Maternal education and risk factors for small-for-gestational-age births

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Abstract

Objectives
This article examines the association between maternal education, smoking and other risk factors and small-for-gestational-age (SGA) births.

Data source
The data are from the 1994/95 National Longitudinal Survey of Children and Youth. The analysis was restricted to a subsample of 4,181 children younger than age 2 and was based on information provided by their biological mothers.

Analytical techniques
Logistic regression was used to estimate the odds ratios for SGA by maternal education, controlling for maternal smoking during pregnancy, household income, family status, maternal age at birth of child, and use of prenatal care.

Main results
Maternal education and smoking during pregnancy appear to have independent effects on SGA, after controlling for other risk factors. The effects of maternal education, smoking and other risk factors are likely underestimated, as the analysis pertains only to children who had survived at the time of the interview.

Key words
pregnancy outcome, low birthweight, maternal behaviour, maternal exposure, smoking during pregnancy

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The prevention of small-for-gestational-age (SGA) births is an important public health objective in the overall strategy to improve child health.[1-3] SGA refers to birthweight less than the 10th percentile of the most recent Canadian birthweight norms by infant sex, gestational age and singleton or multiple birth status.[4] SGA babies may be at higher risk of fetal and infant mortality than non-SGA births.[5,6] While SGA births and preterm births (gestational age less than 37 weeks regardless of birthweight) are two types of low birthweight, the former appear to be more liable to be delayed in subsequent development and to remain small.[7,8]

Several Canadian studies based on vital statistics have indicated an inverse association between adverse birth outcomes and socioeconomic status.[6,9,10] One of the primary indicators of socioeconomic status, educational attainment, is also closely related to a number of other risk factors.[7,11-14] Among the risk factors associated with poor birth outcomes that tend to be more prevalent among

Methods

Data sources

The data are from the first cycle of the National Longitudinal Survey of Children and Youth (NLSCY), conducted in 1994/95. The target population was children from newborn to age 11. In each NLSCY household, up to four children were selected at random, and a question was asked to determine who in the household was the person most knowledgeable about them. For 91.3% of the selected children, that person was the mother (89.9%, biological; 1.4%, step, adoptive or foster).

The first NLSYC cycle resulted in a responding sample of 13,439 households. In these households, 22,831 children were selected to participate in the survey. Data will be collected every two years as these children grow to adulthood.[1] The overall response rate at the household level was 86%. Response rates for the health outcomes of children and the characteristics of persons most knowledgeable (the adult who provided the information) for the sampled children were over 91%.

This analysis is restricted to a subsample of 4,181 children younger than age 2 whose biological mothers were interviewed (Appendix Table A).[15] All responses relating to the birth outcome are based on the mother's recall. The focus of the analysis is small-for-gestational-age (SGA) births; namely, birthweight less than the 10th percentile of Canadian birthweight norms, by infant sex, gestational age, and singleton or multiple birth status.

Analytical techniques

Several behavioural, demographic and socioeconomic risk factors for SGA were examined (see *Definitions)*. Multiple logistic regression was used to estimate the adjusted odds ratios of SGA for maternal education, household income level, maternal age at birth of child, family status, use of prenatal care, and maternal smoking.

The multivariate analysis is based on 4,060 children younger than age 2 in 1994/95 whose mothers reported information on all the variables included in the model. Missing data were excluded. The sample was weighted using sample weights re-scaled to average 1.

In this article, percentages refer to unadjusted prevalence figures (Table 1, Chart 1), while adjusted odds ratios (Table 2) refer to estimates derived from the multiple logistic regression model, which controls for other variables entered in the analysis. Unadjusted odds ratios are also provided (Appendix Tables B and C).

To illustrate the effects of smoking and education on SGA, the estimated probability of SGA under different scenarios was determined by substituting the values of the independent variables in a multiple logistic regression. These estimates are model-based and limited to the current sample.

Limitations

The estimates in this analysis are conservative. The association between risk factors and SGA is subject to selection bias. Infants born too small or too early tend to have higher mortality. Information is not available from the NLSCY about children who died within the first two years of life. Consequently, the number of SGA births will tend to be underestimated, and the effects of risk factors may be attenuated.

To some extent, the NLSCY underestimation of the prevalence of SGA births (compared with vital statistics) may be because the survey results are based on the mothers' recollection of the infants' due date and birthweight. This information could vary with the physicians' clinical assessment and the mothers' recall of what they were told.

