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# Beyond biology: the social context of prenatal behaviour and birth outcomes*

Summary

**Objectives:** In this study we examine the factors that are associated with adverse birth outcomes using a representative national sample. In our analysis we take into account factors which are related to the mother's behaviour during pregnancy and also consider the socio-economic circumstances of the family.
**Methods:** A series of logistic regression models are used to determine the increased risks of low birth weight, preterm, and small for gestational age births associated with maternal smoking, alcohol consumption and high blood pressure in relation to socio-economic factors, such as family dysfunction, social support, income adequacy, age, and education.
**Results:** All socio-economic factors showed gradients of maternal smoking during pregnancy while only mother's education and socio-economic status demonstrated gradients of alcohol use and high blood pressure. Maternal smoking, high blood pressure, higher levels of family dysfunction, and lower levels of mother's education were found to significantly increase the risk of an adverse birth outcome.
**Conclusions:** Interventions designed to mitigate the hazards of adverse birth outcomes should be designed to reflect the gradients of risky prenatal maternal behaviours associated with age, education, income, and family dysfunction.

The purpose of this study to examine how "fundamental social conditions" influence the process leading to high-risk births. Link and Phelan[1] argue for the primacy of social conditions as fundamental causes of disease. The current focus on proximal mechanisms, or risk factors, tends to make epidemiology highly individualistic by ignoring the social origins of disease mechanisms. Further, social conditions frequently give rise to multiple social deficits, which may express themselves through multiple health outcomes. As a consequence, amelioration of any specific linkage may simply shift the dynamic forces to other hazards and outcomes, especially since deficits of education and income tend to cluster in the same individuals. A focus on the fundamental causes of disease leads us to consider the social context of health-related or hazardous behaviours and may also assist in more effective public policy and identification of intervention programmes.
The clinical literature shows that infants born preterm, with low birth weights (LBW), or who are small for gestational age (SGA) are likely to require a high level of medical intervention at birth and are at increased risk for developmental deficits[2–5] which require greater care and attention[6–9]. Most clinical research examining adverse birth outcomes and subsequent developmental deficits are unable to examine the social processes leading to such events as they either use small unrepresentative samples and/or matching techniques in study designs that may obfuscate fundamental social variations.
Clinical research has also identified several prenatal maternal factors associated with adverse birth outcomes, three of which are considered in this study: smoking, alcohol use, and high blood pressure. The deleterious effects of smoking during pregnancy have been consistently demonstrated in research over the past 40 years. Smoking during pregnancy has been shown to increase the risk of low birth weight and preterm birth[10,11], SIDS[12,13], as well as subsequent intellectual

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deficits[14] and problem behaviours such as aggression[15]. Several studies have examined the socio-demographic associations of smoking during pregnancy in Canada. They found that overall levels of smoking during pregnancy declined from 1983 to 1992, but gradients still existed in levels of smoking during pregnancy with age, education, and poverty level that mimic the gradients found in the general population[16]. Also, women who smoke in the second half of pregnancy are more likely to have higher rates of other health risk behaviours and emotional disturbance[17].

Research on fetal exposure to alcohol has concentrated on high consumption levels and fetal alcohol syndrome. However, the association between alcohol consumption and adverse birth outcomes appears to be asymmetrical as moderate consumption, especially in the third trimester, has shown a "protective" effect[10,18]. Another study has linked "social" levels of alcohol consumption during pregnancy to behavioural and cognitive problems in adolescence[19]. Finally, high blood pressure during pregnancy has been shown to be inversely related to fetal growth, increasing the risk of LBW and SGA births[20]. These maternal factors are only three from a wealth of clinical research into predictors of adverse birth outcomes. Other factors that have been shown to raise the probability of an adverse birth outcome, but have not been captured in this study, include maternal drug use, pre-pregnancy weight, gestational weight gain, and various bacterial infections.

