



Published in final edited form as:

Ann Allergy Asthma Immunol. 2010 August ; 105(2): 110–117. doi:10.1016/j.anai.2010.05.016.

Asthma in Pregnancy and its Pharmacologic Treatment

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Introduction

Asthma is among the most common serious medical problems in pregnancy¹, estimated to affect between 3.7% and 8.4% of pregnant women². Further, population data suggest that these rates may be rising^{3, 4}. Management of asthma in pregnancy poses a dilemma for both physicians and their pregnant patients: asthma may itself present risks to the fetus, such as low birth weight and premature delivery,^{5, 6} but the fetal risks of medications used to treat asthma are largely unknown. To improve management, the National Asthma Education and Prevention Program (NAEPP) has published recommendations for treatment of asthma in pregnancy, initially in 1993⁷ and most recently in January, 2005¹, which advise that inhaled steroids be used as first-line treatment for persistent asthma. However, the extent to which these guidelines are followed is unclear.

Using data on mothers of non-malformed infants collected as part of an ongoing program of case-control surveillance of risk factors for birth defects, we examined the prevalence of asthma, levels of asthma control, the use of asthma medications among pregnant women, and the relationship between pregnancy and asthma symptoms. By examining trends in the use of specific asthma medications over time, we also evaluated the impact of changes in both asthma treatment guidelines and the introduction of new medications.

Methods

The Slone Epidemiology Center (SEC) at Boston University has been conducting case-control surveillance to identify risk factors for birth defects since 1976; the methods have been described previously^{8, 9}. In 1998, we began including in our study population a random sample of Massachusetts births of non-malformed infants. On a bi-monthly basis, the SEC receives a data file from the Massachusetts Department of Public Health containing all births reported in the previous five months and from this file, a random sample of mothers of infants between 12 and 18 weeks of age are invited to participate in the study. Known neonatal deaths are excluded. The current report is based on this population-based sample of mothers of normal infants born in Massachusetts between 1998 and 2006.

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Mothers of eligible subjects are interviewed within six months of the baby's birth by trained nurse-interviewers using a standardized questionnaire. The interview elicits demographic information about the mother and father and detailed information regarding maternal illnesses and details of all medications used from 2 months prior to the last menstrual period (LMP) through the end of pregnancy. This study has been approved by Boston University Medical Center's Institutional Review Board (IRB) and the IRBs of all participating institutions as appropriate, and verbal informed consent is obtained from all participants.

The interview included a series of questions related specifically to asthma diagnosis, symptoms, and management. The questions began by asking about the presence, in the past five years, of provider-diagnosed asthma, bronchitis, or reactive airway disease. Because one objective of these questions was to identify women who may have undiagnosed asthma, women who responded "no" to these questions were asked whether, within the past five years, they experienced episodes of coughing, wheezing, chest tightness, or shortness of breath. Women who responded affirmatively were asked about the timing of these symptoms: whether they occurred seasonally; at night; during or after colds; after exercise; after exposure to animals, cut grass or dust; or only during pregnancy. They were also asked whether their symptoms changed during pregnancy and, if so, the date of the change. Next, a series of questions inquired about level of asthma control: whether asthma required unscheduled medical visits, prednisone or cortisone, hospitalization, or intubation. Finally, women were asked questions relating to the extent to which their symptoms interfered with activities or sleep.

The asthma-related questions were the basis for classifying the likelihood of asthma:

1. *Physician-diagnosed asthma* was defined as health-care-provider-diagnosed asthma that was present within the past five years;
2. *Possible asthma* was defined as either a) bronchitis, wheezing, chest tightness, or persistent cough within the past five years; or b) shortness of breath in the past five years with at least one positive response (other than "only during pregnancy") to the questions about timing of symptoms;
3. *Past asthma* was defined as provider-diagnosed asthma that was not present within the past five years.

Subjects not meeting these definitions were classified as *no asthma*.

We also created a scale reflecting degree of symptom control for provider-diagnosed asthma:

1. Asthma that required hospitalization or involved symptoms that were reported to interfere with activities or sleep "constantly" was considered to be *poorly-controlled*;
2. Asthma that required the use of prednisone, caused one or more unscheduled medical visits, or involved symptoms that interfered with activities or sleep "often" was considered to be *not well-controlled* (this is modeled after the EPR3¹⁰ definition which could not be directly applied here because of the 9-month pregnancy timeframe versus the 12-month EPR3 risk domain timeframe);
3. Remaining cases of provider-diagnosed asthma were classified as *well-controlled*.

