancy to the incidence of cancers in children has been investigated. A dose-response relationship has been found between the number of cigarettes smoked per day by the mother during pregnancy and cancer risk of the offspring (44). When all tumours were considered, the cancer risk was 50% higher for the most exposed group than for the controls. The risk was doubled for non-Hodgkin lymphoma, acute lymphoblastic leukaemia, and Wilms' tumour.

SMOKING AND LACTATION

There is a negative correlation between smoking and duration of lactation with a dose-response effect of the number of cigarettes smoked (45). The same conclusion was made in two other recent studies (46,47).

SMOKING INTERVENTION AMONG PREGNANT WOMEN

Brief counselling and improved access to educational materials allows a low-cost, pregnancy-specific self-help smoking cessation programme to be integrated easily into routine prenatal care (48). Such programmes have proved health-care cost saving (49,50).

Pregnant smokers are more likely to stop smoking if they are provided with systematic interventions (7). In a Norwegian intervention study among pregnant women the point prevalence abstinence rate one year after delivery (18 months after the initial intervention) was 15% and 7% in the intervention and the control group, respectively (51). In an American intervention study, which was rather similar to the Norwegian study, 28% in the intervention group and 16% in the control group reported quitting at 32- to 36-week visits. At the postpartum visit, 9% and 10% were nonsmokers, respectively (52).

In another Norwegian study 150 pregnant smokers were assigned to three different smoking intervention programmes (53). Group 1 participated in a smoking cessation programme offering several self-help methods; group 2 attended a doctor's information meeting at the hospital; and group 3 received a pamphlet on the deleterious effects of smoking in pregnancy. Twelve months later, 16%, 6% and 8%, respectively, remained abstinent in the three groups. In another intervention study, the proportion who had ceased smoking early in pregnancy, late in pregnancy and at delivery was 9%, 11.8% and 10.6% in the intervention group versus 2.6%, 4.3% and 4.7% (NS) in the control group (54).

In a follow-up study of pregnant women unwilling to quit smoking, the quitting rate of the negatively motivated women proved similar to that obtained in a stop-smoking intervention protocol used among positively motivated women who also had received additional information (55).

Training family practitioners to provide smoking cessation advice during pregnancy seems to be effective (56). Training resulted in significant changes in the advice provided, with greater emphasis on gaining a commitment to smoking behaviour change, but not in the average time providing the advice, approximately three minutes (56).

Nicotine replacement therapy among pregnant women is a controversial subject. Due to official recommendations in Norway, all kinds of nicotine replacement therapy are contraindicated during pregnancy and the lactation period (Felleskatalogen 1994/95). However, the benefits of nicotine replacement therapy to aid pregnant women who have tried to stop smoking, substantially outweigh the risk of continued smoking, particularly those who smoke 20 cigarettes or more per day (57).

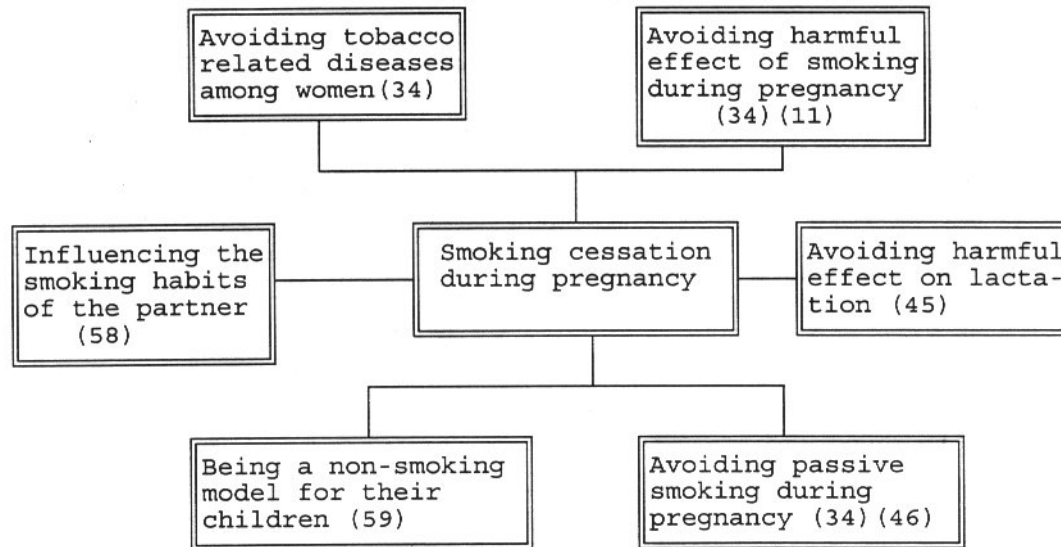


Figure 1. Spreading consequences of smoking cessation among pregnant women.