The three maternal factors – smoking, alcohol use, and high blood pressure – considered in this study have been shown to raise the probability of high-risk birth. However, they may be intervening mechanisms in a process linking the mother's social and economic environment to adverse birth outcomes. Through these factors, the socio-economic environment may have indirect, but important, consequences for a wide range of negative birth outcomes and subsequent developmental delays. In turn, identifying the socio-economic characteristics of mothers who are more likely to smoke or drink throughout pregnancy may provide an efficient direction to prevention programmes and campaigns. If these factors are merely proximal risks in a more complex process, any successful long-term intervention must also address the more distal underlying socio-economic factors.

This study utilises a large, nationally representative sample of children to examine this process in a series of three questions. First, are maternal factors, identified in previous clinical studies, associated with LBW, preterm birth and SGA? Second, is the social environment directly associated with these birth outcomes? Finally, what is the relationship between social factors, maternal factors and adverse birth outcomes?

## Method

*Data*

The data come from a subset of families from the first wave of the Canadian National Longitudinal Survey of Children and Youth (NLSCY), conducted by Statistics Canada in 1994 (n = 22831)[21]. Information was obtained from the Person Most Knowledgeable (PMK) about the child and family circumstances. Retrospective data on the prenatal behaviour of the mother and birth outcomes were collected from the 4696 PMKs whose children were under 24 months of age. To ensure more accurate reporting of maternal behaviour during pregnancy, the 343 male PMKs (7.3%) were excluded. The frequency of LBW infants (<2500 g) captured in the NLSCY (5.6%) is comparable to the national rate (5.5%) in 1992. However, the NLSCY data underrepresents the rate of infants born <1500 g: 0.4% compared to 0.8%[22]. This is to be expected as the population sampled was that of living children that automatically selects for surviving infants while ignoring extremely LBW and/or preterm infants who died.

The sub-sample of 4353 infants came from 4087 households. There were 106 infants from multiple births. As multiple birth status was highly associated with the birth outcomes – 53.7% of multiple birth infants were LBW, 58.5% preterm, and 18.9% SGA – the analyses were restricted to singleton births (n = 4247) and used robust standard errors to compensate for the clustering of some remaining infants within households.

*Measures*

*Birth outcomes*: LBW was defined as infants weighing < 2500 g at birth, which consisted of 4.6% of the final sample of singleton births. Preterm birth was defined as a birth that occurred at 258 days (36 weeks, 2 days) of gestation or less. This identified 8.1% of the sample as preterm births. Defining LBW as < 2500 g and preterm delivery as ≤ 258 days of gestation are generally not considered to be extreme outcomes by today's standards[23] but they do retain their use in epidemiological studies, official statistics, and World Health Organization definitions. Inadequate intrauterine growth (SGA) was determined by having a birth weight below the 10$^{th}$ percentile for the number of weeks of gestation based on the national Canadian birth curves[24]. Separate curves were used for males and females, resulting in 7.0% of births being classified as SGA.

*Proximal factors*: The three proximal factors considered in this study were maternal smoking, alcohol consumption, and high blood pressure during pregnancy. Smoking and alcohol

consumption were coded as dichotomous variables indicating those whom reported participating in the behaviour during all three trimesters of the pregnancy. Self-report studies traditionally suffer from the under-reporting of undesirable behaviours, such as smoking or drinking. These data have similar prevalence rates of smoking to other self-reported data but lower than studies using anthropomorphic measures[25]. High blood pressure during pregnancy was included because it is a risk factor for normal fetal development. However, these self-reported data on high blood pressure are unable to distinguish between conditions with differing clinical implications, such as chronic hypertension and preeclampsia.

*Social environment*: Family dysfunction was measured by the McMaster scale[26] based on 12 questions designed to capture various dimensions of family functioning, such as problem solving, communications, affective responsiveness, and behavioural control (range 0–35; $\alpha = 0.88$). Social support was measured by the social provisions scale[27], based on six questions designed to capture availability of persons to turn to in times of need and to offer general social support (range 0–18; $\alpha = 0.82$). Socio-economic status (SES) was a standardised composite measure, derived by Statistics Canada, based on occupation, household income, and education of the parents with values truncated two standard deviations above and below the mean. For ease of interpretation, the scaled variables were collapsed into quartiles or quintiles. Income adequacy was a five-category measure using total household income adjusted for household size based on Statistics Canada low income cut-offs[28]. Maternal education was a five-category, ordinal variable where 1 = less than secondary and 5 = college or university degree. In the public release data maternal age was collapsed into five categories in ensure the anonymity of the respondents. The broad range of the first category (15–24 years) would tend to hide the increased risks among teenage mothers for adverse birth outcomes that has been shown in other research.

