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Original article

Asthma during pregnancy: effects on fetal well-being, and maternal and perinatal complications[☆]

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Objective: To assess the effects of maternal asthma on pregnancy, analyzing the consequences of the severity of the disease in the impairment of fetal well-being, as well as the related maternal and perinatal complications.

Methods: A retrospective study with 117 pregnancies complicated by maternal asthma and with no other comorbidities, in the period from January, 2005 to December, 2010. Inclusion criteria were as follows: singleton pregnancy; pregnant women diagnosed with asthma prior to pregnancy; initiation of prenatal care before the 28th week of pregnancy; birth at this institution; newborn weighing over 500 g and gestational age at delivery of 22 weeks or more; absence of fetal malformations or chromosomal abnormalities; absence of maternal comorbidities. Asthma was classified as intermittent, mild persistent, moderate persistent, or severe persistent. The results of fetal biophysical profile and of Doppler velocimetry of the umbilical artery performed 14 days prior to birth were analyzed.

Results: Of the total of 117 pregnant women with asthma, 41 (35.0%) had intermittent, 33 (28.2%) mild persistent, 21 (17.9%) moderate persistent, and 22 (18.8%) severe persistent asthma. There was no significant difference among the groups as to the type of birth: cesarean section was performed in 65.8% of the cases, maternal corticosteroid therapy was used at the moment of birth in 20.5%, the gestational age at birth averaged 38.6 weeks (SD 1.9 weeks), and birth weight averaged 3,056 g (SD 581g). The fetal biophysical profile performed during the antepartum period (n = 90, 76.9%) showed a normal result (8 or 10) in 99% of the cases. Doppler velocimetry of the umbilical artery was assessed in 23.9% (n = 28) of the pregnant women, and delivered normal results in 100% of the cases. The use of systemic corticosteroid therapy was significantly (p < 0.001) different among the intermittent (4.9%), mild persistent (9.1%), moderate persistent (28.6%), and severe persistent (45.5%) groups. Regarding the beginning of birth, there was a higher proportion of elective cesarean section in the groups with moderate persistent asthma (52.5%) and severe persistent (54.6%) when compared to the intermittent (21.9%) and mild persistent (24.2%) groups (p = 0.039).

[☆]Study conducted at the Department of Obstetrics and Gynecology of the Medical School of the Universidade de São Paulo, São Paulo, SP, Brazil

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Conclusion: The severity of maternal asthma does not appear to have any direct influence on perinatal outcomes, and does not compromise fetal well-being. Active conduct to enable a better maternal clinical condition provides a favorable prognosis for pregnancy complicated by asthma.

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Asma na gestação: efeitos na vitalidade fetal, complicações maternas e perinatais

R E S U M O

Palavras-chave:

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Objetivo: Avaliar os efeitos da asma materna sobre a gravidez, analisando as repercussões da gravidade da doença no comprometimento do bem-estar fetal, bem como as complicações maternas e perinatais associadas.

Métodos: Foi realizado estudo retrospectivo de 117 gestações complicadas pela asma materna e sem outras comorbidades, no período de janeiro de 2005 a dezembro de 2010. Os critérios de inclusão foram: gestação única; diagnóstico de asma prévio à gestação; início do pré-natal antes da 28ª semana de gravidez; parto realizado na instituição; peso do recém-nascido acima de 500 g e idade gestacional no parto acima de 22 semanas; ausência de malformações fetais ou anomalias cromossômicas; ausência de comorbidades maternas. A gravidade da asma foi classificada em intermitente, persistente leve, persistente moderada, persistente grave. Foram analisados os resultados do perfil biofísico fetal e da dopplervelocimetria de artéria umbilical realizados até 14 dias antes do parto.