CONSEQUENCES FOR PUBLIC HEALTH

A successful smoking intervention programme designed for pregnant women can result in at least six important consequences for public health (Figure 1). Since 89% of Norwegian women are pregnant at least once (1), communicating with daily smoking pregnant women will reach a majority of daily smoking women in young adult age. Smoking cessation research has demonstrated that daily smoking women, like men, are more concerned about the harmful effects of "here and now" rather than harmful effects later in life (12). Focusing the harmful effects on the fetus and the

newborn baby might increase the success of the intervention.

Available data indicate that a majority of pregnant women who stop smoking during pregnancy, resume smoking within the first year postpartum (18). Helping women to remain nonsmokers rather than to resume smoking after the birth is important, perhaps even more important than getting them to stop during pregnancy. Therefore, smoking intervention during pregnancy can have a major impact on the future health of women as well as on the health of their offspring.

REFERANSER

1. Kravdal Ø. The emergence of a positive relation between education and third birth rates in Norway with supportive evidence from the United States. *Popul Stud* 1992; **46**: 459-75.
2. Cnattingius S. Smoking habits in early pregnancy. *Addict Behav* 1989; **14**: 453-7.
3. Madeley RJ, Gillies PA, Power FL, Symonds EM. Nottingham mothers stop smoking project - baseline survey of smoking in pregnancy. *Community Med* 1989; **11**: 124-30.
4. Bonati M, Tognoni G. Cooperative study on drug use in pregnancy. Final report. Workshop on pregnant women and drugs 1991. Bergamo, Italy: June 16-18, 1991.
5. Peen A, Bergsjø P, Nesheim B, Ullern ÅM, Heggelund BW, Matheson I. Characterization of birth populations in two Norwegian counties (Akershus and Hordaland). *Tidsskr Nor Lægeforen* 1991; **111**: 1613-6 (in Norwegian).
6. Cnattingius S, Lindmark G, Meirik O. Who continues to smoke while pregnant? *J Epidemiol Community Health* 1992; **46**: 218-21.
7. Floyd RL, Zahniser SC, Gunter EP, Kendrick JS. Smoking during pregnancy: prevalence, effects, and intervention strategies. *Birth* 1991; **18**: 48-53.
8. Backe B. Maternal smoking and age. Effect on birthweight and risk for small-for-gestational age births. *Acta Obstet Gynecol Scand* 1993; **72**: 172-6.