The mothers' inability to accurately recall or reluctance to admit the amount smoked during their pregnancy may have reduced the association between smoking frequency and SGA.[16,17] The lack of a more pronounced dose-response association may also be attributable to the lack of specificity in the data about the timing of exposure for the fetus.[18] The use of biochemical markers would likely yield better estimates of tobacco use than reliance on self-report.[19] In an assessment of the dose-dependence of birthweight on smoking, there was a closer dose-effect relationship between birthweight deficits and urinary nicotine metabolites/creatine ratios than with self-reported daily cigarette smoking.[20] A recent Canadian study reported that the mean birthweight of infants was inversely associated with maternal serum cotinine levels and that the relative risk of SGA was significantly higher in smokers.[21]

Information on the mothers' education was collected at the time of the survey, not at the time of the child's birth. It is possible that some mothers may have upgraded their education between these two dates; thus, the association between maternal education and SGA births may be slightly underestimated.

The NLSCY contained questions on alcohol consumption and drug use during pregnancy, both of which have been identified as SGA risk factors.[22] However, the number of women reporting that they had consumed substantial quantities of alcohol was too small for meaningful analysis, and the question on drug use did not probe the nature of the drugs. Consequently, neither of these risk factors was included in the model.

women with low educational attainment are teenage pregnancy, lone motherhood, low income, lack of prenatal care, and smoking during pregnancy.[3,11,16,18,23-35]

This article is based on data from the 1994/95 National Longitudinal Survey of Children and Youth (NLSCY). It asseses the relative importance of selected SGA risk factors and examines the association between maternal education and these risk factors for children younger than age 2 (see *Methods* and *Definitions*). Although the relationship of risk factors to unfavourable birth outcomes has been shown in past research, most of those studies lacked the scope of the population-wide NLSCY.[7]

Maternal education and SGA

Education affects an individual's income-generating ability, and hence, access to adequate diet, shelter, health care services, and other material conditions that can promote a healthy pregnancy. Education also may enhance the ability to access and use information.[12] As well, education is associated with a number of health behaviours that may influence birth outcomes.

According to the NLSCY, 6% of children younger than age 2, an estimated 42,100, had been SGA births (Table 1). The percentage varied substantially by maternal education, dropping from 12% of children whose mothers had less than high school graduation to 5% of those whose mothers had a postsecondary diploma or degree. These results are similar to those of a recent birth cohort study.[6]

Definitions

Definitions

SGA was not directly collected by the NLSCY. It was derived from information about the child's gestational age and birthweight. Mothers were asked, "Was ... born before or after the due date?" Those who answered that the baby was not born on the due date were asked the number of days before or after the due date. Mothers were also asked, "What was his/her birthweight in kilograms and grams or pounds and ounces?" This information about gestation and birthweight was used in conjunction with Canadian norms for birthweight to classify births as SGA; specifically, birthweight less than the 10th percentile for infant sex, gestational age, and singleton or multiple birth status.[4] SGA births include full-term births that are too small for their gestational age.[7,36,37]

Smoking during pregnancy was determined by asking "Did you smoke during your pregnancy with ...?" Mothers who answered "yes" were asked, "How many cigarettes per day did you smoke during your pregnancy with ....?" These responses were grouped into three categories: no smoking, 1 to 10 cigarettes per day, and 11 or more cigarettes per day. Mothers were also asked, "At what stage in your pregnancy did you smoke this amount?" The same question was repeated for "during the first three months," "during the second three months," and "during the third three months." The

response options for each trimester were "yes" or "no." A limitation of these questions is that a "no" response could mean that the mother was smoking more or less. Consequently, the amount smoked during each trimester is not known and could not be used in the analysis. In fact, some mothers may actually have quit smoking at a particular stage in their pregnancy, but this would not be revealed by the NLSCY questions.

Maternal education was defined as less than high school graduation, high school graduation or some postsecondary education, and postsecondary graduation.

Based on household size, *household income* quintiles were derived and further grouped as low (quintiles 1 and 2), middle (quintiles 3 and 4), and high (quintile 5).

Maternal age at birth of child was defined as younger than 20, 20 to 24, 25 to 34, and 35 and older.

*Family status* was defined as either lone-mother or two-parent family (including stepfather).

Prenatal care refers to whether the mother received prenatal care from a doctor, nurse or midwife.

