

ORIGINAL ARTICLE

Is Fetal Gender Associated with Emergency Department Visits for Asthma During Pregnancy?

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Background. To investigate if fetal gender (1) affects the risk of having an emergency department (ED) visit for asthma; and (2) is associated with adverse pregnancy outcomes among women who had at least one visit to the ED for asthma during pregnancy. **Methods.** We linked two provincial administrative databases containing records on in-patient deliveries and ED visits. The study sample included women who delivered a live singleton baby between April 2003 and March 2004. Pregnant women who made at least one ED visit for asthma were counted as cases and the rest of the women as control subjects. We performed a multivariable analysis using logistic regression to model the risk of having an ED visit for asthma, with fetal gender being one of the predictors. In addition, a series of multivariable logistic regressions were also constructed separately for cases and controls for the following adverse delivery outcomes: low birth weight baby, preterm delivery, and delivery via Caesarian section. **Results.** Among 109,173 live singleton deliveries, 530 women had visited ED due to asthma during pregnancy. While having an ED visit for asthma was positively associated with teenage pregnancy, low income, and presence of pregnancy-induced hypertension, it was not associated with fetal gender (OR 1.01, 95% CI 0.85–1.19). Fetal gender was not a significant predictor of adverse pregnancy outcomes among women who had an asthma ED visit during pregnancy. **Conclusion.** Fetal gender does not affect the risk of having an ED visit for asthma during pregnancy, and it is not associated with adverse pregnancy outcomes among women who had an asthma-related ED during pregnancy.

Keywords asthma, pregnancy, fetal gender, emergency department visit

INTRODUCTION

A relatively high prevalence of asthma in the general population and female predominance among adult patients (1–2) make asthma the most frequent respiratory disorder complicating pregnancy. According to various estimates, 3.7% to 8.4% of pregnant women have asthma (3–6). It is known that asthmatic women have a higher risk of developing pregnancy complications and adverse delivery outcomes (5, 7–10) compared to the general population.

Pregnancy also may affect the course of asthma in women (11). Severity of pre-pregnancy asthma is the main predictor of worsening of asthma during pregnancy (12). There is also some evidence suggesting that fetal gender can modify the course of asthma during pregnancy. Results from recent studies suggest that asthmatic women pregnant with female fetuses are more likely than those pregnant with male fetus to have increased symptoms of asthma during pregnancy (13, 14). Interestingly, the incidence of intrauterine growth retardation was also shown to be higher in daughters than in sons of asthmatic women (15, 16). These findings seem to indicate that the worsening of both asthma symptoms and adverse neonatal outcomes may be more prevalent in pregnancies with female fetuses than in pregnancies with male fetuses. Although the mechanism behind this phenomenon is

not completely clear, the interaction between fetal gender and regulation of placental glucocorticoid and immune response in asthmatic pregnancies has been implicated (16, 17).

Clinical administrative records offer a way to examine the association between fetal gender and both maternal asthma morbidity and delivery outcomes in pregnant asthmatics. In this retrospective comparison of the emergency department (ED) visits for asthma by pregnant women who delivered girls versus those who delivered boys, we aimed to answer the following research questions:

1. Does fetal gender influence the frequency, outcomes and temporary pattern of ED visits by pregnant asthmatic women?
2. Are there any differences in delivery outcomes between pregnant asthmatic women who visited the ED and subsequently delivered girls versus those who delivered boys?

METHODS

Study Design and Data Sources

Emergency department visits made by pregnant women were identified through linkage of two administrative clinical databases: (1) the hospital Discharge Abstract Database (DAD), which contains demographic, diagnostics, and procedural and administrative information about all in-patient admissions across Canada; and (2) the National Ambulatory Care Reporting System (NACRS) database that contains ED

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visit records. Both databases were provided by the Canadian Institute for Health Information (CIHI). Information on in-hospital deliveries that occurred in Ontario hospitals between April 2003 and March 2004 was received as linked maternal-newborn records. Cases of multiple deliveries and stillbirth were excluded. The maternal portion of mother-infants dyads includes information on women's age at delivery, modes of delivery (vaginal versus Caesarian section [C-section]), pregnancy and delivery complications, and major obstetric procedures. The newborn portion contains information on baby's gender, gestational age, birth weight, and birth date. Based on a woman's residential postal codes her socioeconomic status was estimated through an approach developed by Statistics Canada that assigns neighborhoods to five equally sized quintiles based on income data reported on the 2001 Census (18). A higher quintile value of a residential area is associated with higher socioeconomic status of residents in that area.