Resultados: Do total de 117 gestantes asmáticas analisadas: 41 (35,0%) eram intermitentes, 33 (28,2%) persistentes leves, 21 (17,9%) persistentes moderadas e 22 (18,8%) persistentes graves. Não houve diferença significativa entre os grupos quanto ao tipo de parto: a cesárea foi realizada em 65,8% dos casos, a corticoterapia materna no momento do parto em 20,5%, a idade gestacional no parto apresentou média de 38,6 semanas (DP 1,9 semanas) e o peso ao nascimento apresentou média de 3056 g (DP 581 g). O perfil biofísico fetal realizado no período anteparto (n = 90, 76,9%) apresentou resultado normal (8 ou 10) em 99% dos casos. A dopplervelocimetria de artéria umbilical foi avaliada em 23,9% (n = 28) das gestantes, e apresentou-se normal em 100% dos casos. O uso de corticoterapia sistêmica foi significativamente (p < 0,001) diferente entre os grupos intermitente (4,9%) e persistente leve (9,1%), persistente moderada (28,6%), persistente grave (45,5%). Quanto ao início do parto, houve maior proporção de cesárea eletiva no grupo com asma persistente moderada (52,5%) e persistente grave (54,6%) quando comparados aos grupos intermitente (21,9%) e persistente leve (24,2%) (p = 0,039).

Conclusão: A gravidade da asma materna não parece influenciar diretamente os resultados perinatais e não compromete a vitalidade fetal. A conduta ativa proporcionando melhor quadro clínico materno promove evolução favorável para a gestação complicada pela asma.

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Introduction

Literature describes different prevalences of asthma during pregnancy. In Canada, asthma affects only 0.43% of pregnant women,¹ while in the United States this rate can reach 8.4%.² In Brazil, although there are only few studies on the topic, it is estimated that the prevalence of asthma in the population is closer to U.S. patterns, ranging from 5% to 8%.³

Research on perinatal outcomes in pregnancy complicated by asthma shows higher perinatal morbidity,^{4,5} but few studies relate the severity of maternal asthma with impairment of fetal well-being. In a study published in 1992, fetal distress was an indication for cesarean section in 25% of the cases analyzed.⁶ Asthma is a pathology characterized by intermittent

or persistent symptoms of bronchoconstriction, including: dyspnea, wheezing, cough, and chest tightness. The diagnosis is reached by analyzing the response to bronchodilator obtained through spirometry. It is may be clinically classified as intermittent, persistent, mild, moderate, or severe, pursuant to the types and frequency of symptoms shown by the patient and the results obtained in respiratory tests.

Asthma in pregnancy is deemed a high risk factor for pregnant women and their fetuses. Controlled studies have shown a significantly increased risk of complications in pregnant women with asthma, especially in those with poorly controlled asthma.^{7,8} These complications include: prematurity,^{9,10} low birth weight,¹¹ preeclampsia,^{12,13} higher proportion of cesarean section delivery,¹⁴ and higher perinatal morbidity.⁵ Some hypotheses were raised to explain such

complications, namely: 1) common etiology for uterine and bronchial hyperactivity, 2) hypoxia secondary to maternal asthma, 3) bioactive mediators released during an asthma attack, 4) medications used to treat asthma during pregnancy.¹⁵

This study presents the experience in prenatal care of pregnancies complicated by maternal asthma, and aims to assess its effects on pregnancy, by analyzing how the severity of the disease impairs fetal well-being, i.e., impairment on fetus oxygenation, as well as related maternal and perinatal complications.

Methods

This study was conducted in a tertiary level university hospital that attends to high-risk pregnancies. This was a retrospective and descriptive study that adopted the following inclusion criteria: pregnant women diagnosed with asthma prior to pregnancy; singleton pregnancy; initiation of prenatal care before the 28th week of pregnancy; birth at this institution; newborn weighing more than 500 g and gestational age at delivery of 22 weeks or more; absence of fetal malformations or chromosomal abnormalities; absence of maternal comorbidities; and prenatal care at the Lung Diseases and Prenatal Care Sector in the period from January, 2005 to December, 2010. The research project was approved by the institution's research ethics committee under the number 745/10.

Patients were chosen, and data collected included information obtained through medical records and registers of births filed in the institution's Section of Medical Files, as well as information obtained through consultation to the department's computerized database.