9. Eriksson K, Salvensen K, Haug K, Eik-Nes S. Smoking habits among pregnant women in a Norwegian county 1987-94. *Acta Obst Gynecol Scand*. In press.
10. Haug K, Aarø LE, Fugelli P. Smoking habits in early pregnancy and attitudes towards smoking cessation among pregnant women and their partners. *Fam Pract* 1992; **9**: 494-9.
11. Cnattingius S, Haglund B, Meirik O. Cigarette smoking as risk factor for late fetal and early neonatal death. *Br Med J* 1988; **297**: 258-61.
12. Fredricsson B, Gilljam H. Smoking and reproduction. Short and long term effects and benefits of smoking cessation. *Acta Obstet Gynecol Scand* 1992; **71**: 580-92.
13. O'Campo P, Faden RR, Brown H, Gielen AC. The impact of pregnancy on women's prenatal and postpartum smoking behavior. *Am J Prev Med* 1992; **8**: 8-13.
14. Windsor RA, Li CQ, Lowe JB, Perkins LL, Ershoff D, Glynn T. The dissemination of smoking cessation methods for pregnant women: achieving the year 2000 objectives. *Am J Public Health* 1993; **83**: 173-8.
15. Land GH, Stockbauer JW. Smoking and pregnancy outcome: trends among black teenage mothers in Missouri. *Am J Public Health* 1993; **83**: 1121-4.
16. Haug K, Aarø LE, Fugelli P. Smoking habits in early pregnancy related to age of smoking debut. *Fam Pract* 1993; **10**: 66-9.
17. Duffy J, Coates TJ. Reducing smoking among pregnant adolescents. *Adolescence* 1989; **24**: 29-37.
18. Fingerhut LA, Kleinman JC, Kendrick JS. Smoking before, during and after pregnancy. *Am J Public Health* 1990; **80**: 541-4.
19. Brenner H, Mielck A. The role of childbirth in smoking cessation. *Prev Med* 1993; **22**: 225-36.
20. Suzuki K, Horiguchi T, Comas-Urrutia AC, Mueller-Heubach E, Morishima HO, Adamsons K. Placental transfer and distribution of nicotine in the pregnant rhesus monkey. *Am J Obstet Gynecol* 1974; **119**: 253-62.
21. Suzuki K, Horiguchi T, Comas-Urrutia AC, Mueller-Heubach E, Morishima HO, Adamsons K. Pharmacologic effects of nicotine upon the fetus and mother in the rhesus monkey. *Am J Obstet Gynecol* 1971; **111**: 1092-1101.
22. Lehtovirta P, Forss M. The acute effect of smoking on intervillous blood flow of the placenta. *Br J Obstet Gynaecol* 1978; **85**: 729-31.
23. Lindblad A, Marsal K, Andersson KE. Effect of nicotine on human fetal blood flow. *Obstet Gynecol* 1988; **72**: 371-82.
24. Longo LD. The biological effects of carbon monoxide on the pregnant women, fetus, and newborn infant. *Am J Obstet Gynecol* 1977; **129**: 69-103.
25. Nebert DW, Winker J, Gelboin HV. Aryl hydrocarbon hydroxylase activity in human placenta from cigarette smoking and nonsmoking women. *Cancer Res* 1969; **29**: 1763-9.
26. Simpson WJ. A preliminary report of cigarette smoking and the incidence of prematurity. *Am J Obstet Gynecol* 1957; **73**: 808-15.
27. Brooke OG, Anderson HR, Bland JM, Peacock JL, Stewart CM. Effects on birth weight of smoking, alcohol, caffeine, socioeconomic factors, and psychosocial stress. *Br Med J* 1989; **298**: 795-801.
28. Kleinman JC, Madans JH. The effects of maternal smoking, physical stature, and educational attainment on the incidence of low birth weight. *Am J Epidemiol* 1985; **121**: 843-55.
29. Stillman RJ, Rosenberg MJ, Sachs BP. Smoking and reproduction. *Fertil Steril* 1986; **46**: 545-66.
30. Bakketeig LS, Jacobsen G, Hoffman HJ, et al. Pre-pregnancy risk factors of small-for-gestational age births among parous women in Scandinavia. *Acta Obstet Gynecol Scand* 1993; **72**: 273-9.
31. Meyer MB, Tonascia JA. Maternal smoking, pregnancy complications, and perinatal mortality. *Am J Obstet Gynecol* 1977; **128**: 494-502.
32. Nandi C, Nelson MR. Maternal pregravid weight, age, and smoking status as risk factors for low birth weight births. *Public Health Rep* 1992; **107**: 658-62.
33. Davies DP, Gray OP, Ellwood PC, Abernethy M. Cigarette smoking in pregnancy: Associations with maternal weight gain and fetal growth. *Lancet* 1976; **i**: 385-7.
34. The health consequences of smoking for women: A report of the surgeon general. Rockville, Md.: U.S. Department of Health and Human Services, 1980.
35. Olsen J. Cigarette smoking in pregnancy and fetal growth. Does the type of tobacco play a role? *Int J Epidemiol* 1992; **21**: 279-84.
36. Underwood P, Hester LL, Laffitte TJ, Gregg KV. The relationship of smoking to the outcome of pregnancy. *Am J Obstet Gynecol* 1965; **91**: 270-6.