Eligible maternal-newborn dyads from DAD were linked to ED records in NACRS using deterministic linkage based on the encrypted health card number (unique personal identifier). We subsequently verified validity of the linkage, comparing the values of common variables across linked records (e.g., mother's age and postal code). ED visits due to asthma were identified through the principal diagnosis in the ED records: *J45.0-45.9* (asthma or *status asthmaticus* according to the International Classification of Diseases, version 10 [ICD-10]). We included only those ED visits that occurred during pregnancy. The start date of pregnancy was determined through records of baby's gestational age. The following variables were abstracted from the ED records: date of ED visit, triage level, and visit disposition. Triage level in NACRS is assigned according to the Canadian Triage Acuity Scale (CTAS) developed by Canadian Association of Emergency Physicians (17). CTAS provides a measure of the patients' priority for treatment and can be used as an indirect estimator of the severity of patients' symptoms on arrival to the ED. It is a 5-point scale with the urgency or need for ED treatment decreasing with increase in CTAS level. That is, CTAS 1 corresponds to the most severe, often life-threatening situations, while CTAS 5 is assigned to mild, non-urgent conditions (19).

Ethical Considerations

This study was conducted according to the Ethical Conduct for Research Involving Human Tri-Council Policy Statement (20) and the Canadian Institutes of Health Research (CIHR) guidelines on Secondary Use of Personal Information in Health Research (21). We applied several security safeguards in the data access, handling, and storage. After linkage and creation of an analysis file with all necessary information, all personal identifiers were removed. The study received research ethics approval from the McMaster University Research Ethics Board.

Statistical Analysis

We note here that a mother (patient) is the unit of analysis for all outcomes. All women who delivered a live singleton baby were divided into two groups according to the gender of the baby. Frequency of ED visits, top 10 reasons for ED visit during pregnancy, and temporal patterns of ED visits by week of gestation were compared between these two groups.

Women who had an ED visit for asthma were designated as cases, while the rest of the women were control subjects. The probability of having an ED visit for asthma during pregnancy was modeled through multivariable logistic regression with fetal gender, maternal age at delivery, socioeconomic status, and presence of pregnancy-induced hypertension as predictor variables. The diagnosis of pregnancy-induced hypertension (PIH) was defined as presence of an additional diagnosis of *O13-O14* (according to ICD-10) in maternal charts. Women were divided into three age groups: teenage mothers—younger than 20 years old; between 20 and 35; and older than 35 years. The reference age group was set to mothers who were 20 to 35 years. Three middle neighborhood income quintiles (2, 3, and 4) were combined and used as a reference group to estimate the impact of two extreme quintiles: "poor" neighborhood (income quintile 1) and "rich" neighborhood (income quintile 5).

Women who had at least one asthma-related ED visit during pregnancy were analyzed further. Their sociodemographic, pregnancy-related, and ED-related characteristics were compared by fetus gender. Results are summarized using descriptive measures expressed as mean (standard deviation [SD]) for continuous variables that have a symmetric distribution or median (first quartile [Q1]-third quartile [Q3]) for those that have a non-symmetric distribution; and number (percent) for categorical variables. Differences between two groups were tested using the chi-square test for categorical variables and *t* test for continuous variables.