## Results

An initial examination of the data revealed that 18.7% of mothers smoked throughout their pregnancy at an average of 10.5 cigarettes per day which is comparable with the prevalence rate found in other studies[16,17,29]. Of the mothers who smoked at all during pregnancy, 84% smoked throughout. Alcohol consumption during pregnancy did not vary significantly among those who reported as such. Consumption was consistent at one to three drinks per month regardless of trimester with only 1% reporting more than one drink per week. Only 17.1% of mothers drank at any time during pregnancy and of those, 36% drank throughout resulting in 6.9% overall. The prevalence of reported high blood pressure during pregnancy was 9.5%.

| | Low birth weight | Preterm | Small for gestational age |
|---|---|---|---|
| Smoking | 1.69** | 1.31* | 3.04*** |
| Alcohol consumption | 0.93 | 1.17 | 1.54 |
| High blood pressure | 2.51*** | 2.09*** | 1.28 |

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (2-tailed tests).

**Table 1** Unadjusted odds ratios of birth outcomes among proximal factors

As shown in Table 1, mothers who smoked throughout pregnancy had significantly higher odds ratios of all three adverse birth outcomes. Maternal alcohol consumption had a weak and inconsistent effect while high blood pressure produced significantly higher odds ratios of LBW and preterm birth. These findings are generally consistent with the evidence from clinical studies.

Table 2 presents the unadjusted odds ratios for the three birth outcomes and three proximal factors among the social environment variables. Higher family dysfunction, lower levels of education, and lower SES all are associated with increased odds of all three adverse birth outcomes. Taken together, these results suggest that there is a modest direct relationship between the social environment variables and adverse birth outcomes. These results also demonstrate the importance of the maternal environment on the risk of smoking during pregnancy. Significant differences in the odds ratios of smoking are shown in all of the social environment variables. The SES quintiles showed the greatest difference in odds ratios with those mothers in the lowest quintile having odds ratios 10 times greater than those in the highest quintile. Less dramatic associations are shown with mother's age, family dysfunction, and social support. These results lend national sample evidence to Canadian regional findings of gradients in smoking during pregnancy associated with age, education, and poverty[16]. The association of the social environment variables on alcohol consumption are less clear but are generally the opposite to those of smoking. The highest odds rations of consuming alcohol throughout pregnancy were with mothers who had higher levels of education and the highest quintiles of income adequacy and SES. Women in the lowest SES category and highest level of family dysfunction had significantly higher odds of reporting high blood pressure.

Table 3 presents a series of models examining the relationship between social factors, maternal factors, and adverse birth outcomes. To avoid problems of multicollinearity, SES