Table 1
Children younger than age 2 who were SGA at birth, by mothers' characteristics, Canada excluding territories, 1994/95

Mothers' characteristics	Small for gestational age (SGA)	
	Number	% of all children younger than age 2
Total SGA children younger than age 2	**42,100**	**6**
Educational attainment†		
Less than high school	12,900	12
High school graduation/Some postsecondary	17,100	6
Postsecondary graduation	12,000	5
Smoking status during pregnancy†		
11+ cigarettes per day	6,900	13
1-10 cigarettes per day	12,400	12
Did not smoke	21,700	4
Household income		
Low	11,900	9
Middle	27,400	6
High	2,800	4
Family status		
Lone mother	7,900	10
Father present	34,200	6
Age at birth of child		
Less than 20 years	1,500	7
20-24 years	7,300	7
25-34 years	27,700	6
35+ years	5,600	7
Received prenatal care†		
No	1,800	11
Yes	39,200	6

Data source: *1994/95 National Longitudinal Survey of Children and Youth*
† Excludes missing.

Chart 1
Prevalence of SGA risk factors among mothers of children younger than age 2, by educational attainment, Canada excluding territories, 1994/95

% of all mothers with children younger than age 2
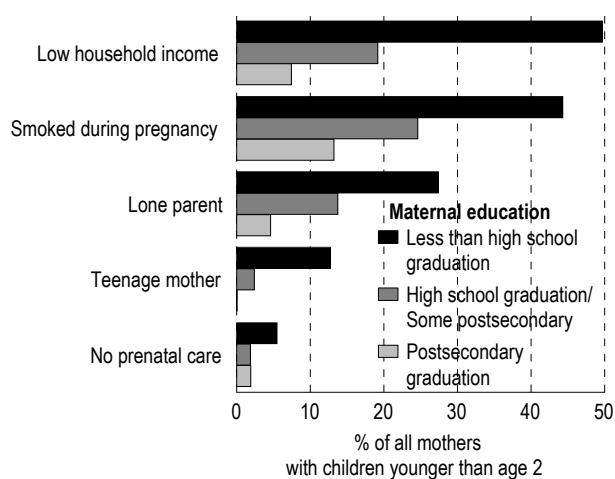
Data source: *1994/95 National Longitudinal Survey of Children and Youth*
- Nil

Risk factors for SGA

Perhaps the most well-known risk factor for SGA is maternal smoking during pregnancy. Smoking causes fetal oxygen deprivation, which can retard fetal growth and result in low birthweight.[38-40] About 12% of children younger than age 2 whose mothers had smoked while pregnant had been SGA births, compared with only 4% whose mothers had not smoked (Table 1, Appendix Table C).

Household income, too, was related to SGA births. In low-income households, 9% of children had been SGA births, compared with 4% of children in high-income households. Similarly, family status was associated with SGA births: 10% of children in lone-mother families had been SGA births versus 6% in two-parent families.

Very few mothers had not received prenatal care (Appendix Table A), but among the children of this minority, 11% had been SGA births. The prevalence of SGA births, however, did not vary by the mother's age when she had the baby.

Maternal education and SGA risk factors

Low maternal education was strongly associated with smoking (Chart 1 and Appendix Table B). This is not surprising, as smoking tends to be more prevalent among people with relatively little education.[41] Forty-four percent of mothers who had not graduated from high school had smoked when they were pregnant, compared with 13% of those who had completed a postsecondary program. In addition, smoking intensity declined with increasing education. About 16% of mothers with less than high school graduation smoked more than 10 cigarettes a day, whereas just 4% who were postsecondary graduates had done so (data not shown). These results are consistent with previous studies.[33,35]

As might be expected, low maternal education was related to low household income, lone parenthood and teenage pregnancy. As well, the percentage of mothers who had received no prenatal care was higher among those who had not completed high school than among postsecondary graduates.

Clearly, maternal education is strongly associated with various risk factors for SGA births. It is equally apparent that many of these risk factors are interrelated. For instance, lone parenthood, teenage motherhood and low income frequently co-exist (data not shown).

Smoking and education crucial factors

After accounting for the effects of maternal education, household income, maternal age at birth of child, family status and the receipt of prenatal care, the odds of having been an SGA birth were significantly higher for children whose mothers had smoked during pregnancy (Table 2). Compared with the children of women who did not smoke, the odds ratios were elevated among children of both heavy smokers (2.7) and light smokers (2.6).

In addition, even after adjusting for smoking during pregnancy, household income, maternal age, family status and prenatal care, the association between low education and SGA persisted. Among children whose mothers had not graduated from high school, the odds of having been an SGA birth were twice as high (2.1) as among those whose mothers were postsecondary graduates.