The probability of having selected delivery outcomes was modeled separately in women who had an asthma ED visit during pregnancy (cases) and those who did not visit ED for asthma (but might have visited ED for other reasons). The following adverse delivery outcomes were analyzed: delivery of low birth weight baby (defined as birth weight less than 2,500 grams), preterm delivery (less than 37 weeks of gestation), and delivery through C-section. All models had the same set of predictor variables: fetal gender, maternal age at delivery, neighborhood income quintile, and presence of pregnancy-induced hypertension. Results of regression analyses are expressed as odds ratio (OR), corresponding 95% confidence interval (CI), and associated *p* value. *P* values are reported to three decimal places with *p* values less than 0.001 reported as *p* < 0.001. The criterion for statistical significance was set apriori at alpha = 0.05. Statistical software used for all analyses was SAS 9.2 (Chicago, Illinois, USA). We examined the residuals to assess model assumptions. Goodness-of-fit for the models was performed using Hosmer-Lemeshow test (H-LT) (22). We used the likelihood ratio test to determine if there were differences between cases (group 1) and controls (group 2) in model parameters. The null hypothesis was that two groups had similar model coefficient vectors. The test statistic had chi-squared distribution with 6 degrees of freedom (total number of variables in the two choice models minus number of variables in the joint model) and was calculated as

$$2*((\log L_{\text{Group 1}} + \log L_{\text{Group 2}}) - \log L_{\text{Joint}}) \quad (1)$$

where $L_{\text{Group 1}}$, $L_{\text{Group 2}}$ and L_{Joint} represents the likelihood for model based on group 1, group 2, and combined sample, respectively.

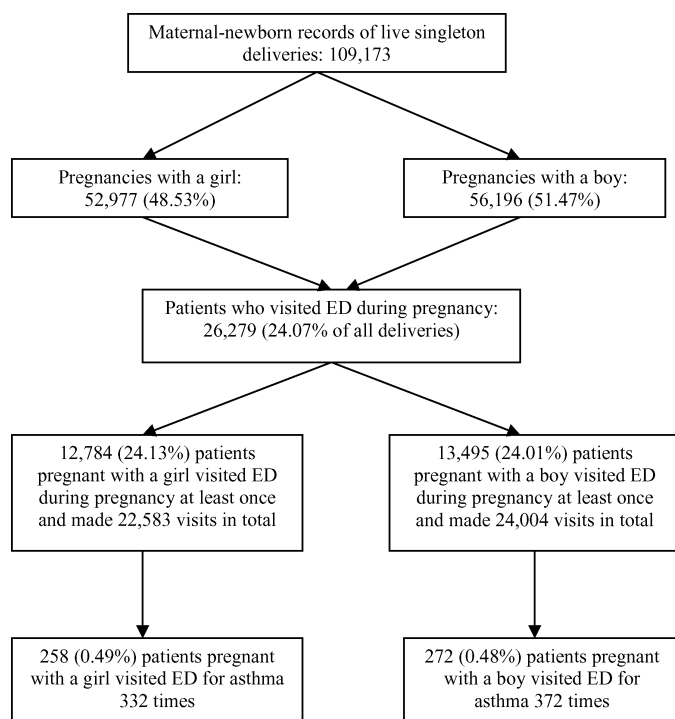


FIGURE 1.—ED visits by pregnant woman.

RESULTS

Among 109,173 women who delivered a live singleton baby between April 2003 and March 2004, 26,279 (24.07%) visited EDs at least once during pregnancy (Figure 1). Equal percentages of women had an ED visit among those who were pregnant with a girl and those who were pregnant with a boy: 24.01% and 24.13%, respectively. Women went to EDs for various reasons (Table 1), but almost one third of their ED visits were pregnancy related. Throughout the pregnancy the peak of all ED visits occurred during gestational weeks 6 and 7, after which the frequency of visits gradually decreased (Figure 2A).

TABLE 1.—Top 10 reasons for visiting emergency departments by pregnant women according to fetus gender.

