Almost 10% of women around the world report consuming alcohol during pregnancy, which can lead to fetal alcohol spectrum disorder (FASD) in children. FASD is a diagnostic term that describes numerous symptoms and disabilities resulting from prenatal alcohol exposure, including facial dysmorphology, growth restriction, intellectual disabilities and social and behavioural difficulties that persist throughout the lifespan. The global incidence of FASD has been estimated to be 1 in every 100 live births and significantly higher in vulnerable populations. The lifelong impact of this disorder makes FASD a global public health concern and significant clinical and policy challenge.

Physicians delivering prenatal health care (PNC) services to women are in a unique position to help prevent or reduce the amount of alcohol consumed during pregnancies and can play an integral role in decreasing the prevalence of FASD. PNC is often the first point of access of care for women of child-bearing age and a frequently used preventive health care service in countries that provide universal health care. Physicians delivering PNC should routinely screen for alcohol use in pregnancy, and when they identify pregnant patients who are consuming alcohol they should refer them to treatment and support programs and link them to community resources. PNC has been shown to be more effective if it

Abstract

Background: Few studies have investigated prenatal care use among women who use alcohol during pregnancy. The objective of this study was to investigate rates of prenatal care usage of women who have given birth to children with fetal alcohol spectrum disorder (FASD).

Methods: We conducted a case–control study of women with children born in Manitoba between Apr. 1, 1984, and Mar. 31, 2012, with follow-up until 2013, using linkable administrative data. The study group included women whose child(ren) was (were) diagnosed with FASD (n = 702) between Apr. 1, 1999, and Mar. 31, 2012, at a centralized diagnostic clinic. The comparison group included women whose child(ren) did not have an FASD diagnosis (n = 2097), exact matched on the index child’s birthdate, postal code and socioeconomic status. Adequacy of prenatal care was defined using the Revised Graduated Prenatal Care Utilization Index.

Results: Women in the study group had lower socioeconomic status than women in the comparison group and were more likely to have mental disorders and involvement with the child welfare system. Rates of inadequate prenatal care were higher among women in the study group (adjusted relative risk 2.47, 95% confidence interval [CI] 2.08–2.94), as were rates of no prenatal care (adjusted relative risk 3.55, 95% CI 2.42–5.22). In the study group, 41% of women accessed inadequate or no prenatal care, and 59% received intermediate, adequate or intensive prenatal care.

Interpretation: Women who give birth to children with FASD have higher rates of inadequate prenatal care and significant social complexities. Socioeconomic disparities in the use of prenatal care should be addressed; multisector interventions are needed that facilitate the uptake of prenatal care by high-risk women who use alcohol.
begins in the first trimester of pregnancy and regular visits are continued throughout pregnancy.11 The International Charter on Prevention of FASD12 recognizes the importance of screening for at-risk alcohol use in women of child-bearing age in primary care settings. Recommendations by professional societies such as the American Congress of Obstetricians and Gynecologists state that screening, brief intervention and referral to treatment should be implemented in general primary care and obstetric settings to reduce alcohol use during pregnancy.13 These interventions are particularly relevant in countries where there is access to universal health care, specifically free access to regular PNC, as cost can be a significant barrier to seeking care.

Few studies have investigated the actual rates of PNC utilization by women who have given birth to children with FASD. Documenting whether women who give birth to children with FASD access PNC and receive adequate PNC is the first step in investigating the potential role PNC settings can play in reducing prenatal alcohol use and ultimately the incidence of FASD. If screening programs in PNC settings are to be successful, it is imperative to know whether the women to whom these programs are targeted are actually using the health care service.

This study uses a population-based cohort from a country with a universal health care system to compare rates of PNC utilization among women whose child(ren) has (have) FASD with those of women whose child(ren) does (do) not have FASD.

Methods

Study setting
We conducted a retrospective analysis of the Manitoba Mothers and FASD Cohort,14 a population-based cohort of Manitoba women whose child(ren) was (were) born between Apr. 1, 1984, and Mar. 31, 2012, and diagnosed with FASD between Apr. 1, 1999, and Mar. 31, 2012.15 The FASD diagnosis data first became available in 1999, making this the earliest year in which we are able to identify children with FASD.