117 pregnancies complicated by maternal asthma were assessed; data related to the population characteristics are presented in Table 1. Severity of asthma was classified based on the clinical protocol adopted in the institution.¹⁶ Thus, asthma was classified as intermittent, mild persistent, moderate persistent, or severe persistent. This classification is based on the following parameters: frequency of daytime symptoms, frequency of night-time symptoms, variation in maximal expiratory pressure (MEP), and forced expiratory volume in one second (FEV1). Patients showing daily symptoms up to twice a week, night-time symptoms up to twice a month, FEV1 \geq 80% of the expected number, and/or variation in MEP lower than 20% were classified with intermittent asthma. Patients classified as mild persistent showed daily symptoms three or more times a week and less than once a day, night-time symptoms three or more times a month, FEV1 \geq 80% of the expected number, and/or variation in MEP between 20% and 30%. Those classified as moderate persistent showed daily symptoms, night-time symptoms twice or more a week, FEV1 between 60% and 80% of the expected number, and/or variation in MEP higher than 30%. And, finally, those showing persistent daily symptoms, frequent night-time symptoms, FEV1 \leq 60%, and/or variation in MEP higher than 30% were classified with severe persistent asthma.¹⁶

Fetal well-being was assessed through antenatal cardiotocography, fetal biophysical profile (BPP), and Doppler

Table 1 – Characteristics of pregnancies complicated by maternal asthma.

Characteristics	n (%)
Maternal age (years), average (SD)	26.7 (6.6)
White	76 (65.0)
Nulliparous	41 (35.0)
Asthma complications in the second trimester	46 (39.3)
Asthma complications in the third trimester	44 (37.6)
Systemic corticosteroid therapy for asthma	21 (17.9)
Complications	
Fetal growth restriction	14 (11.9)
Pneumonia	11 (9.4)
Urinary infection/pyelonephritis	6 (5.1)
Preeclampsia	4 (3.4)
Premature rupture of membranes	10 (8.5)
Gestational diabetes	3 (2.5)
Placental abruption	4 (3.4)
Severity of asthma, n (%)	
Intermittent	41 (35.0)
Mild persistent	33 (28.2)
Moderate persistent	21 (17.9)
Severe persistent	22 (18.8)
Doppler velocimetry of the umbilical artery (n = 28)	
A/B ratio, average (SD)	2.50 (0.37)
Pulsatility index, average (SD)	0.91 (0.18)
Type of birth	
Vaginal delivery without medical instruments	27 (23.1)
Forceps	13 (11.1)
Cesarean section	77 (65.8)
Complications during labor/postpartum, n (%)	
Asthma attack	10 (8.6)
Atony	2 (1.7)
Surgical wound infection	1 (0.9)
Corticosteroid therapy during labor, n (%)	24 (20.5)
Gestational age at birth (weeks), average (SD)	38.6 (1.9)
Weight of the newborn (g), average (SD)	3,056 (581)
Gender of the newborn, n (%)	
Female	61 (52.1)
Male	56 (47.9)
1 min Apgar score < 7, n (%)	3 (2.6)
5 min Apgar score < 7, n (%)	0 (0)

velocimetry of umbilical arteries. Patients were submitted to tests in the same period of the prenatal visit, in the third trimester of pregnancy. In this research, the results of the last evaluation performed up to two weeks before birth were analyzed. BPP parameters were evaluated through ultrasonography (tone, fetal body movements, fetal breathing movements, and amniotic fluid volume). The ultrasound equipment used was Toshiba® model SSA-220A and Philips® model Envisor; and a Hewlett Packard® cardiotocography machine. The results of cardiotocography were classified pursuant to the clinical protocol, which classifies an active fetus as normal when the window shows at least two transient accelerations of 15 bpm of amplitude within a 30-minute window, baseline fetal heart rate (FHR) between 110 and

160 bpm, variability greater than 5 bpm, and absence of decelerations. Fetuses with abnormal cardiotocography tracings were designated as hypoactive fetus or inactive fetus. Amniotic fluid volume was assessed through amniotic fluid index (AFI), and the values were classified as normal when higher than 5.0 cm. For Doppler velocimetry of umbilical arteries, the insonation of the umbilical cord segment was close to the placental insertion site and was performed in the absence of fetal body and breathing movements. The recording of at least three sonograms with a minimum of five uniform sound waves was deemed satisfactory. A/B ratios (systole/diastole ratio) and pulsatility index (PI) were calculated. Values obtained were compared with the normality curve for that vessel.¹⁷

The following clinical, obstetrical, and perinatal variables were assessed: respiratory complications in the second and third trimester, need for systemic corticosteroid therapy during pregnancy, systemic corticosteroid therapy at birth, obstetric complications, type of birth, how labor was triggered (spontaneous labor, labor induction, or elective cesarean section), complications during birth or postpartum (uterine atony, infections, exacerbation of asthma), gestational age at birth, newborn weight and adequacy, newborn gender, and Apgar score from 1 to 5 minutes.