Conditions	ICD-10	Female fetus Total = 22,583 Number (%)	Male fetus Total = 24,004 Number (%)
Pregnancy-related	O00-O99	6,884 (30.48)	7,143 (29.75)
Unspecified symptoms, signs and abnormal clinical findings	R00-R99	4,428 (19.61)	4,697 (19.57)
Contact with health services	Z00-Z99	2,802 (12.41)	3,003 (12.51)
Injury, poisoning, and consequences of external causes	S00-T98	1,750 (7.75)	1,847 (7.70)
Diseases of respiratory system	J00-J99	1,721 (7.62)	1,830 (7.62)
Diseases of genitourinary system	N00-N99	1,333 (5.90)	1,469 (6.11)
Diseases of the digestive system	K00-K93	1,067 (4.72)	1,135 (4.73)
Diseases of musculoskeletal system and connective tissue	M00-M99	694 (3.07)	761 (3.17)
Infectious and parasitic diseases	A00-B99	366 (1.62)	401 (1.67)
Diseases of nervous system	G00-G99	295 (1.31)	318 (1.32)

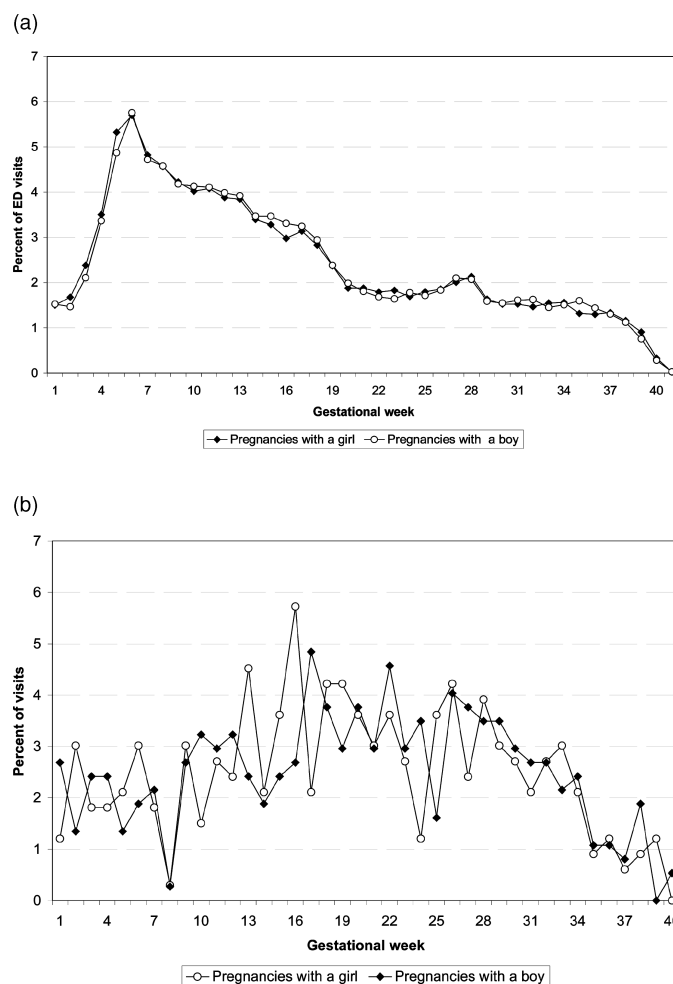


FIGURE 2.—A. Time of ED visit due to any reason by the week of gestation; B. Time of ED visit due to asthma by the week of gestation.

A total of 530 women visited an ED due to asthma exacerbation: 258 were pregnant with a girl and 272 were pregnant with a boy. They made in total 704 ED visits (332 and 372, respectively). There was no major difference in sociodemographic characteristics among asthmatic women who visited an ED by gender of a fetus (Table 2). Interestingly, almost one third of pregnant women who visited an ED for asthma were from areas with the lowest income quintile. Women pregnant with a girl had a higher percent of low birth weight and preterm delivery than those pregnant with a boy: 8.5% versus 5.9% and 8.5% versus 6.2%, respectively. Conversely, women pregnant with a boy had a higher percent of Caesarian and instrumental delivery. There was no significant difference in CTAS distribution, percent of hospitalization from ED, and ED length of stay between women pregnant with a boy and women pregnant with a girl. Temporal pattern of ED visits throughout pregnancy was similar in pregnancies with both female and male babies (Figure 2B). The highest number of ED visits occurred between 15 and 27 weeks of gestation. There were noticeably fewer visits at the end of the third trimester, particularly a few weeks before delivery.

TABLE 2.—Characteristics of women who visited the ED for asthma during their pregnancy by baby's gender.