Data sources
This study used administrative health, social and educational data from the Population Research Data Repository housed at the Manitoba Centre for Health Policy (MCHP) and clinical assessment data from the Manitoba FASD Centre, which is the only referral/diagnostic centre for FASD in the province.15 The data set consists of children who have received a diagnosis of FASD, children who have been assessed but did not meet the criteria for an FASD diagnosis, and those who have received a deferred status, meaning that they will be assessed at a later time (e.g., when they are older and symptoms may be more apparent). Table 1 provides a description of all databases used in this study.15 Health records from the Ministry of Health are deidentified before being transferred to the MCHP repository. They remain linkable across multiple databases by way of scrambled personal health identification numbers. Rates of PNC utilization were obtained from Manitoba Health’s hospital discharge abstracts and medical/physician reimbursement claims. The reliability and validity of the data in the MCHP repository have been well established, and the databases are widely used for health and social service research,16–19 including studies drawing on the Manitoba Mothers and FASD Cohort.14,20

Study cohort
Women included in this study were drawn from the entire Manitoba population of women who had a live birth in Manitoba between Apr. 1, 1984, and Mar. 31, 2012, and continued living in Manitoba until December 2013.15 This population generated 2 groups (Figure 1).

Study group: Mothers whose children had received a clinical diagnosis of FASD
We first identified all Manitoba children and youth (up to the age of 21 yr) who had been diagnosed with FASD between 1999 and 2012 using the Manitoba FASD Centre data15 and then identified their birth mothers by linking the Manitoba FASD Centre data to administrative health data in the repository.17 We excluded women who were not residents of Manitoba and were therefore not covered by Manitoba’s universal health care program during the period of 3 years before the birth of their child until March 2013,15 as well as women whom we could not link to their children because of missing postal code information.15 See Figure 1 for more information on the study cohort.

Comparison group: Mothers whose children had not received a clinical diagnosis of FASD
The comparison group included women from the general population who had no evidence of prenatal alcohol use and whose child(ren) had no evidence of FASD according to data from the Manitoba FASD Centre and repository (see Figure 1 for exclusion criteria). We matched this group to the study group on the index child’s birthdate, postal code of residence and socioeconomic status at a ratio of 3:1,15 using exact matching.