Since symptom frequency and pulmonary function were not captured, the NAEPP severity and control classification could not be utilized. However, symptoms interfering with sleep and activity are part of the impairment domain of asthma severity and control, and exacerbations requiring oral corticosteroids are part of the risk domains of asthma severity and control¹⁰. While this study predated the publication of validated asthma control questionnaires¹¹⁻¹³,

questions regarding asthma symptoms interfering with sleep and activity are included in all of those tools.

Drug treatments were grouped into five major classes: corticosteroids, beta-2 agonists, leukotriene modifiers, combination products, and others (primarily mast cell stabilizers). Corticosteroids and beta-2 agonists were further subdivided according to route of administration. Exposure was considered separately for each of these classes, and, where numbers were sufficient, for specific medications. We also classified asthma medications as either controller or reliever drugs: controllers included inhaled steroids, salmeterol, cromolyn, nedocromil, theophylline, leukotriene modifiers, and formoterol; relievers included all other asthma medications.

We examined rates of asthma among study women, identified factors associated with asthma presence and control, examined the timing and direction of changes in the control of symptoms during pregnancy, and determined rates of use of the various classes of medication in each of the asthma categories. We also investigated changes in the use of medications over time.

Multiple logistic regression was used to evaluate each potential risk factor while controlling for the effects of others. Tests for trend were performed using regression to assess changes over time.

Results

Between 1998 and 2006, mothers of 5,323 non-malformed infants in Massachusetts were located and approached for participation; 3,609 (67.8%) agreed to be interviewed. Overall, 502 women (13.9%) met our definition of provider-diagnosed asthma; an additional 578 (16.0%) were classified as possible asthma and 137 (3.8%) as past asthma (Table 1).

Physician-diagnosed asthma was most prevalent among the youngest women, and decreased with age (Table 2). Higher prevalences were also observed among women who were white, obese, had less than high school education, smoked during pregnancy, and lived in households with 5 or more members. Similarly, possible asthma was more prevalent among women who were young, less well-educated, and who smoked during pregnancy, but, in contrast to physician-diagnosed asthma, possible asthma was most common among underweight women (BMI less than 18.5), and was not associated with household size. Restricting subjects to those with physician-diagnosed asthma (Table 3), women classified as poorly-controlled tended to be older, less well-educated, smoke during pregnancy, have lower family incomes, and live in larger households than women with well-controlled asthma, although only the relationships with lower income and larger household size were statistically significant. Women in the not well-controlled category were more likely to be over age 24 and in the lowest income group.

There was no significant trend over time in the prevalence of physician-diagnosed asthma, but the proportion of women with possible asthma declined from 21% to 10% ($p < .05$) between 1997 and 2005 (data not shown).

The relationship between pregnancy and asthma symptoms varied considerably according to degree of symptom control (Table 4). While, overall, about half (53%) of women with provider-diagnosed asthma reported no change in symptoms, the proportion varied from 41% among poorly-controlled to 69% among well-controlled subjects. Those whose symptoms changed were almost equally divided between those who improved (24.6%) and those who worsened (22.4%). Women with poorly-controlled asthma were more likely to report improvement (34.9%) than women with not well-controlled (23%) or well-controlled asthma (16.7%). Worsening of symptoms was almost equally likely to occur in any trimester (6.7%-7.9%),

whereas improvement was noted somewhat more often in the first trimester (11.8% vs. 8.3% or 4.5%).

To consider rates of asthma medication use according to asthma status, we examined drugs reported by study subjects to have been used for asthma (indication-based medication use); to capture use among women who had undiagnosed or unknown asthma (and therefore would not report medications use “for asthma”), we also examined drugs known to be used in the treatment of asthma (class-based medication use) (Table 5). For both drug groups, rates were highest among those with provider-diagnosed asthma and within that category use declined with better symptom control; there was very little use among subjects with possible or past asthma. Of note, 63.3% of women whose asthma symptoms were poorly controlled did not use a controller medication during pregnancy. As expected, among women classified as non-asthmatics, none reported using a medication to treat asthma, although 4.1% reported use of a recognized asthma medication for other indications, such as colds or allergy.

To explore possible trends in the use of asthma medications over time, we restricted our analyses to women with provider-diagnosed asthma and investigated use according to year of LMP. Among the drug classes, there were no significant trends in use of any asthma drug, any steroid, any beta-2 agonist, or any other asthma medication (Figure 1), nor did use of steroids by specific route change significantly (Figure 2). Virtually all beta-2 agonist use was via inhalation.

According to lunar month of pregnancy, rates of use of inhaled steroids and beta-2 agonists were nearly constant for the period beginning 2 months prior to the LMP through the 4th lunar month. Inhaled steroids declined from 5% before pregnancy to 4.5%, and for beta-2 agonists the corresponding rates were 16% and 14% (data not shown).