	Deliveries with a girl (<i>n</i> = 258)	Deliveries with a boy (<i>n</i> = 272)	Test of difference <i>p</i> value (statistics; <i>df</i>)
SOCIODEMOGRAPHIC CHARACTERISTICS			
Maternal age at delivery (years): mean (SD)	27.3 (5.9)	27.7 (6.0)	<i>p</i> = 0.500 (<i>t</i> = −0.67; <i>df</i> = 528)
Mothers younger than 20 years: <i>n</i> (%)	28 (10.8)	24 (8.8)	<i>p</i> = 0.342 (χ^2 = 2.14; <i>df</i> = 2)
Between age 20–35 years: <i>n</i> (%)	202 (78.3)	208 (76.5)	
Mothers older than 35 years: <i>n</i> (%)	28 (10.8)	40 (14.7)	
Neighborhood income: <i>n</i> (%) quintile*			
1	85 (32.9)	90 (33.1)	<i>p</i> = 0.714 (χ^2 = 2.12; <i>df</i> = 4)
2	52 (20.2)	49 (18.0)	
3	45 (17.4)	42 (15.4)	
4	45 (17.4)	43 (15.8)	
5	27 (10.5)	38 (13.9)	
PREGNANCY AND DELIVERY-RELATED CHARACTERISTICS			
Pregnancy-induced hypertension: <i>n</i> (%)	19 (7.3)	19 (6.9)	<i>p</i> = 0.866 (χ^2 = 0.03; <i>df</i> = 1)
C-section delivery: <i>n</i> (%)	60 (23.3)	73 (26.8)	<i>p</i> = 0.342 (χ^2 = 0.90; <i>df</i> = 1)
Use of forceps: <i>n</i> (%)	5 (1.9)	15 (5.5)	<i>p</i> = 0.031 (χ^2 = 4.66; <i>df</i> = 1)
Use of vacuum: <i>n</i> (%)	12 (4.6)	21 (7.7)	<i>p</i> = 0.144 (χ^2 = 2.14; <i>df</i> = 1)
Baby's birth weight (grams): mean (SD)	3,280 (571)	3,416 (628)	<i>p</i> = 0.009 (<i>t</i> = −2.60; <i>df</i> = 528)
LBWT babies: <i>n</i> (%)	22 (8.5)	16 (5.9)	<i>p</i> = 0.238 (χ^2 = 1.39; <i>df</i> = 1)
Baby's gestational age in weeks: mean (SD)	38.9 (1.8)	38.9 (2.2)	<i>p</i> = 0.917 (<i>t</i> = −0.10; <i>df</i> = 1)
Preterm deliveries: <i>n</i> (%)	22 (8.5)	17 (6.2)	<i>p</i> = 0.316 (χ^2 = 1.01; <i>df</i> = 1)
Hospital LOS in days: Median (Q1-Q3)	2.0 (2-3)	2.0 (2-3)	<i>p</i> = 0.590 (<i>t</i> = −0.54; <i>df</i> = 528)
ED VISIT-RELATED CHARACTERISTICS			
ED visits: <i>n</i> (%)	332 (47.2)	372 (52.8)	<i>p</i> = 0.159 (χ^2 = 1.99; <i>df</i> = 1)
Repeat visits: <i>n</i> (%)	74 (22.3)	100 (26.9)	
CTAS level : <i>n</i> (%)			
1 (Resuscitation)	—	2 (0.5)	<i>p</i> = 0.158 (χ^2 = 6.61; <i>df</i> = 4)
2 (Emergent)	7 (8.3)	42 (11.3)	
3 (Urgent)	195 (58.7)	193 (51.9)	
4 (Less urgent)	102 (30.7)	120 (32.3)	
5 (Non urgent)	8 (2.4)	15 (4.0)	
Hospitalizations from ED: <i>n</i> (%)	18 (5.4)	16 (4.3)	<i>p</i> = 0.489 (χ^2 = 0.48; <i>df</i> = 1)
ED LOS in minutes: Median (Q1-Q3)	137 (72.5-232)	123 (71-189.5)	<i>p</i> = 0.309 (<i>t</i> = −1.02, <i>df</i> = 702)

*Income quintile 1 indicates the area with the lowest fifth of incomes; quintile 2 is the area with the 2nd lower fifth of the incomes, and so on. There were 14 patients with invalid postal codes values who were not assigned any quintile (4 in pregnancies with girls and 10 in pregnancies with boys).