| | Low birth weight | Preterm | Small for gestational age | Smoking | Alcohol consumption | High blood pressure |
|---|---|---|---|---|---|---|
| *Family dysfunction* | | | | | | |
| 1 lowest | – | – | – | – | – | – |
| 2 | 1.82** | 1.38* | 1.33 | 1.41** | 1.10 | 1.11 |
| 3 | 1.80** | 1.15 | 1.52* | 1.62*** | 1.05 | 1.28 |
| 4 highest | 2.11** | 1.54** | 1.50* | 2.50*** | 1.16 | 1.47** |
| *Social support* | | | | | | |
| 1 lowest | 1.37 | 1.07 | 1.24 | 1.76*** | 1.00 | 1.31 |
| 2 | 1.18 | 1.09 | 1.16 | 1.59*** | 0.92 | 1.22 |
| 3 | 1.12 | 1.03 | 0.83 | 1.39** | 0.87 | 1.20 |
| 4 highest | – | – | – | – | – | – |
| *Income adequacy* | | | | | | |
| 1 lowest | 1.53 | 1.68 | 1.16 | 5.31*** | 0.59 | 1.62 |
| 2 | 1.68 | 1.31 | 1.90* | 5.39*** | 0.41** | 1.40 |
| 3 | 1.18 | 1.06 | 1.29 | 2.25*** | 0.54** | 1.14 |
| 4 | 1.50 | 1.24 | 1.26 | 1.42 | 0.64* | 1.41 |
| 5 highest | – | – | – | – | – | – |
| *Maternal education* | | | | | | |
| < High school | 1.65** | 1.31 | 2.02*** | 4.72*** | 0.43*** | 1.15 |
| High school | 1.67** | 1.45* | 1.66** | 2.24*** | 0.35*** | 0.87 |
| Diploma | 1.22 | 1.17 | 1.25 | 2.05*** | 0.52*** | 1.00 |
| Degree | – | – | – | – | – | – |
| *Maternal age* | | | | | | |
| 15–24 | 1.04 | 1.10 | 1.29 | 2.11*** | 0.41*** | 1.63*** |
| 25–29 | 0.91 | 0.92 | 1.42 | 1.28* | 0.66* | 1.26 |
| 30–34 | – | – | – | – | – | – |
| 35–39 | 0.55 | 0.92 | 1.13 | 0.82 | 1.15 | 0.82 |
| 40+ | 0.97 | 0.55 | 1.15 | 0.56 | 0.73 | 0.89 |
| *Socio-economic status* | | | | | | |
| 1 lowest | 2.23** | 1.31 | 2.23*** | 10.63*** | 0.48** | 1.72** |
| 2 | 2.09** | 1.22 | 1.85** | 6.11*** | 0.58** | 1.31 |
| 3 | 1.68 | 1.10 | 1.33 | 3.84*** | 0.31*** | 1.74** |
| 4 | 1.48 | 0.94 | 1.31 | 2.41*** | 0.72 | 1.41* |
| 5 highest | – | – | – | – | – | – |

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (2-tailed tests)
Reference categories chosen to show increasing risks.

**Table 2** Unadjusted odds ratios of birth outcomes and proximal factors among social environment variables

and social support were excluded. SES because it is a composite measure of education, income and occupation, two of which were already included and social support because it was highly negatively correlated with family dysfunction ($r = -0.53$). For each birth outcome, the first model contains only the social environment variables while the second model adds the proximal factors. Both models use sex of the child and parity, as coded by a dichotomous variable of first child status versus other births, as controls. Overall, the results show that the direct effects of the social environment variables were mediated when the proximal factors were added to the model. However, there remained direct effects of family dysfunction on LBW births and maternal education on preterm and SGA births. Of the proximal factors, smoking and high blood pressure retained their higher odds ratios of LBW in the presence of the social environment variables, as did high blood pressure for preterm births and smoking for SGA births.

## Discussion

These findings provide evidence that a modest relationship between the mother's social environment and adverse birth outcomes remains in the presence of three well-known risk factors. However, all three risk factors have notable associations with the mother's social environment, especially smoking (Tab. 2). The social distribution of smoking, alcohol consumption, and high blood pressure during pregnancy provide the context for the direct risk these factors have for an adverse birth outcome. As Link and Phelan[1] note, the reduced associations between the social environment and outcomes in the presence of individual risk factors do not "explain away" their effect, but challenges the analyst to think in terms of processes and mechanisms rather than of independent associations in a contextual void. In addition, the associations found in this study may well be, in themselves, underestimated because of the self-reported, retrospective data on maternal factors and the population sampled was surviving infants, thereby excluding those infants who may have been LBW, preterm, or SGA and died early.