Variables

Outcomes
Physician claims and hospital discharge abstracts were used to assess the quantity and timing of PNC visits. The gestational age of the baby was obtained from the hospital birth record and physician claims files were used to identify the number and initiation of PNC visits. Pregnancy trimesters were defined as follows: the first trimester is from the date of conception to 91 days, the second trimester is from 92 to 189 days and the third trimester is from 190 days to the date of birth. The date of conception was calculated by subtracting the gestational age from the birthdate of the child. The following outcomes were calculated to investigate PNC utilization: (a) no care, (b) late initiation of PNC, (c) care initiated in the first trimester, (d) care initiated in the second trimester, (e) care initiated in the third trimester, (f) low number of
| Name of data set                          | Description                                                                                                                                                                                                 | Years of data used | Information retrieved                                                                 |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------|
| Population registry                     | This registry is maintained by the provincial department of health and includes information for all Manitobans eligible to receive health services since 1970. It includes demographic information and patients’ 6-digit residential postal code. | 1970/71 to June 2013 | Demographic information: region of residence                                         |
| Canadian census                         | Social data from the Statistics Canada population census were used to indicate area-level income. The Manitoba population was divided into 5 income quintiles according to average household income, with Q1 being the lowest and Q5 being the highest income quintile. | 1996, 2001, 2006, 2011 | Socioeconomic status information                                                    |
| Employment and income assistance        | Data maintained by the Manitoba Department of Families provide information on Manitoba residents who receive provincial income assistance.                                                                     | 1995/96 to 2012/13 | Receipt of income assistance                                                        |
| Babies First/Families First screening programs | Data on newborn risk factors are collected as part of a home visiting program conducted by Healthy Child Manitoba. The screening form is filled out by public health nurses for all families with newborns in Manitoba and captures data on biological, social and demographic risk factors and alcohol use during pregnancy. | 2003 to 2013 (Families First), 2000 to 2002 (Babies First) | Alcohol and drug use during pregnancy, social isolation                             |
| InSight program                         | Data are collected from the InSight outreach program, in which mentors provide support to women who use substances and are pregnant or have recently had a baby. This data set includes information on women who have prenatal alcohol use. | 1999 to 2012/2013 | Alcohol and substance use during pregnancy                                           |
| Hospital discharge abstracts            | Manitoba Health maintains health data on all hospital admissions in Manitoba. Up to 16 ICD-9-CM diagnostic codes are included for discharges before Apr. 1, 2004, and up to 25 ICD-10-CA diagnostic codes for discharges on or after Apr. 1, 2004. | 1981 to 2012/13 | Physical and mental health diagnoses, antenatal hospitalizations, suicide attempts |
| Medical/physician reimbursement claims  | Manitoba Health maintains health data on all ambulatory visits to physicians in Manitoba. A single ICD-9 diagnostic code is associated with each visit, coded to the third digit. | 1981 to 2013 | Physical and mental health diagnoses, physician visits, prenatal care           |
| Prescription claims: Drug Program Information Network | Manitoba Health maintains data on all prescription drug claims from the Drug Program Information Network (an electronic, online, point-of-sale prescription drug database that connects Manitoba Health and all pharmacies in Manitoba). Information on all prescription drugs dispensed in Manitoba is included. | 1995/96 to 2012/13 | Physical and mental health conditions                                                |
| Manitoba FASD Centre                    | This data set includes clinical assessments and diagnoses received under the FASD umbrella for all children referred to the Manitoba FASD Centre. It contains data for children who have received a diagnosis of FASD, children who have been assessed but do not meet the criteria for FASD and children who have received a deferred status, meaning that they will be assessed at a later time. | 1999 to 2012/13 | FASD diagnosis                                                                      |
| Vital statistics                        | A longitudinal population-based registry is maintained by the Manitoba Vital Statistics Agency that contains data for all Manitobans who have died since January 1970, including the cause of death. | 1970 to 2012/13 | Cause of premature death, suicide completion                                      |
| Education: enrolment, marks and assessments | The Manitoba Department of Education and Training maintains data on enrolment, marks, high school completion and special funding. (Special education funding is provided to children with severe to profound disabilities.) | 1995/96 to 2012/13 | High school completion, level of special education funding |

Note: FASD = fetal alcohol spectrum disorder, ICD-9 = 9th revision of the International Classification of Diseases; ICD-9-CM = clinical modification of the ICD-9; ICD-10-CA = Canadian version of the 10th revision of the International Classification of Diseases. (Adapted, with permission, from Singal D, Brownell M, Hanlon-Dearman A, et al. Manitoba mothers and fetal alcohol spectrum disorders study (MBMomsFASD): protocol for a population-based cohort study using linked administrative data. Bmj Open 2016;6:e013330. 14)
Figure 1: Study cohort formation. InSight is an intensive mentoring program for women who are pregnant or have recently had a baby and have issues with substance issue and are at high risk of having children with fetal alcohol spectrum disorder. Note: ADHD = attention-deficit hyperactivity disorder, FASD = fetal alcohol spectrum disorder.

prenatal visits and (g) adequacy of PNC (see Table 2 for definitions).

Adequacy of PNC was evaluated using the Revised Graduated Prenatal Care Utilization Index (R-GINDEX); this commonly used validated index is based on the full American College of Obstetricians and Gynecologists guidelines.9,10,21,22 The R-GINDEX is derived using 3 variables: gestational age, the trimester in which care was initiated and the number of prenatal visits. Gestational age is obtained from the birth hospitalization discharge abstract, and prenatal care is derived
from physician claims. These 3 variables are used to categorize PNC into 6 distinct groups: (a) no care, (b) inadequate care, (c) intermediate care, (d) adequate care, (e) intensive care and (f) missing. For example, for a woman who began prenatal care in her first trimester and gave birth at 40 weeks gestation, 1–7 prenatal care visits is considered inadequate care, 8–12 visits is considered intermediate care, 13–16 visits is considered adequate care and 17 or more visits is considered intensive care. These 6 categories of care are used consistently across different measures of PNC as they provide accurate measurements of PNC utilization; this is critical for monitoring trends and assessing potential relationships.