Use of other asthma medications, including leukotriene modifiers and combination products (e.g., Advair®), was generally low, but use of leukotriene modifiers increased consistently over time, and use of combination products increased significantly ($p<.01$), consistent with their recent introduction to the market (Figure 3).

The most commonly reported specific asthma medications were albuterol (53%), fluticasone (9.4%), beclomethasone (5.2%), and budesonide (3.0%). Over the study years, only use of fluticasone changed significantly, from 2.4% to 8.4% ($p<.05$), perhaps due to its relatively recent introduction in 1997 (data not shown).

Discussion

Asthma is recognized as one of the most common serious chronic conditions to complicate pregnancy¹, with a prevalence estimated to range up to 8%, although one Australian study among women who had recently given birth reported a rate as high as 12.4%¹⁴. We found that over 14% of women in our study reported provider-diagnosed asthma. While this is higher than previously reported^{2, 15, 16}, it may not be inconsistent with other observations. It is known that the prevalence of asthma increased through the 1990's^{3, 17, 18} and since our data are derived from 1998-2006, the increasing prevalence may account in part for our higher rates. Also, the northeast region of the United States, and Massachusetts in particular, have among the highest reported rates in the general U.S. population; in 2001, the Massachusetts rate of current asthma was 9.5, compared to the national average of 7.2¹⁹

One novel aspect of this description of asthma in pregnancy is the attempt to include undiagnosed asthma. To do this, we relied not only on patient reports of physician diagnosed asthma but also used self-reported symptoms to assess asthma status. Using responses to the questions developed to elicit information on symptoms, we estimated the overall prevalence

of both provider-diagnosed and possible asthma. Responses to questions were also used to develop a scale of symptom control, and we believe the data on drug treatment for asthma provide indirect support for the validity of this scale. Although drug treatment (other than systemic steroids) was not an element of the symptom control classification, we found a strong inverse trend for increasing medication use according to degree of control. Although our questions measured control more than severity, the two constructs are related, and there is an inverse relationship between severity and control²⁰. Thus, we saw medication use increase as control declined or severity increased, as would be expected. However, among women whose symptoms were poorly-controlled, we found almost 2/3 did not use controller medications, suggesting that asthma symptoms in pregnancy may be inadequately treated. We also found a strong relation between use of multiple drugs and level of asthma symptom control. As would be expected, among women with unrecognized asthma (“possible asthma”), none reported use of a medication to treat asthma; however, these women did use asthma medications for what they considered to be other respiratory indications.

Many of the characteristics that we found to be positively associated with physician-diagnosed asthma among these pregnant women have been previously reported among asthmatics in general: race^{3, 21}, education²¹, income²¹, and obesity²¹⁻²³; we also found asthma to be more common in larger households, a variable associated with socioeconomic status. The higher prevalence of smoking among asthmatics with poorly-controlled disease (35%) was disturbing, given that the 2000 joint position statement of the American College of Obstetrics and Gynecology, the American College of Asthma, Allergy, and Immunology and the American Academy of Asthma, Allergy, and Immunology specifically identifies cigarettes as one of the asthma triggers to be avoided during pregnancy²⁴. Higher smoking rates among asthmatics compared to non-asthmatics have been reported by others^{14, 25}, suggesting that this may be an area for further education and intervention.

Several studies have reported that asthma symptoms remain stable during pregnancy for about a third of women, another third worsen, and the final third improve^{26, 27}. Others have found that asthma is more likely to worsen in women with severe asthma^{28, 29}. Our results may differ slightly due to the fact that we considered only asthma symptoms, while others compared physiologic measurements or exacerbations.

One potential limitation of the current study is that objective measures of asthma status, such as pulmonary function, could not be used to confirm the self-reports. However, self-reported physician-diagnosed asthma has been shown to be a method of identifying patients with asthma in epidemiologic studies.³⁰

This study did not evaluate the risks to the fetus of asthma itself, but there appears to be general acceptance that uncontrolled asthma in pregnancy poses greater risks to the fetus than currently recommended asthma treatments^{15, 31, 32}. It is also widely recognized that there are insufficient data on the risks and safety of asthma medications in pregnancy³²⁻³⁴. In order to provide guidance to health care providers treating pregnant women with asthma, the NAEPP reviewed existing research and recommended what are considered to be effective and relatively safe treatments. Guidelines specifically for pregnancy were published in 1993⁷, followed by a general update in 1997³⁵ and a pregnancy-specific update in 2005¹. Since 1997, inhaled corticosteroids have been recommended as first-line therapy in pregnancy, yet we observed no substantial increase in inhaled corticosteroid use. This finding is consistent with data from the Slone Survey, a population-based survey of medication use in the U.S.^{36, 37}; among women of child-bearing age interviewed between 1998 and 2005, use of inhaled steroids ranged from 1.9% in 1999 to 1.3% in 2006 (personal communication, Judy Kelly). It is possible that women might discontinue their use of inhaled steroids upon learning that they are pregnant because of concerns for the fetus, and discontinuation of these medications in early pregnancy has been

reported³⁸. However, we saw little evidence of such a change when we compared use in the two months prior to pregnancy with use through the fourth lunar month of pregnancy.