Gestational age was calculated from the last menstrual period (LMP), when compatible with the gestational age estimated by ultrasonography performed no later than the 20th week of pregnancy. In cases in which such correlation was not observed, the gestational age was calculated through data from the first ultrasonography. The weight of the newborn, in grams, measured in the delivery room, was compared with the normality curve of Alexander et al.,¹⁸ in a way that the newborns with weight below the 10th percentile of the corresponding range were classified as small for the gestational age.

Results were analyzed by using the Medcalc software (Medcalc, version 11.5.1.0). Categorical variables were analyzed in a descriptive manner, by calculating absolute and relative frequencies. In order to analyze the continuous variables, the results were expressed in averages and standard deviations. The chi-squared test was used to compare proportions and,

when applicable, Fisher's exact test. The ANOVA test was used to compare the averages among the groups for variables with normal distribution, and the Kruskal-Wallis test was used for abnormally distributed variables. The value of 0.05 (alpha = 5%) was adopted as the significance level, and descriptive levels (p) below this value were deemed significant (p < 0.05).

Results

A total of 117 pregnancies complicated by maternal asthma were included in the case selection. Maternal characteristics, birth information, and perinatal outcomes are presented in Table 1. Regarding the distribution of the cases pursuant to severity of the disease, the higher proportion of cases classified as intermittent is notable. Cases of severe asthma corresponded to 19% of the sample, and only one patient of this group needed to be hospitalized in an intensive care unit (ICU) due to disease exacerbation. The most frequent obstetric complication was fetal growth restriction, suspected in the antenatal period in 12% of the cases. Regarding the type of birth, cesarean section was the most frequent (65.8%). In postpartum, there was exacerbation of the disease in 8.6% of the patients.

Of all study cases, 90 (76.9%) pregnant women were submitted to evaluation of antepartum fetal well-being. Results are presented in Table 2. The cardiotocography showed normal results (active fetus) in the majority of the cases; the same was observed regarding fetal BPP. The diagnosis of oligohydramnios occurred in four of 90 cases (4.4%). Doppler velocimetry of umbilical arteries showed normal results in all cases in which this test was performed (n = 28, 23.9%).

Table 3 presents the comparison of the main study parameters in different groups categorized pursuant to the severity of maternal asthma. During the prenatal period, respiratory complications were similar in the groups analyzed. In the second and third trimesters, these complications were observed in at least 30% of the cases in each group. The need for maternal corticosteroid therapy during prenatal period was

Table 2 – Assessment of fetal well-being according to severity of maternal asthma

Result	Intermittent (n = 32)		Mild persistent (n = 25)		Moderate persistent (n = 16)		Severe persistent (n = 17)		p
Cardiotocography									
Active	27	(84.4)	25	(100)	14	(87.5)	16	(94.1)	0.197
Hypoactive	5	(15.6)	0	(0)	2	(12.5)	1	(5.9)	
Fetal biophysical profile									
10	24	(75.0)	21	(84.0)	13	(81.3)	12	(70.6)	0.806
8	7	(21.9)	4	(16.0)	3	(0.19)	5	(29.4)	
6	1	(3.1)	0	(0)	0	(0)	0	(0)	
AFI									
≥ 5.0 cm	31	(96.9)	24	(96.0)	16	(100)	15	(88.2)	0.387
< 5.0 cm	1	(3.1)	1	(4.0)	0	(0)	2	(11.8)	
AFI, average (SD)	10.1	(4.9-19.0)	11.2	(4.9-17.3)	11.8	(5.6-25.0)	9.7	(3.2-15.6)	0.130

SD, standard deviation; AFI, amniotic fluid index.