Covariates

The following covariates were selected on the basis of clinical relevance and were adjusted for in each of the outcome models: region of residence, date of birth of index child and socioeconomic status. Socioeconomic status was defined using area-level (available at the dissemination area level, which is approximately 400–700 individuals) mean household income from census information and grouped into quintiles ranked from 1 (low) to 5 (high), with approximately 20% of the population assigned to each quintile.

Analysis

A summary data set for the total number of events (e.g., total number of mothers with inadequate PNC) was produced to model the rate of PNC utilization comparing the study and comparison groups. We modelled adjusted relative rates of PNC utilization using generalized linear models with a Poisson or negative binomial distribution. This type of model is suitable for non-normally distributed data such as counts. We adjusted for covariates tested for differences between the study group and comparison group. The log of the population was included as an offset in the model to generate a relative rate versus a relative count of events. For the Poisson distribution we used a robust variance estimator proposed by Liang-Zeger. Administrative data are not collected for research.
purposes; therefore, we could not include various confounding variables present in the literature that are known to affect women accessing health care services, including limited transportation and feelings of stigma or fear. To address this limitation, gamma sensitivity analysis was conducted to measure how strong an unmeasured confounder would have to be to nullify statistically significant results.26,27

Ethics approval
This study was approved by the University of Manitoba's Health Research Ethics Board (HS16460[H2013:221]) and the Manitoba Health Information Privacy Committee (HIPC no. 2013/2014-20).

Results
Our study population consisted of women who were born between 1946 and 1992, with ages ranging from 14 to 46 years (Table 3). Most of the women from both groups were from an urban location and had a wide variety of social and health complexities (Table 3). Women in our study group had low socioeconomic status; 19% had a history of receiving income assistance before the birth of the child, indicating the considerable level of poverty present in this cohort. Women in the study group were also more likely to be lone parents, more likely to have higher gravidity and parity and more likely to have mental health disorders than women in the comparison group.

Prenatal care utilization
Thirty-three percent of the study group had inadequate PNC and 8.12% had no PNC, whereas 14% and 2% of our comparison group had inadequate and no PNC, respectively (Table 4). When we adjusted for maternal age, region of residence and socioeconomic status, our study group had over 2 times the rate of inadequate PNC (adjusted relative rate 2.47, 95% confidence interval [CI] 2.08–2.94) and over 3 times the rate of no PNC versus our comparison group (adjusted relative rate 3.55, 95% CI 2.42–5.22). Women in the study group also had higher rates of the following: PNC that was initiated in the second trimester (adjusted relative rate 1.69, 95% CI 1.35–2.13), late/no initiation of care (adjusted relative rate 1.69, 95% CI 1.39–2.04), low number of prenatal visits (adjusted relative rate 3.15, 95% CI 2.59–3.83), intermediate PNC (adjusted relative rate 1.62, 95% CI 1.34–1.94) and inadequate/no PNC (adjusted relative rate 2.63, 95% CI 2.25–3.08). Despite the high rates of inadequate or no prenatal care, 59% of women in the study group did receive intermediate, adequate or intensive PNC.

Gamma sensitivity analysis
Sensitivity analyses found that all of the models generating rates of quality and frequency of prenatal care were reasonably robust to unmeasured confounding (Table 4), including late or no initiation of care and all levels of quality of PNC measured by the R-GINDEX. Hence, the likelihood of confounders existing, after adjustment for covariates included in the models, that would nullify the direction and significance of our results is small. However, the sensitivity measure regarding care initiated in the first trimester may be more sensitive to unmeasured confounding and could potentially become nonsignificant if there were very strong unmeasured confounders for which we were unable to account. The findings regarding care initiated in the third trimester were quite sensitive to unmeasured confounding, which is a limitation; however, neither of these situations would weaken the overall findings from these analyses.