On the other hand, when other risk factors were taken into account, household income, lone parenthood, prenatal care and maternal age did not have statistically significant effects on SGA. This may be partially related to a health-selection effect. That is, very low birthweight infants might have died by the time of the NLSCY, so the risk factors associated with their births (and subsequent deaths) would not be part of the analysis.

Profiles

The pronounced influence of smoking and education is evident in how the presence or absence of these factors alters the probability of an SGA birth. For instance, consider children of lone mothers aged 25 to 34 living in low-income households, who had not graduated from high school, who received no prenatal care, and who smoked heavily during pregnancy. The estimated probability of having been an SGA birth for such

children is 26%. But for children born to mothers with the same characteristics except that they did not smoke during pregnancy, the estimated probability of SGA falls to 11%.

The importance of education can be seen by the differences in probabilities of SGA birth for children whose mothers have the same characteristics except for education. Among children born to lone mothers aged 25 to 34 living in low-income households who received no prenatal care, did not smoke during pregnancy and were postsecondary graduates, the estimated probability of SGA decreases almost by half, from 11% to 6%.

Table 2

Adjusted odds ratios for SGA at birth among children younger than age 2, by mothers' characteristics, Canada excluding territories, 1994/95

Mothers' characteristics	Adjusted odds ratio	95% confidence interval
Educational attainment		
Less than high school	2.1**	1.4, 3.1
High school graduation/Some postsecondary	1.3	0.9, 1.8
Postsecondary graduation†	1.0	...
Smoking status during pregnancy		
11+ cigarettes per day	2.7**	1.9, 4.0
1-10 cigarettes per day	2.6**	1.9, 3.5
Did not smoke†	1.0	...
Household income		
Low	1.7	0.9, 3.1
Middle	1.6	0.9, 2.7
High†	1.0	...
Family status		
Lone mother	1.2	0.8, 1.8
Father present†	1.0	...
Age at birth of child		
Less than 20 years	0.5	0.3, 1.1
20-24 years	0.8	0.5, 1.1
25-34 years†	1.0	...
35+ years	1.1	0.8, 1.7
Received prenatal care		
No	1.2	0.6, 2.4
Yes†	1.0	...

Data source: *1994/95 National Longitudinal Survey of Children and Youth*
Note: *The multivariate analysis is based on 4,060 children younger than age 2 whose mothers reported information on all variables in the model.*
† Reference category, for which odds ratio is always 1.0
··· Not applicable
* p < 0.05
** p < 0.01

The final example concerns children born in more favourable circumstances. In this case, their mothers were married postsecondary graduates, who had high household income, who had received prenatal care, and who did not smoke during pregnancy. The estimated probability of SGA among these children is 2%.

Implications

According to the 1994/95 National Longitudinal Survey of Children and Youth, maternal education was associated with smoking during pregnancy, household income, teenage parenthood, lone parenthood, and the mother's age when the child was born, all of which were risk factors for SGA among children younger than age 2. These results echo a Canadian study on the prevalence of risk behaviours during pregnancy[42] and a recent analysis of the association between maternal education and SGA.[6] Even when these risk factors were controlled, low levels of maternal educational were associated with increased odds of an SGA birth.

The other variable that remained significantly associated with the odds of an SGA birth, after adjusting for potential confounding factors, was smoking during pregnancy. This is consistent with previous studies,[22,43-46] except there was only a small difference in SGA births among children whose mothers were heavy or light smokers. As noted, the absence of a marked gradient in SGA by smoking intensity may be related to the questions used to measure smoking frequency in the NLSCY, along with the mother's inability to accurately recall the amount she smoked.[17] Selection bias may also be a factor, since maternal smoking, especially heavy smoking, had a weak (not statistically significant) association with low birthweight and pre-term birth (data not shown).

The two risk factors for SGA births shown to be significant in this analysis, low educational attainment and smoking, potentially affect a substantial share of children. In 1994/95, 17% of children younger than age 2 had been born to mothers who had not completed high school, and 23% had been born to mothers who had smoked when they were pregnant.