37. Risch HA, Weiss NS, Clarke EA, Miller AB. Risk factors for spontaneous abortion and its recurrence. *Am J Epidemiol* 1988; **128**: 420-30.
38. Kline J, Stein ZA, Susser M, Warburton D. Smoking: a risk factor for spontaneous abortion. *N Engl J Med* 1977; **297**: 793-6.
39. Editorial. Cigarette smoking and spontaneous abortion. *Br Med J* 1978; **i**: 259-60.
40. Himmelberger DU, Brown BW Jr, Cohen EN. Cigarette smoking during pregnancy and the occurrence of spontaneous abortion and congenital abnormality. *Am J Epidemiol* 1978; **108**: 470-9.
41. Naeye RL, Harkness WL, Utts J. Abruptio placentae and perinatal death: A prospective study. *Am J Obstet Gynecol* 1977; **128**: 740-6.
42. Naeye RL. Abruptio placentae and placenta previa: frequency, perinatal mortality, and cigarette smoking. *Obstet Gynecol* 1980; **55**: 701-4.
43. Haglund B, Cnattingius S. Cigarette smoking as a risk factor for sudden infant death syndrome: a population-based study. *Am J Public Health* 1990; **80**: 29-32.
44. Stjernfeldt M, Berglund K, Lindsten J, Ludvigsson J. Maternal smoking during pregnancy and risk of childhood cancer. *Lancet* 1986; **i**: 1350-2.
45. Nylander G, Matheson I. Breast feeding. Effects of smoking and education. *Tidsskr Nor Lægeforen* 1989; **109**: 970-3.
46. Håkansson A, Carlsson B. Maternal cigarette smoking, breast-feeding, and respiratory tract infections in infancy. A population-based cohort study. *Scand J Prim Health Care* 1992; **10**: 60-5.
47. Widstrom AM, Werner S, Matthiesen AS, Svensson K, Uvnas-Moberg K. Somatostatin levels in plasma in nonsmoking and smoking breast-feeding women. *Acta Paediatr Scand* 1991; **80**: 13-21.
48. Petersen L, Handel J, Kotch J, Podedworny T, Rosen A. Smoking reduction during pregnancy by a program of self-help and clinical support. *Obstet Gynecol* 1992; **79**: 924-30.
49. Elixhauser A. The costs of smoking and the cost effectiveness of smoking cessation programs. *J Public Health Policy* 1990; **11**: 218-37.
50. Windsor RA, Lowe JB, Perkins LL, et al. Health education for pregnant smokers: its behavioral impact and cost benefit. *Am J Public Health* 1993; **83**: 201-6.
51. Haug K, Fugelli P, Aarø LE, Foss OP. Is smoking intervention in general practice more successful among pregnant than non-pregnant women? *Fam Pract* 1994; **11**: 111-6.
52. Messimer SR, Hickner JM, Henry RC. A comparison of two antismoking interventions among pregnant women in eleven private primary care practices. *J Fam Pract* 1989; **28**: 283-8.
53. Valbø A, Schioldborg P. Smoking cessation in pregnancy. Mode of intervention and effect. *Acta Obstet Gynecol Scand* 1991; **70**: 309-13.
54. Rush D, Orme J, King J, Eiser JR, Butler NR. A trial of health education aimed to reduce cigarette smoking among pregnant women. *Paediatr Perinat Epidemiol* 1992; **6**: 285-97.
55. Valbø A, Schioldborg P. Smoking in pregnancy: A follow-up study of women unwilling to quit. *Addict Behav* 1993; **18**: 253-7.
56. Secker-Walker RH, Solomon LJ, Flynn BS, et al. Training obstetric and family practice residents to give smoking cessation advice during prenatal care. *Am J Obstet Gynecol* 1992; **166**: 1356-63.
57. Benowitz NL. Nicotine replacement therapy during pregnancy. *JAMA* 1991; **266**: 3174-7.
58. Health benefits of smoking cessation: A report of the Surgeon General. Rockville, Md.: U.S. Department of Health and Human Services, 1990.
59. Aarø LE, Hauknes A, Berglund E-L. Smoking among Norwegian schoolchildren 1975-1980. *Scand J Psychol* 1981; **22**: 297-309.