Interpretation
Women who give birth to children with FASD often receive inadequate PNC. Over a third (41%) of women in the study group received inadequate or no PNC, compared with just over 15% of women in the comparison group. Study findings also indicate that women who give birth to children with FASD have increased social complexities, including lone parenthood, low socioeconomic status, higher gravidity and parity and higher rates of mental health disorders.20,28 These social complexities may affect the way they access prenatal care. These results suggest that screening and intervention programs implemented in PNC settings may miss a population at extremely high risk for alcohol use during pregnancy. Within FASD prevention strategies focusing on prenatal care, it may be useful to implement outreach efforts developed to reduce the inequities in access to and use of prenatal care by women who may be harder to reach.29

Despite the high proportion of inadequate PNC in the study group, 59% of women who have given birth to a child with FASD received adequate, intensive or intermediate PNC and consumed alcohol throughout their pregnancy. Results of this study therefore also demonstrate that a significant proportion of women who give birth to children with FASD do access regular PNC, identifying an important target for alcohol prevention and reduction interventions.

These study results are consistent with the few previous studies in this area.10–13 All of the previous studies reported that women who give birth to children with FASD receive less PNC than women in comparison groups and generally begin PNC later in their pregnancies.10–13 Previous studies were limited by the use of small sample sizes generated from high-risk populations and were not conducted in countries with universal access to health care. The model of health care delivery is an important factor when investigating health care utilization, as lack of health care insurance and inability to pay for health services are significant barriers to accessing regular care. Moreover, cultural differences between women in high-risk conditions may preclude the generalization of study results to women in general populations. Furthermore, measures used to assess the frequency of PNC visits in previous studies were not standardized, potentially resulting in biases when calculating the frequency of care received by women.

This study adds to the international literature by contributing data from a large North American sample of women who have access to universal PNC and by employing a novel analysis that uses a standardized index to evaluate PNC utilization. Through the use of this index we can
### Table 3 (part 1 of 2): Characteristics of women whose child(ren) was (were) diagnosed with FASD and a matched sample of women whose child(ren) did not have FASD

| Characteristic                                      | Study group, no. (%)* | Comparison group, no. (%)* |
|-----------------------------------------------------|-----------------------|----------------------------|
|                                                     | $n = 702$             | $n = 2097$                 |
| Maternal age at birth of index child, yr            |                       |                            |
| Mean ± SD                                           | 24.43 ± 6.14          | 29.24 ± 5.69               |
| Range                                               | 14–43                 | 14–46                      |
| Maternal age at birth of index child, yr            |                       |                            |
| < 18                                                | 72 (10.3)             | 231 (11.0)                 |
| 18–24                                               | 333 (47.4)            | 831 (39.6)                 |
| 25–29                                               | 146 (20.8)            | 525 (25.0)                 |
| 30–34                                               | 96 (13.7)             | 367 (17.5)                 |
| ≥ 35 and missing†                                   | 55 (7.8)              | 143 (6.8)                  |
| Maternal age at first birth, yr                     |                       |                            |
| < 18                                                | 266 (37.9)            | 246 (11.7)                 |
| 18–24                                               | 340 (48.4)            | 854 (43.1)                 |
| 25–29                                               | 54 (7.7)              | 530 (25.3)                 |
| 30–34                                               | 29 (4.1)              | 306 (14.6)                 |
| ≥ 35 and missing†                                   | 13 (1.9)              | 112 (5.3)                  |
| History of teen pregnancy                          | 266 (37.9)            | 246 (11.7)                 |
| Region of residence                                 |                       |                            |
| Rural                                               | 251 (35.8)            | 764 (36.4)                 |
| Urban                                               | 451 (64.2)            | 1333 (63.6)                |
| Mean household income                               |                       |                            |
| Q1 (lowest)                                         | 466 (64.4)            | 1398 (66.7)                |
| Q2                                                  | 104 (14.8)            | 312 (14.9)                 |
| Q3                                                  | 57 (8.1)              | 171 (8.2)                  |
| Q4                                                  | 36 (5.1)              | 108 (5.2)                  |
| Q5 (highest)                                        | 26 (3.7)              | 78 (3.7)                   |
| Missing                                             | 13 (1.9)              | 30 (1.4)                   |
| Receipt of income assistance 3 yr before birth of the index child‡ | 63 (18.3)             | 98 (9.6)                   |
| Socioeconomic status                                |                       |                            |
| Income quintile                                     |                       |                            |
| Low (Q1)                                            | 466 (66.4)            | 1398 (66.7)                |
| Middle (Q2 and Q3)                                  | 161 (22.9)            | 483 (23.0)                 |
| High (Q4 and Q5)                                    | 62 (8.8)              | 186 (8.9)                  |
| Missing                                             | 13 (1.9)              | 30 (1.4)                   |
| Married at birth of child                            | 66 (9.4)              | 773 (36.9)                 |
| Gravidity                                           |                       |                            |
| 0–3                                                 | 357 (50.9)            | 1966 (93.8)                |
| ≥ 4                                                 | 306 (43.6)            | 113 (5.4)                  |
| Missing                                             | 39 (5.6)              | 18 (0.9)                   |
| Parity                                              |                       |                            |
| 0–3                                                 | 524 (74.6)            | 2063 (98.4)                |
| ≥ 4                                                 | 139 (19.8)            | 16 (0.8)                   |
| Missing                                             | 39 (5.6)              | 18 (0.9)                   |
assess the varying degrees of PNC quality and utilization among our study sample, and we can assess not only whether women received inadequate care but also what proportions of them received adequate PNC and continued to consume alcohol during pregnancy. The use of administrative claims data in investigating PNC utilization by women who give birth to children with FASD strengthens the rigour of the study; these data are tremendously valuable for investigating the health care utilization of populations because their use eliminates important biases inherent in previous studies that used primary data collection methods, including nonresponse, recall and interviewer bias. Furthermore, by using clinical data from the Manitoba FASD Centre we ensured that our study group comprised women whose children have undergone a comprehensive multidisciplinary assessment in a central tertiary-level provincial diagnostic clinic that follows the Canadian guidelines for the diagnosis of FASD.