SD = standard deviation; LOS = length of stay; Q1 and Q3 = first and third quartiles; *df* = Degrees of freedom.

Results of multivariable logistic model of probability of having an asthma-related ED visit during pregnancy are shown in the Table 3. Visit to an ED for asthma was not associated with gender of a baby (OR 1.01, 95% CI 0.85-1.19). However, it was positively associated with teenage pregnancy (OR 2.22, 95% CI 1.66-2.97), low income (OR 1.55, 95% CI 1.28-1.87), and presence of pregnancy-induced hypertension (OR 1.61, 95% CI 1.16-2.24). Older maternal age (36 years and older) was inversely associated with having an asthma ED visit (OR 0.72, 95% CI 0.53-0.95).

Tables 4 and 5 present results of multivariable logistic regressions for having a low birth baby, preterm deliv-

ery, and delivery via C-section in women who had an ED visit for asthma and those who did not have an asthma ED visit during pregnancy, respectively. In women who had an asthma ED visit, fetal gender was not associated with any of the delivery outcomes (Table 4). The significant predictors of having a low birth weight baby were teenage pregnancy and PIH. Preterm delivery was positively associated with extremes of mother's age, residence in low-income neighborhood, and PIH. Delivery via C-section was more likely to occur in older mothers and those with PIH.

In women who did not have an ED visit for asthma during pregnancy, fetal gender was a significant predictor of all adverse delivery outcomes (Table 5). Having a female fetus was positively associated with the probability of having a low birth weight baby (OR 1.15, 95% CI 1.09-1.22), and inversely associated with preterm delivery (OR 0.89, 95% CI 0.85-0.94) and delivery via C-section (OR 0.90, 95% CI 0.87-0.92). Nearly all other variables were also significant predictors of outcomes in all three models due to large sample of control group. Goodness-of-fit tests yielded high *p* values in all models indicating a good fit of models for data. Likelihood ratio tests indicated that there were no significant differences between cases and control subjects in model coefficient vectors.

TABLE 3.—Results of multivariate logistic regression—OR associated with ED visit for asthma during pregnancy.

Covariates	OR	95% CI	<i>p</i> value
Female fetus	1.01	0.85–1.19	0.930
Maternal age under 20 years	2.22	1.66–2.97	<0.001
Maternal age older than 35 years	0.72	0.53–0.95	<0.022
Income quintile 1	1.55	1.28–1.87	<0.001
Income quintile 5	0.80	0.61–1.05	<0.112
PIH	1.61	1.16–2.24	<0.005

PIH = pregnancy-induced hypertension

Goodness-of-fit statistics - Hosmer-Lemeshov test (H-LT): χ^2 = 3.35, degrees of freedom (*df*) = 6, *p* = 0.763.

TABLE 4.—Results of multivariable logistic regression for delivery outcomes in patients who had at least one ED visit for asthma during pregnancy: OR (95% CI), *p* value.

Predictor	Delivery of low birth weight baby	Delivery of preterm baby	Delivery through C-section
Female fetus	1.47 (0.74–2.91), <i>p</i> = 0.267	1.43 (0.73–2.79), <i>p</i> = 0.301	0.84 (0.56–1.26), <i>p</i> = 0.396
Maternal age under 20 years	3.70 (1.57–8.60), <i>p</i> = 0.003	3.31 (1.37–7.98), <i>p</i> = 0.008	0.52 (0.22–1.19), <i>p</i> = 0.121
Maternal age older than 35 years	2.40 (0.93–6.30), <i>p</i> = 0.076	3.21 (1.33–7.76), <i>p</i> = 0.009	2.10 (1.15–3.84), <i>p</i> = 0.015
Income quintile 1	1.71 (0.84–3.45), <i>p</i> = 0.137	2.08 (1.02–4.26), <i>p</i> = 0.044	0.87 (0.55–1.37), <i>p</i> = 0.555
Income quintile 5	0.80 (0.22–2.88), <i>p</i> = 0.731	1.48 (0.50–4.36), <i>p</i> = 0.476	1.31 (0.72–2.40), <i>p</i> = 0.374
PIH	2.38 (0.85–6.66), <i>p</i> = 0.098	2.24 (0.79–6.31), <i>p</i> = 0.125	3.26 (1.65–6.43), <i>p</i> < 0.001
Goodness-of-fit Statistics (H-LT)	$\chi^2 = 3.68$, <i>df</i> = 7, <i>p</i> = 0.816	$\chi^2 = 4.13$, <i>df</i> = 6, <i>p</i> = 0.658	$\chi^2 = 3.90$, <i>df</i> = 5, <i>p</i> = 0.563