In Canada, previous national health surveys did not attempt to monitor the smoking behaviour of pregnant women. Nonetheless, there has been a report of a decline in the prevalence of smoking among pregnant women in a local regional study.[35] Further progress may require attention to the social and environmental context that gives rise to high-risk behaviors.[23,24,37,42] The development of health education programs tailored to pregnant women may lead to higher smoking cessation rates than would be attained using conventional clinic information.[47] Education in the broadest sense (including formal education and prenatal care programs) appears to be an important factor in SGA births. Efforts to enable women to improve their educational attainment or to reach pregnant women may affect the prevalence of SGA.[7,47] ●

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Appendix

Table A
Distribution of children younger than age 2, by mothers' characteristics, Canada excluding territories, 1994/95

Mothers' characteristics	Sample size	Estimated population	% of total
All children younger than age 2	4,181	661,849	100
Educational attainment			
Less than high school	710	112,641	17
High school graduation/Some postsecondary	1,883	283,018	43
Postsecondary graduation	1,577	265,155	40
Missing	11	1,035	--
Smoking status during pregnancy			
11+ cigarettes per day	397	52,942	8
1-10 cigarettes per day	693	99,885	15
Did not smoke	3,043	500,565	76
Missing	48	8,457	1
Household income			
Low	918	130,621	20
Middle	2,841	452,265	68
High	422	78,963	12
Family status			
Lone mother	522	82,250	12
Father present	3,659	579,599	88
Age at birth of child			
Less than 20 years	170	21,462	3
20-24 years	795	108,582	17
25-34 years	2,761	450,136	68
35+ years	455	81,669	12
Received prenatal care			
No	107	16,700	3
Yes	4,030	637,552	96
Missing	44	7,597	1

Data source: *1994/95 National Longitudinal Survey of Children and Youth*
-- Amount too small to be expressed

Table B
Unadjusted odds ratios for risk factors for SGA births, by educational attainment of mothers of children younger than age 2, Canada excluding territories, 1994/95

Risk factor/Mothers' education	Odds ratio	95% confidence interval
Smoked during pregnancy		
Less than high school	5.2**	4.2, 6.4
High school graduation/Some postsecondary	2.1**	1.8, 2.6
Postsecondary graduation[†]	1.0	...
Smoked heavily during pregnancy		
Less than high school	4.0**	2.9, 5.5
High school graduation/Some postsecondary	2.0**	1.5, 2.7
Postsecondary graduation[†]	1.0	...
Low household income		
Less than high school	12.2**	9.6, 15.4
High school graduation/Some postsecondary	2.9**	2.4, 3.6
Postsecondary graduation[†]	1.0	...
Lone mother		
Less than high school	7.7**	5.8, 10.2
High school graduation/Some postsecondary	3.3**	2.5, 4.3
Postsecondary graduation[†]	1.0	...
Teenage mother[‡]		
Less than high school	11.2**	7.8, 16.2
High school graduation or more[†]	1.0	...
No prenatal care		
Less than high school	2.9**	1.8, 4.7
High school graduation/Some postsecondary	1.0	0.6, 1.6
Postsecondary graduation[†]	1.0	...

Data source: *1994/95 National Longitudinal Survey of Children and Youth*
† Reference category, for which odds ratio is always 1.0
‡ Because very few teenage mothers were postsecondary graduates, the reference category was those who had high school graduation or more.
... Not applicable
* p < 0.05
** p < 0.01

Table C
Unadjusted odds ratios for SGA at birth among children younger than age 2, by mothers' characteristics, Canada excluding territories, 1994/95

Mothers' characteristics	Odds ratio	95% confidence interval
Educational attainment		
Less than high school	2.7**	2.0 , 3.8
High school graduation/Some postsecondary	1.4	1.0 , 1.8
Postsecondary graduation†	1.0	...
Smoking status during pregnancy		
11+ cigarettes per day	3.3**	2.3 , 4.8
1-10 cigarettes per day	3.1**	2.3 , 4.1
Did not smoke†	1.0	...
Household income		
Low	2.8**	1.6 , 4.8
Middle	1.8*	1.1 , 2.9
High†	1.0	...
Family status		
Lone mother	1.7**	1.2 , 2.4
Father present†	1.0	...
Age at birth of child		
Less than 20 years	1.1	0.6 , 2.2
20-24 years	1.1	0.8 , 1.6
25-34 years†	1.0	...
35+ years	1.1	0.8 , 1.6
Received prenatal care		
No	1.8	1.0 , 3.5
Yes†	1.0	...

Data source: *1994/95 National Longitudinal Survey of Children and Youth*
† Reference category, for which odds ratio is always 1.0
··· Not applicable
* p < 0.05
** p < 0.01