Further investigation is warranted to examine how physicians approach PNC for women at risk for alcohol consumption during pregnancy (including screening, identifying and treating these at-risk women). Our results also indicate the need for further work to uncover the barriers and facilitators to PNC access for women with alcohol use and dependence issues, to develop effective outreach programs that make it easier for women at high risk for alcohol use during pregnancy to access PNC, and to develop programs and supports that help women to abstain from alcohol use during pregnancy.

### Limitations

Although the data from the Manitoba FASD Centre provide good specificity, they provide uncertain sensitivity because women whose children are not referred to the clinic for assessment will be excluded from the study group. Therefore, the denominator was limited to women who had babies after 1998 to ensure 3 years of data were available before the birth of the child to evaluate the number of women who had income assistance 3 years before the birth of their children; 345 women in the study group and 1026 women in the comparison group had babies after 1998. To ensure that we adhered to the privacy rules associated with using MCHP data, we combined these women with the women in the ≥ 35 yr class.

### Table 3 (part 2 of 2): Characteristics of women whose child(ren) was (were) diagnosed with FASD and a matched sample of women whose child(ren) did not have FASD

| Characteristic                                           | Study group, no. (%)* | Comparison group, no. (%)* |
|----------------------------------------------------------|----------------------|---------------------------|
| Involvement with child and family services 3 yr before the birth of the child§ | n = 345§             | n = 1026§                 |
| Diagnosis of psychiatric disorder 3 yr before the birth of the child§ | 580 (82.6)           | 566 (27.0)                |
| Substance abuse**                                       | 179 (25.5)           | 41 (2.0)                  |
| Personality disorder**                                   | 22 (3.1)             | 6 (0.3)                   |
| Mood and anxiety disorder**                             | 237 (33.8)           | 397 (18.9)                |
| Schizophrenia**                                         |                       |                           |
| Prenatal psychological distress‡‡                       | 529 (75.4)           | 293 (14.0)                |
| Postnatal psychological distress§§                       | 528 (75.2)           | 923 (44.0)                |

Note: FASD = fetal alcohol spectrum disorder, SD = standard deviation.