In summary, this study confirms that asthma is a common condition in pregnant women in Massachusetts; we found that nearly 14% of mothers of normal newborns reported having been told by a health care provider that they had asthma within the five years prior to the pregnancy, and 50% of these reported using at least one medication for their asthma during pregnancy. An additional 16% reported symptoms consistent with asthma, and almost 10% of those were treated with an asthma medication. Given the NAEPP guidelines and the introduction of new medications, we expected to see appreciable changes in the drug management of asthma. Although we observed a small increase in use of inhaled steroids to 23%, it remains well below that of beta-2 agonists (50-60%).

Leukotriene modifiers and combination drugs appear to have had little impact on the pharmacologic treatment of asthma during pregnancy in the current study. Of concern, among women whose symptoms were poorly controlled, only about 37% reported use of controller medications, suggesting inadequate treatment of potentially severe asthma symptoms. These rates of asthma, asthma symptoms and asthma medication use underscore the need to better understand the risks and safety of these medications in pregnancy, as well as the risks of asthma itself.

Acknowledgments

We thank Dawn Jacobs, RN, MPH, Fiona Rice, MPH, Rita Krolak, RN, Kathleen Sheehan, RN, Karen Bennett Mark, RN, Clare Coughlin, RN, Nastia Dynkin, Nancy Rodriguez-Sheridan, and Meghan Malone-Moses, MPH for their assistance in data collection and computer programming and the staff of the Massachusetts Department of Public Health for providing data on Massachusetts births; we also thank all the mothers who participated in the study.

This work was supported by Sanofi-Aventis, Inc; additional support was provided by the National Heart, Lung, and Blood Institutes grant HL 50763 and GlaxoSmithKline.

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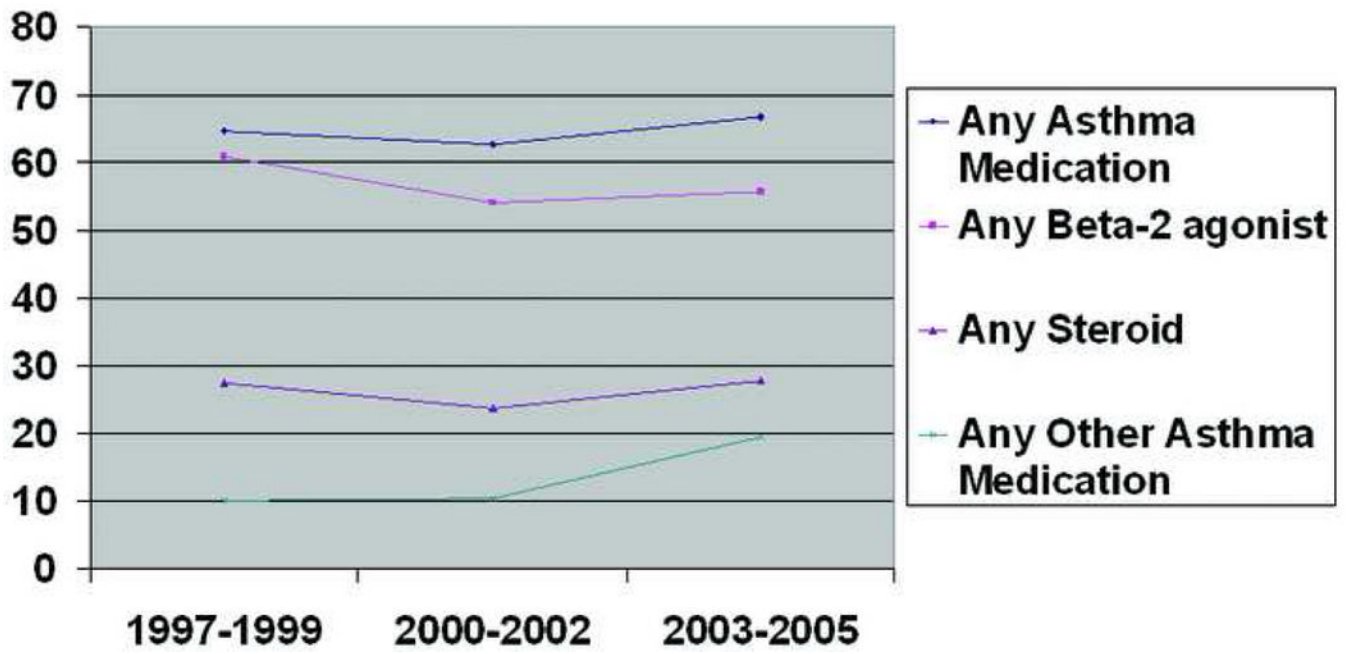