Of the three risk factors, smoking and high blood pressure had significant effects while alcohol use was non-significant

| | Low birth weight | | Preterm | | Small for gestational age | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (1) | (2) | (1) | (2) |
| *Family dysfunction* | | | | | | |
| 1 lowest | – | – | – | – | – | – |
| 2 | 1.78** | 1.76* | 1.35 | 1.33 | 1.31 | 1.28 |
| 3 | 1.67* | 1.60* | 1.10 | 1.07 | 1.43* | 1.36 |
| 4 highest | 1.91** | 1.75* | 1.43* | 1.35 | 1.30 | 1.14 |
| *Income adequacy* | | | | | | |
| 1 lowest | 1.15 | 1.04 | 1.58 | 1.50 | 0.88 | 0.72 |
| 2 | 1.21 | 1.11 | 1.09 | 1.05 | 1.36 | 1.13 |
| 3 | 0.91 | 0.89 | 0.93 | 0.92 | 1.01 | 0.96 |
| 4 | 1.26 | 1.23 | 1.13 | 1.11 | 1.09 | 1.08 |
| 5 highest | – | – | – | – | – | – |
| *Maternal education* | | | | | | |
| < High school | 1.59 | 1.47 | 1.20 | 1.17 | 2.08*** | 1.75** |
| High school | 1.77** | 1.78** | 1.50* | 1.54** | 1.65** | 1.56* |
| Diploma | 1.21 | 1.20 | 1.15 | 1.15 | 1.21 | 1.12 |
| Degree | – | – | – | – | – | – |
| *Maternal age* | | | | | | |
| 15–24 | 0.76 | 0.72 | 0.90 | 0.87 | 0.82 | 0.80 |
| 25–29 | 0.85 | 0.82 | 0.85 | 0.83 | 1.33 | 1.32 |
| 30–34 | – | – | – | – | – | – |
| 35–39 | 0.59 | 0.61 | 0.96 | 0.98 | 1.18 | 1.24 |
| 40+ | 0.86 | 0.94 | 0.52 | 0.54 | 0.98 | 1.15 |
| *Smoking* | – | 1.59** | – | 1.21 | – | 2.89*** |
| *Alcohol consumption* | – | 0.93 | – | 1.21 | – | 1.47 |
| *High Blood Pressure* | – | 2.51*** | – | 2.13*** | – | 1.26 |
| *Sex of child*[a] | 0.71* | 0.70* | 1.10 | 1.10 | 0.83 | 0.84 |
| *First child*[b] | 1.37 | 1.32 | 1.18 | 1.14 | 1.68*** | 1.74*** |
| Model $\chi^2$ (df) | 42.2 (16) $p = 0.000$ | 90.6 (19) $p = 0.000$ | 24.2 (16) $p = 0.085$ | 59.1 (19) $p = 0.000$ | 56.3 (16) $p = 0.000$ | 130.5 (19) $p = 0.000$ |

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (2-tailed tests).
[a] Male child = 1 [b] First child = 1.
Reference categories chosen to show increasing risks.
Model (1): Controls and social environment variables; Model (2): Controls, social environment variables, and proximal factors.

**Table 3** Adjusted odds ratios of brith outcomes among social environment variables and proximal factors (n = 4122)

for all three birth outcomes. This may be due to the fact that consumption itself was generally reported as minimal. Conversely, mothers who reported smoking during their pregnancy, the vast majority (84%) continued to do so throughout their entire pregnancy indicating that pre-pregnancy smoking is very likely to continue through all trimesters. High blood pressure was a risk factor for LBW and preterm outcomes and was also significantly associated with SES. Other research has linked high blood pressure to other social factors such as low levels of decision latitude at work that come with lower-end jobs[30] and diet which is determined, in part, by economic resources[31] – neither of which were available in these data.

It follows then, that a disadvantaged environment places the mother-to-be and, ultimately, the entire pregnancy on a trajectory that is more likely to result in adverse birth outcomes because of an increased likelihood of these women to engage in risky prenatal behaviours. Moreover, as is demonstrated by the prevailing literature, this trajectory is also likely to have long-term consequences for the child. This last point bears directly on the extensive research which indicates that the psychosocial and emotional adjustment of preterm infants is largely determined by an interaction between medical risk factors and family functioning, especially as they relate to effective parent-child dyads[9,32]. The strong association between maternal smoking, family dysfunction, maternal education, and income adequacy suggests that not only will these infants have to contend with the medical and developmental risks associated with such a birth, but they will likely be placed in an environment ill-equipped to supply the effective parent-child interaction required to compensate for such risks. Therefore, maternal risk-taking behaviour during pregnancy could be a warning for potential interventions before, *and after*, the birth of the infant. This further suggests that any efforts designed to mitigate the hazards of high-risk birth and, ultimately, developmental risks associated with these outcomes should be designed to move beyond the actual maternal behaviours to examine the social context in which they occur. While this moves us outside of the common individualistic approach to treating risky behaviours such as smoking, success will likely be limited until the environment in which these behaviours occur is addressed.