PIH = Pregnancy-induced hypertension; H-LT = Hosmer-Lemeshow test; *df* = Degrees of freedom.

DISCUSSION

To the best of our knowledge, this is the first study to investigate the relationship between ED visits for asthma and fetal gender in asthmatic pregnant women. Our study estimates that 0.5% of women who delivered a live singleton baby had at least one ED visit for asthma during pregnancy. This number is substantially lower than the self-reported prevalence of asthma among pregnant women (3, 5). However, the percentage of asthmatic women who visit ED during pregnancy is also expected to be low. The recent study of asthma morbidity among pregnant women estimated that only 11% of women with asthma had an asthma-related ED visit during pregnancy (4). Therefore, our 0.5% of ED visit would correspond roughly to 5% prevalence of asthma among pregnant women—a number, that falls within the range of self-reported prevalence of asthma. Interestingly, our estimate is close to published estimates of the prevalence of asthma in pregnancy of 0.43 to 0.51% reported in earlier studies that used hospital chart reviews of parturient women (7–9). This indicates that only clinically significant asthma tends to be recorded on the hospital charts of women admitted for delivery, resulting in a large underestimation of prevalence reported by those studies.

We were unable to detect any significant effect of fetal gender on the risk of having an ED visit for asthma. However, we found that teenage mothers and those from low-income neighborhoods were significantly more likely to have an asthma-related ED visit during pregnancy. It is consistent with previous observation that, in general, asthmatic patients who depend on EDs are likely to be from low-income groups (23). Lower level of knowledge about asthma and poor asthma self-management skills are likely explanations to why low income and young age are associated with crisis-oriented care (24).

While ED visits for any cause tended to occur early in pregnancy, peak ED visits for asthma took place at the end

of the second and the beginning of the third trimesters of pregnancy. A previous study that analyzed diary-cards filled by asthmatic pregnant women reported that asthma symptom severity peaked between 29 and 36 weeks of gestation (11). Interestingly, this study also observed an improvement in asthma symptoms during the last 4 weeks of pregnancy, which is consistent with our finding of a decrease in number of ED visits shortly before delivery.

For women who had at least one ED visit for asthma during their pregnancy, our analysis revealed no significant association between the gender of the fetus and any of the three pregnancy outcomes: a low birth weight baby, a preterm baby, and a C-section delivery. Conversely, among control women (those who did not have an ED visit for asthma), gender of the fetus was a statistically significant predictor of all three outcomes, although its impact was small. However, we note here that the control group was about 200 times larger than the case group (pregnant women who visited the ED for asthma), which could lead to increased power to detect even a weak association.

Several limitations of our study result from the use of administrative data. First, it was impossible in our data to distinguish non-asthmatic women from those asthmatic women who never visited an ED for asthma during pregnancy. Thus we assumed that asthmatic women who did not visit an ED during pregnancy were similar to non-asthmatic pregnant women in distribution of predictors. Second, although both hospital and ED visit databases provide a comprehensive coverage of all in-hospital deliveries and ED visits in Ontario, the performed record linkage might have affected the completeness of case identification. It is known that while the positive predictive value of deterministic linkage is nearly 100% (no falsely matched records), it has low sensitivity (does not identify all true matches) (25). We did not have information on omitted cases, and therefore we could not assess whether they are systematically different from identified cases such that

TABLE 5.—Results of multivariable logistic regression for delivery outcomes in patients who have not visited ED for asthma during pregnancy: OR (95% CI), *p* value.