Figure 1. Trends in the Use of Asthma Medications During Pregnancy Among 502 Mothers with Provider-Diagnosed Asthma.

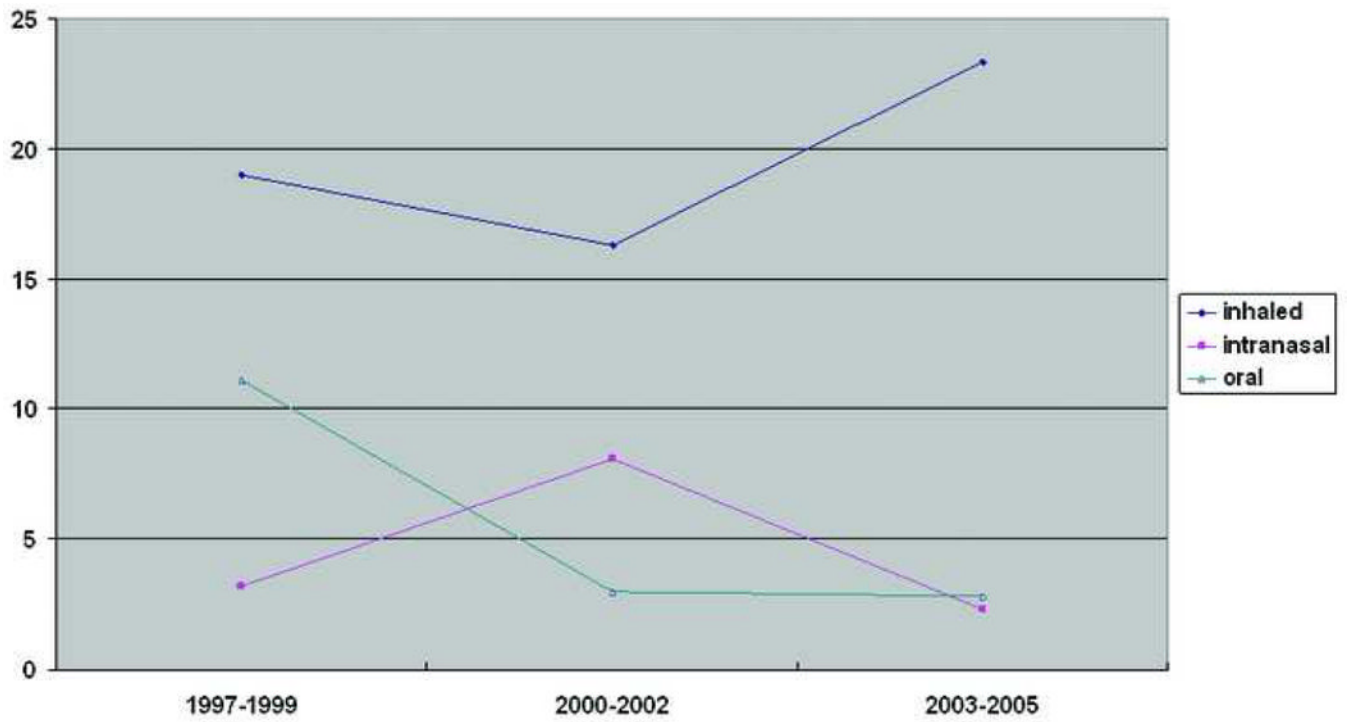


Figure 2.
Trends in the Use of Corticosteroids During Pregnancy Among 502 Mothers with Provider-Diagnosed Asthma.