Zusammenfassung

**Jenseits der Biologie: pränatales Verhalten im sozialen Kontext und die Einflüsse auf Problemgeburten**

**Fragestellung:** In dieser Studie untersuchen wir anhand eines repräsentativen Datensatzes die Faktoren, die mit Risikogeburten (Frühgeburten, geringes Gewicht oder Unterentwicklung bei Geburt) assoziiert sind.

**Methoden:** In unserer Untersuchung berücksichtigen wir Faktoren, die mit dem Verhalten der Mutter während der Schwangerschaft und mit den sozialen und wirtschaftlichen Umständen der Familie in Verbindung stehen. Wir verwenden logistische Regressionsmodelle, um das erhöhte Risiko von geringem Geburtsgewicht, Frühgeburten und verminderter Fruchtentwicklung, das mit Nikotin- und Alkoholkonsum sowie hohem Blutdruck während der Schwangerschaft verbunden ist, mit sozio-ökonomischen Faktoren, wie Zerrüttungen in der Familie, sozialer Unterstützung, Einkommen, Alter und Ausbildung, zu bestimmen.

**Ergebnisse:** Während alle sozio-ökonomischen Variablen das Rauchen der Mutter während der Schwangerschaft erklären, finden wir für den Alkoholkonsum und hohen Blutdruck nur Unterschiede in Bezug auf Ausbildung und sozio-ökonomischen Status. Rauchen während der Schwangerschaft, hoher Blutdruck und niedrigerer Ausbildungsstand der Mutter sowie ein höherer Grad von Familienzerrüttung zeigen einen signifikanten Anstieg des Risikos einer Problemgeburt.

**Schlussfolgerungen:** Interventionen, die das Risiko von Problemgeburten zu mindern versuchen, sollten die unterschiedlichen Einflüsse, die mit Alter, Ausbildung, Einkommen, Familienstand und riskantem Verhalten der Mutter während der Schwangerschaft assoziiert sind, berücksichtigen.

Résumé

**Au delà de la biologie: le contexte social du comportment prénatal et les résultats à la naissance**

**Objectifs:** Dans cette étude, nous examinons les facteurs qui sont associés avec les résultats negatifs pour les naissances, en utilisant un échantillon national et représentatif.

**Méthodes:** Dans l'analyse, nous prenons en compte des facteurs qui sont liés avec le comportement de la mère pendant la grossesse, et aussi nous considérons les circonstances socio-économiques de la famille. Une série de modèles de régression logistique est exploitée pour déterminer les risques accrus de petits poids de naissance, naissance prématurée, et petite taille par rapport à l'âge gestationnel, qui sont associés avec le tabagisme maternel, la consommation d'alcool et la tension artérielle élevée, vis-à-vis des facteurs socio-économiques comme le dysfonctionnement familial, le soutien social, l'adéquation des revenus, l'âge et l'éducation.

**Résultats:** Tous les facteurs socio-économiques indiquent des courbes linéaires avec le tabagisme maternel pendant la grossesse, mais seulement l'éducation de la mère et le status socio-économique montrent des courbes linéaires avec la consommation de l'alcool et la tension artérielle élevée. On a trouvé que le tabagisme maternel, la tension artérielle élevée, le dysfonctionnement familiale élevé, et le niveau bas d'éducation de la mère augmentent le risque d'un résultat negatif à la naissance.

**Conclusions:** Les interventions prévues pour réduire le risque des résultats négatifs à la naissance doivent tenir compte des relations entre des comportements maternels dangereux avant la naissance, ainsi que l'âge, l'éducation, le revenu, et le dysfonctionnement familial.

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