Table 3 – Complications during pregnancy, birth information and perinatal outcomes according to severity of maternal asthma

Result	Intermittent (n = 41)	Mild persistent (n = 33)	Moderate persistent (n = 21)	Severe persistent (n = 22)	p
Maternal age (years), average (SD)	25.7 (7.5)	27.2 (6.5)	29.5 (5.7)	25.1 (5.2)	0.097
White, n (%)	(51.2)	23 (69.7)	14 (66.7)	18 (81.8)	0.090
Nulliparous, n (%)	17 (41.5)	12 (36.4)	3 (14.3)	9 (40.9)	0.065
Pulmonary complications					
Second trimester	13 (31.7)	12 (36.4)	12 (57.1)	9 (40.9)	0.269
Third trimester	15 (36.6)	12 (36.4)	8 (38.1)	9 (40.9)	0.986
Systemic corticosteroid therapy, n (%)	2 (4.9)	3 (9.1)	6 (28.6)	10 (45.5)	< 0.001
Beginning of labor					
Spontaneous labor	21 (51.2)	15 (45.1)	4 (19.0)	7 (31.8)	
Labor induction	11 (26.8)	10 (30.3)	6 (28.5)	3 (13.6)	0.039
Cesarean section	9 (21.9)	8 (24.2)	11 (52.5)	12 (54.6)	
Type of birth					
Vaginal delivery without medical instruments	11 (26.8)	9 (27.2)	2 (9.5)	4 (18.2)	
Forceps	5 (12.3)	5 (15.3)	3 (14.3)	1 (4.6)	0.459
Cesarean section	25 (60.9)	19 (57.5)	16 (76.2)	17 (77.2)	
Intrapartum fetal distress	6 (9.8)	3 (9.1)	3 (9.5)	1 (4.5)	0.904
Corticosteroid therapy during labor, n (%)	2 (4.8)	8 (24.2)	4 (19.4)	10 (45.4)	< 0.001
GA at birth (weeks), average (SD)	38.5 (1.86)	38.75 (1.98)	38.72 (2.25)	38.14 (1.64)	0.700
Weight of the newborn (g), average (SD)	3,102.4 (592.1)	2,979.3 (561.7)	3,265.7 (704.9)	2,884.0 (395.9)	0.138
SGA newborn	9 (22.0)	4 (12.1)	2 (9.5)	4 (18.2)	0.541
1 min Apgar score < 7, n (%)	2 (4.8)	1 (3.0)	0 (0)	0 (0)	0.591
Gender of the newborn					
Female	22 (53.7)	16 (48.5)	10 (47.6)	13 (59.1)	0.847
Male	19 (46.3)	17 (51.5)	11 (52.4)	9 (40.9)	

GA, gestational age; SGA, small for gestational age.

significantly different in the study groups, with higher use of systemic corticosteroids in the groups of pregnant women with moderate persistent and severe persistent asthma. The analysis of data on the beginning of labor in different groups shows that elective cesarean section was more often indicated in cases showing greater severity and, conversely, spontaneous labor occurred more often in cases of intermittent and mild persistent asthma. However, when analyzing the types of birth that effectively occurred, there was a high proportion of cesarean sections in all groups. There was no difference regarding fetal distress during labor. The use of systemic corticosteroids during labor showed a significant difference among the groups, with higher frequency in the group with severe persistent asthma. No difference was noted in perinatal outcomes among the study groups.

Discussion

Occurrence of perinatal complications in pregnancies complicated by asthma did not show significant differences among the groups categorized by the severity of the maternal disease. However, it was verified that, in cases of greater severity, there was a higher proportion of cases in which the elective cesarean section was performed before the beginning of labor, in order to end the pregnancy, which may have contributed to similar perinatal outcomes in all groups analyzed.

There are conflicting results regarding the impact of asthma on pregnancy. Studies indicate association of the disease with small for gestational age (SGA) or underweight newborns, in addition to prematurity,^{5,9,10,11,14} especially related to the severity of the disease. However, in a meta-analysis performed by Murphy et al.,⁴ no increased risk was verified for these adverse events. The present study also did not verify association between the severity of asthma and adverse prenatal outcomes, with preserved fetal well-being, which may be explained, in part, by the control of the maternal disease and by the active decision to end the pregnancy. Fetal growth restriction was verified in 11.9% of the cases, although there were no cases of abnormality in the Doppler velocimetry of the umbilical artery. The mechanism by which reduction in fetal growth occurs is not fully established. The placental physiology appears to suffer changes in pregnancies complicated by maternal asthma, due to the reduced activity of the 11-beta-hydroxysteroid dehydrogenase type 2 enzyme in pregnancies with female fetuses.¹⁹ This enzyme appears to protect the fetus against the excess of maternal glucocorticoids, and influences fetal growth.²⁰ Prospective studies addressing changes in placental flow and in enzyme expression in the placenta may clarify these aspects.