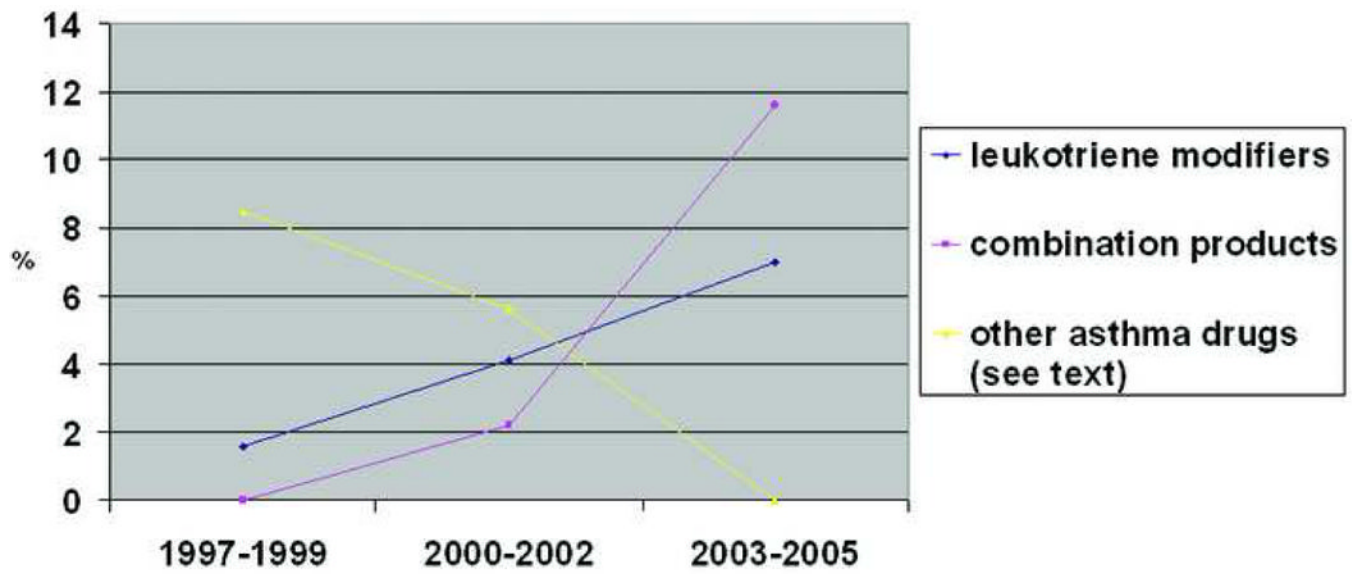


Figure 3.
Trends in the Use of Selected Asthma Medications Among 502 Mothers with Provider-Diagnosed Asthma.

Table 1
Rates of Asthma Among 3609 Mothers of Normal Newborns

Asthma Status	Number	%
Provider-diagnosed	502	13.9
Well-controlled	153	4.2
Not well-controlled	202	5.6
Poorly-controlled	147	4.1
Possible	578	16.0
Past	137	3.8
No Asthma	2392	66.3

Table 2
Prevalence of Asthma According to Selected Factors Among 3609 Mothers of Normal Newborns*

	Physician-diagnosed		Possible		No Asthma	
	N (%)	Adj OR	N (%)	Adj OR**	N (%)	N (%)
Age	≤24	126 (19.4)	Ref	110 (16.9)	Ref	391 (60.2)
	25-29	122 (15.4)	0.7 (0.5, 1.0)	116 (14.7)	0.9 (0.6, 1.3)	512 (64.7)
	30-34	149 (11.3)	0.5 (0.3, 0.7)	214 (16.2)	1.0 (0.7, 1.3)	917 (69.3)
	≥35	103 (12.4)	0.5 (0.4, 0.8)	137 (16.4)	1.0 (0.7, 1.4)	565 (67.8)
Race/Ethnicity	White	418 (14.8)	Ref	468 (16.6)	Ref	1835 (65.1)
	Black	23 (13.6)	0.8 (0.5, 1.4)	28 (16.6)	1.1 (0.7, 1.7)	106 (62.7)
	Hispanic	48 (11.9)	0.6 (0.4, 0.9)	63 (15.7)	0.9 (0.7, 1.3)	272 (67.7)
	Asian	6 (4.2)	0.2 (0.1, 0.6)	13 (9.0)	0.5 (0.3, 1.0)	119 (82.6)
	Other	7 (9.2)	0.4 (0.2, 0.9)	6 (7.9)	0.4 (0.2, 0.9)	60 (78.9)
Body Mass Index	Underweight	20 (13.4)	1.1 (0.6, 1.8)	34 (22.8)	1.8 (1.2, 2.8)	92 (61.7)
	Normal weight	287 (12.9)	Ref	318 (14.3)	Ref	1540 (69.2)
	Overweight	104 (13.9)	1.1 (0.8, 1.5)	140 (18.7)	1.4 (1.1, 1.7)	470 (62.8)
	Obese	84 (19.8)	1.8 (1.3, 2.3)	77 (18.2)	1.5 (1.1, 2.0)	248 (58.5)
Education	Less than high school	51 (18.1)	1.4 (0.9, 2.1)	53 (18.8)	1.3 (0.9, 1.9)	167 (59.2)
	High school	227 (14.8)	Ref	260 (17.0)	Ref	981 (64.1)
	Some college	224 (12.5)	1.1 (0.8, 1.4)	265 (14.8)	1.0 (0.8, 1.3)	1241 (69.2)
	Never	248 (12.2)	Ref	264 (13.0)	Ref	1448 (71.1)
Smoking	Before pregnancy	132 (14.6)	1.3 (1.0, 1.7)	151 (16.7)	1.4 (1.1, 1.7)	592 (65.4)
	During pregnancy	122 (18.3)	1.6 (1.2, 2.2)	162 (24.3)	2.4 (1.9, 3.2)	352 (52.9)
	Never	172 (14.7)	Ref	183 (15.7)	Ref	773 (66.2)
Caffeine	Before pregnancy	141 (13.9)	0.9 (0.7, 1.2)	168 (16.6)	1.0 (0.8, 1.3)	664 (65.5)
	During pregnancy	81 (15.0)	0.9 (0.7, 1.3)	92 (17.0)	0.9 (0.7, 1.3)	350 (64.8)
Alcohol	Never	219 (14.2)	Ref	241 (15.6)	Ref	1016 (65.8)
	Before pregnancy	263 (13.6)	1.0 (0.8, 1.2)	307 (15.9)	0.9 (0.8, 1.3)	1301 (67.3)
	During pregnancy	20 (15.0)	1.2 (0.7, 2.1)	30 (22.6)	1.6 (1.0, 2.6)	75 (56.4)