Predictor	Delivery of low birth weight baby	Delivery of preterm baby	Delivery through C-section
Female fetus	1.15 (1.09–1.22), <i>p</i> < 0.001	0.89 (0.85–0.94), <i>p</i> < 0.001	0.90 (0.87–0.92), <i>p</i> < 0.001
Maternal age under 20 years	1.60 (1.42–1.78), <i>p</i> < 0.001	1.39 (1.23–1.54), <i>p</i> < 0.001	0.58 (0.53–0.63), <i>p</i> < 0.001
Maternal age older than 35 years	1.19 (1.11–1.29), <i>p</i> < 0.001	1.21 (1.13–1.29), <i>p</i> < 0.001	1.61 (1.55–1.67), <i>p</i> < 0.001
Income quintile 1	1.18 (1.10–1.26), <i>p</i> < 0.001	1.09 (1.03–1.16), <i>p</i> = 0.003	0.96 (0.93–0.99), <i>p</i> = 0.034
Income quintile 5	0.80 (0.73–0.86), <i>p</i> < 0.001	0.88 (0.82–0.94), <i>p</i> < 0.001	0.97 (0.93–1.01), <i>p</i> = 0.115
PIH	4.26 (3.93–4.62), <i>p</i> < 0.001	3.35 (3.10–3.62), <i>p</i> < 0.001	1.84 (1.74–1.95), <i>p</i> < 0.001
Goodness-of-fit Statistics (H-LT)	$\chi^2 = 1.71$, <i>df</i> = 6, <i>p</i> = 0.944	$\chi^2 = 5.08$, <i>df</i> = 5, <i>p</i> = 0.406	$\chi^2 = 3.395$, <i>df</i> = 6, <i>p</i> = 0.758

PIH = Pregnancy-induced hypertension; H-LT = Hosmer-Lemeshow test; *df* = Degrees of freedom.

their inclusion would significantly change the results. Third, the databases used for the study had no information on several potential confounders. For example, we did not know what type of asthma treatment women received. Research shows that under-treatment of asthma during pregnancy is associated with increased risk of adverse delivery outcomes, while the aggressive treatment leads to better delivery outcomes (26–29). The situation could be further complicated by existence of an association between fetal gender and the use of asthma medication, as it was suggested by one small case study (30). Knowledge of the type of asthma management would have allowed us to separate the effect of fetal gender from the effect of drug therapy. Information on other maternal lifestyle risk factors, such as smoking, alcohol consumption, and environmental exposures, was also not available. However, it is unlikely that their distribution in pregnant asthmatic women may be associated with the gender of the baby.

Despite listed limitations, our study has confirmed several well-recognized risk factors for ED visits for asthma and adverse pregnancy outcomes. Therefore, we believe that if fetal gender indeed had a clinically significant effect on the risk of ED visit for asthma or adverse pregnancy outcomes among women who had an asthma-related ED visit, our analysis would have revealed it. Furthermore, according to likelihood ratio tests, there were no significant differences between model parameters for adverse pregnancy outcomes in women who had asthma-related ED visits and those who had not. Thus, even if we have overlooked a weak association between fetal gender and adverse pregnancy outcomes among women who visited ED for asthma, this association should not be very different from the one among any pregnancies.

CONCLUSION

Fetal gender does not affect the risk of having an ED visit for asthma during pregnancy. Among those asthmatic pregnant women who had asthma-related ED visits during pregnancy, fetal gender is not a significant predictor of adverse pregnancy outcomes. Because of the design and identification of cases, the results of our study may not be generalizable to all asthmatic pregnancies. Future studies that either follow asthmatic pregnant women prospectively and ascertain the gender of the baby after delivery, or identify cases retrospectively using more sensitive criteria (e.g., including not only ED visits but also visits to a general practitioner), should help to shed more light on relationships between fetal gender, maternal asthma, and pregnancy outcomes.

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