In cases that assessed fetal well-being through a BPP, only one showed a suspicious result during the antepartum period. Also, no difference was found in the proportion of cases developing intrapartum fetal distress in the groups formed pursuant to severity of maternal asthma. In a study comparing

antenatal cardiotocography in pregnant patients with asthma and pregnant patients without comorbidities, no significant difference was found in FHR parameters, although a difference in the patterns of fetal movement was observed, indicating that the counting of fetal movements may be a useful method to assess fetal well-being.²¹ Cesarean section was chosen in 66% of the cases, a higher proportion than that described in high-risk pregnancies monitored in this hospital (57%).²²

Regarding respiratory complications during the prenatal period, they may result from aggravation of the disease by the increased intra-abdominal pressure, in addition to higher oxygen consumption by the maternal organism.²³ Treatment of asthma is based, mainly, on inhaled corticosteroids. And, when the clinical condition is aggravated, inhaled corticosteroid dosages are adjusted, and it is also possible to associate it with other medications, such as long-acting beta-agonists and oral systemic corticosteroids, for improved control of the condition. As to intermittent conditions or exacerbations, oxygenation and short-acting beta-agonists are the most used. In cases of more severe and poorly controlled attacks, oral corticosteroids may be used.²⁰

The incidence of pneumonia in pregnancy does not appear to differ from the general population of non-pregnant women. However, asthma may be a predisposing factor, as this maternal disease is reported in 46.4% of the cases in which pneumonia was diagnosed during pregnancy.²⁴ In the present study, pneumonia was reported in 9.4% of the cases analyzed.

There are studies showing that, during pregnancy, drug treatment of asthma does not result in adverse effects on pregnant women and fetuses, instead benefiting both by controlling the disease.^{9,13,14} In this study, prenatal maternal corticosteroid therapy was used in higher proportion in the group with severe asthma, which may have contributed to improve the control of the maternal disease and to a better perinatal outcome. Similarly, Dombrowski et al.¹⁴ found no statistically significant difference for perinatal complications, except for neonatal sepsis, and maternal complications among pregnant women without asthma and pregnant women with asthma, but they found a significant difference as to the incidence of cesarean births.

Asthma is a disease with variable course that may present variations in severity. Therefore, the physician should be aware of the clinical and functional parameters at all times. If a pregnant woman shows asthma controlled for more than three weeks, medication should be reduced. But when the disease is partially controlled, non-controlled or aggravated, an increase in medication should be considered. Discontinuation of the treatment during pregnancy may contribute to worsen the maternal condition, and this is reported in the study by Lim et al.,²⁵ in which 25.8% of the study professionals would reduce or discontinue the medication previously used, even during asthma attacks. In the present study, patients had their medications adjusted in cases of aggravation of the disease, and were oriented as to environmental measures, such as: avoid contact with pollen, mold, mites, occupational sensitizers, cold air, physical exercises, respiratory infections, and smoking. Therefore, this study evidences that the benefit of having asthma controlled during pregnancy exceeds any potential harm resulting from the medications used to control the disease.

Despite the efforts used to keep asthma controlled, exacerbations may occur. There are several factors that may trigger it, such as: discontinuation of medication, exposure to allergens, stress, and respiratory tract infection. While prevention is the most suitable conduct to avoid exacerbations, Schatz et al.²⁶ evidenced that 52% of the patients with severe asthma showed exacerbation of the disease during pregnancy, and many of them needed hospitalization.

Therefore, it is important that obstetricians properly recognize, conduct, and treat severe cases.²⁷ Treatment strategies are based on additional oxygenation, so that saturation remains above 95%; short-acting beta-agonists and corticosteroids; prevention and correction of hypoxemia; or reduction of hypercapnia.²⁸ In this study, no pregnant woman showed to be immune to the medical treatment of asthma indicating the need for an emergency cesarean section.