	Physician-diagnosed		Possible		No Asthma	
	N (%)	Adj OR	N (%)	Adj OR**	N (%)	N (%)
Income	<25,000	68 (16.8)	1.0 (0.7, 1.5)	68 (16.8)	0.9 (0.7, 1.4)	249 (61.6)
	25,000-45,000	70 (15.2)	1.0 (0.7, 1.4)	79 (17.2)	1.6 (1.0, 2.6)	284 (61.7)
	>45,000	305 (13.1)	Ref	368 (15.8)	Ref	1582 (67.8)
Household size	1-2	178 (14.2)	Ref	189 (15.0)	Ref	830 (66.0)
	3-4	230 (12.1)	0.9 (0.7, 1.1)	316 (16.7)	1.1 (0.9, 1.3)	1284 (67.8)
	5+	92 (20.6)	1.5 (1.1, 2.0)	73 (16.3)	1.1 (0.8, 1.5)	271 (60.0)

* Percentages may not total 100 due to missing data.

** Adjusted for all other factors in the table

Table 3
Asthma Symptom Control According to Selected Factors Among 502 Mothers with Provider-diagnosed Asthma

	Poorly-controlled		Not Well-controlled		Well-controlled	
	N (%)	Adj OR	N (%)	Adj OR	N (%)	N (%)
Age						
≤24	55 (43.7)	Ref	29 (23.0)	Ref	42 (33.3)	
25-29	32 (26.2)	1.5 (0.7,3.4)	54 (44.3)	3.7 (1.6,8.7)	36 (29.5)	
30-34	34 (22.8)	2.0 (0.8,5.0)	69 (46.3)	5.2 (2.2,12)	46 (30.9)	
≥35	26 (25.2)	1.7 (0.7,4.2)	48 (46.6)	4.8 (1.9,12)	29 (28.2)	
Race/Ethnicity						
White	110 (26.3)	Ref	178 (42.6)	Ref	130 (31.0)	
Black	12 (52.2)	2.2 (0.6,7.3)	6 (26.1)	1.1 (0.3,4.3)	5 (21.7)	
Hispanic	21 (43.8)	0.6 (0.2,1.6)	12 (25.0)	0.5 (0.2,1.3)	15 (31.3)	
Asian	1 (16.7)	2.3 (0.1,47)	4 (66.7)	1.5 (0.1,16)	1 (16.7)	
Other	3 (42.9)	0.5 (0.1,4.8)	2 (28.6)	0.9 (0.1,7.6)	2 (28.6)	
Body Mass Index						
Underweight	6 (30.0)	1.3 (0.3,5.3)	9 (45.0)	1.4 (0.4,5.3)	5 (25.0)	
Normal weight	80 (27.9)	Ref	109 (38.0)	Ref	98 (34.1)	
Overweight	37 (35.6)	1.5 (0.8,3.0)	40 (38.5)	1.4 (0.6,2.2)	27 (26.0)	
Obese	21 (25.0)	0.8 (0.4,1.8)	41 (48.8)	1.1 (0.6,2.2)	22 (26.2)	
Education						
Less than high school	20 (39.2)	1.3 (0.6,3.6)	19 (37.3)	1.9 (0.6,6.1)	12 (23.5)	
High school	77 (33.9)	Ref	85 (37.4)	Ref	65 (28.6)	
Some college	50 (22.3)	0.9 (0.5,1.7)	98 (43.8)	0.9 (0.5,1.6)	78 (33.9)	
Smoking						
Never	74 (29.8)	Ref	89 (35.9)	Ref	85 (34.3)	
Before pregnancy	30 (22.7)	1.0 (0.5,1.9)	62 (47.0)	1.3 (0.7,2.2)	40 (30.3)	
During pregnancy	43 (35.2)	1.5 (0.7,3.3)	51 (41.8)	1.7 (0.8,3.6)	28 (23.0)	
Coffee consumption						
Never	57 (33.1)	Ref	63 (36.6)	Ref	52 (30.2)	
Before pregnancy	47 (33.3)	1.3 (0.7,2.6)	48 (34.0)	1.1 (0.6,2.2)	46 (32.6)	
During pregnancy	17 (21.0)	0.6 (0.2,1.3)	42 (51.9)	1.3 (0.6,2.4)	22 (27.2)	
Alcohol						
Never	68 (31.1)	Ref	103 (47.0)	Ref	48 (21.9)	
Before pregnancy	75 (28.5)	0.7 (0.4,1.3)	89 (33.8)	0.3 (0.2,0.6)	99 (37.6)	