*Unless indicated otherwise.
†There were fewer than 6 women in the study group with missing information for this characteristic.
To ensure that we adhered to the privacy rules associated with using MCHP data, we combined these women with the women in the ≥ 35 yr class.
§Income data were available after 1995. Therefore, the denominator was limited to women who had babies after 1998 to ensure 3 years of data were available before the birth of the child.
¶Includes substance abuse, personality disorders, mood and anxiety disorders, prenatal psychological distress, postnatal psychological distress and schizophrenia.
**Diagnosed 3 yr before the birth of the index child.
††The crude rate was suppressed because n < 6.
‡‡Diagnosed 8 mo before the birth of the index child.
§§Diagnosed 12 mo after the birth of the index child.
and these estimates rely on the accuracy of physician coding. There may be missing PNC records in hospital or physician charts, and data from health care providers who do not submit claims for PNC may be missed. However, as previously stated, the data in the MCHP repository have been extensively validated for health services research, and therefore missing data are expected to have a practically negligible effect on the outcomes of this study. 10,16–19,34,35 Although we controlled for socioeconomic status, the date of birth of the index child, and region of residence, there may be additional covariates that we did not account for. Another possible limitation of our study is that we were not able to determine if physicians had screened patients for alcohol use during pregnancy or counselled these women about the importance of refraining from alcohol use during pregnancy. Although universal screening for substance use during pregnancy is recommended, not all women are screened during their PNC visits as physicians may be inadequately trained to screen for prenatal alcohol use and may question the likelihood that women will reduce their alcohol use. Physicians may also be unaware of how to help their patients or connect them with resources if they do discuss alcohol use. Pregnant women may also be reluctant to disclose alcohol use during pregnancy because they may fear stigma and judgment and they may be afraid that they will lose their children to child welfare services.

## Table 4: Prenatal care of women who gave birth to a child with FASD compared with that of women who did not give birth to a child with FASD

| Outcome | Crude rate (%) | Adjusted RR (95% CI)* | Sensitivity to unmeasured confounding† |
|---------|----------------|------------------------|--------------------------------------|
|          | Women who gave birth to a child with FASD | Women who did not give birth to a child with FASD |
| Trimester in which care was initiated |       |       |
| First trimester | 536 (76.4) | 1798 (85.7) | 0.88 (0.81–0.97) | 17.9 |
| Second trimester | 116 (16.5) | 209 (10.0) | 1.69 (1.35–2.13) | 56.9 |
| Third trimester | 33 (4.7) | 65 (3.1) | 1.54 (1.02–2.35) | 4.1 |
| Late or no initiation of PNC | 166 (23.7) | 299 (14.3) | 1.69 (1.39–2.04) | 63.8 |
| Low number of PNC visits | 209 (29.8) | 200 (9.5) | 3.15 (2.59–3.83) | 83.1 |
| Quality of PNC care as determined by the R-GINDEX |       |       |
| Inadequate PNC | 234 (33.3) | 287 (13.7) | 2.47 (2.08–2.94) | 80.9 |
| Intermediate PNC | 175 (24.9) | 327 (15.6) | 1.62 (1.34–1.94) | 61.8 |
| Adequate PNC | 113 (16.1) | 399 (19.0) | 0.84 (0.68–1.04) | NS |
| Intensive PNC | 123 (17.5) | 1036 (49.4) | 0.35 (0.29–0.43) | 82.0 |
| No PNC | 57 (8.1) | 48 (2.2) | 3.55 (2.42–5.22) | 69.7 |
| Inadequate or no PNC | 291 (41.5) | 335 (16.0) | 2.63 (2.25–3.08) | 87.3 |

Note: CI = confidence interval, FASD = fetal alcohol spectrum disorder, NS = not statistically significant; PNC = prenatal care, RR = relative risk. We adjusted for region of residence, age at birth of index child and socioeconomic status.

*Women who gave birth to a child with FASD v. women who did not give birth to a child with FASD (reference).
†Analyzed using γ sensitivity test; γ sensitivity analysis was not conducted for findings that were not statistically significant.

## Conclusion

Women who give birth to children with FASD have higher rates of inadequate PNC as well as higher rates of social complexities including poverty, mental health issues and involvement with child welfare services. Multisector interventions that address the social determinants of health are needed to facilitate access to prenatal care for vulnerable women who consume alcohol. A substantial percentage of the women in this study who used alcohol during pregnancy did receive adequate PNC and consumed enough alcohol to affect the fetus, highlighting an important need for additional research to better understand the quality of PNC and the opportunities to reduce or eliminate alcohol consumption through this health service.

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