	Poorly-controlled		Not Well-controlled		Well-controlled	
	N (%)	Adj OR	N (%)	Adj OR	N (%)	N (%)
During pregnancy	4 (20.0)	1.0 (0.2,4.3)	10 (50.0)	0.5 (0.1,1.6)	6 (30.0)	
Income*						
<25,000	29 (42.6)	6.8 (2.3,20)	29 (42.6)	2.8 (1.0,8.0)	10 (14.7)	
25,000-45,000	20 (28.6)	1.0 (0.5,2.2)	25 (35.7)	0.7 (0.2,1.5)	25 (35.7)	
>45,000	71 (23.3)	Ref	133 (43.6)	Ref	101 (33.1)	
Household size						
1-2	36 (20.2)	Ref	76 (42.7)	Ref	66 (37.1)	
3-4	68 (29.6)	1.7 (1.0,3.1)	93 (40.4)	1.0 (0.6,1.7)	69 (30.0)	
5+	43 (46.7)	3.6 (1.6,8.3)	32 (34.8)	1.1 (0.5,2.7)	17 (18.5)	

* Percentages may not total 100 due to missing data.

** Adjusted for all other factors in the table

Table 4

Changes in Asthma Symptoms during Pregnancy.

	Asthma Control			Total
	Poorly Controlled	Not Well Controlled	Well Controlled	
No Change	60 (41.0)	97 (49.5)	104 (69.3)	261 (53.0)
Symptoms Improved				
Trimester 1	17 (11.6)	25 (12.8)	16 (10.7)	58 (11.8)
Trimester 2	25 (17.1)	8 (4.1)	8 (5.3)	41 (8.3)
Trimester 3	9 (6.2)	12 (6.1)	1 (0.7)	22 (4.5)
Total	51 (34.9)	45 (23.0)	25 (16.7)	121 (24.6)
Symptoms Worsened				
Trimester 1	9 (6.2)	24 (12.2)	6 (4.0)	39 (7.9)
Trimester 2	17 (11.6)	15 (7.7)	6 (4.0)	38 (7.7)
Trimester 3	9 (6.2)	15 (7.7)	9 (6.0)	33 (6.7)
Total	35 (24.0)	54 (27.6)	21 (14.0)	110 (22.4)
Total	146	196	150	492

Table 5

Use of Asthma Drugs Among 3609 Mothers of Normal Newborns According to Asthma Status.

Asthma Status	Indication-based asthma medication use	Indication-or Class-based asthma medication use	
	Medication used to treat asthma	Use of at least 1 Asthma Medication	Use of 2 or more known Asthma Medications
Provider-diagnosed	292 (58.2)	321 (63.9)	286 (57.0)
Poorly-controlled	109 (74.1)	111 (75.5)	105 (71.4)
Not well-controlled	121 (59.5)	140(69.3)	122 (60.4)
Well-controlled	62 (40.5)	70 (45.8)	59 (38.6)
Possible	0 (0.0)	50 (8.7)	19 (3.3)
Past	1 (0.7)	6 (4.4)	6 (4.4)
No Asthma	0 (0.0)	97 (4.1)	21 (0.9)