Improvement in the exacerbation of severe asthma after birth results from two concomitant factors: intra-abdominal pressure reduction and oxygen consumption reduction.²⁹ Birth treatment in patients with asthma should be cautious, even in the absence of exacerbations. Continuous-use medications to control the disease should not be delayed or discontinued due to labor. In this study, patients showing exacerbation were medicated with systemic corticosteroid at the moment of labor and of birth. Only one pregnant woman with severe asthma needed support in the intensive care unit (for seven days), and birth was performed with general anesthesia.

The limitations of this study include the restricted number of cases with Doppler velocimetry assessment, and the difficulty in obtaining information due to the retrospective characteristic of the work. Additionally, a control group of pregnant women without asthma in the same period was not obtained, given that this hospital primarily attends to high-risk pregnancies.

Conclusion

Severity of maternal asthma does not appear to have any direct influence on perinatal outcomes and does not compromise fetal well-being. Although the exacerbation of asthma during pregnancy is not related to the severity of the disease, poorly controlled asthma during pregnancy may pose risks of adverse perinatal outcome. Active conduct to enable a better maternal clinical condition provides a favorable prognosis for pregnancy complicated by asthma.

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Conflict of interest

All authors declare to have no conflict of interest.

R E F E R E N C E S

1. Wen SW, Demissie K, Liu S. Adverse outcomes in pregnancies of asthmatic women: results from a Canadian population. *Ann Epidemiol.* 2001;11(1):7-12.
2. Kwon HL, Belanger K, Bracken MB. Asthma prevalence among pregnant and childbearing-aged women in the United States: estimates from national health surveys. *Ann Epidemiol.* 2003;13(5):317-24.
3. Almeida ML, Santana PA, Guimarães AM, Gurgel RQ, Vianna EO. Asthma and pregnancy: repercussions for neonates. *J Bras Pneumol.* 2010;36(3):293-300.
4. Murphy VE, Namazy JA, Powell H, Schatz M, Chambers C, Attia J, et al. A meta-analysis of adverse perinatal outcomes in women with asthma. *BJOG.* 2011;118(11):1314-23.
5. Firoozi F, Lemièrre C, Beauchesne MF, Perreault S, Forget A, Blais L. Impact of maternal asthma on perinatal outcomes: a two-stage sampling cohort study. *Eur J Epidemiol.* 2012;27(3):205-14.
6. Perlow JH, Montgomery D, Morgan MA, Towers CV, Porte M. Severity of asthma and perinatal outcome. *Am J Obstet Gynecol.* 1992;167(4 pt 1):963-7.
7. Bakhireva LN, Schatz M, Jones KL, Chambers CD, Organization of Teratology Information Specialists Collaborative Research Group. Asthma control during pregnancy and the risk of preterm delivery or impaired fetal growth. *Ann Allergy Asthma Immunol.* 2008;101(2):137-43.
8. Firoozi F, Lemièrre C, Ducharme FM, Beauchesne MF, Perreault S, Bérard A, et al. Effect of maternal moderate to severe asthma on perinatal outcomes. *Respir Med.* 2010;104(9):1278-87.
9. Bakhireva LN, Schatz M, Chambers CD. Effect of maternal asthma and gestational asthma therapy on fetal growth. *J Asthma.* 2007;44(2):71-6.
10. Acs N, Puhó E, Bánhidly F, Czeizel AE. Association between bronchial asthma in pregnancy and shorter gestational age in a population-based study. *J Matern Fetal Neonatal Med.* 2005;18(2):107-12.
11. Enriquez R, Griffin MR, Carroll KN, Wu P, Cooper WO, Gebretsadik T, et al. Effect of maternal asthma and asthma control on pregnancy and perinatal outcomes. *J Allergy Clin Immunol.* 2007;120(3):625-30.
12. Liu S, Wen SW, Demissie K, Marcoux S, Kramer MS. Maternal asthma and pregnancy outcomes: a retrospective cohort study. *Am J Obstet Gynecol.* 2001;184(2):90-6.
13. Källén B, Otterblad Olausson P. Use of anti-asthmatic drugs during pregnancy. 1. Maternal characteristics, pregnancy and delivery complications. *Eur J Clin Pharmacol.* 2007;63(4):363-73.
14. Dombrowski MP, Schatz M, Wise R, Momirova V, Landon M, Mabie W, et al. Asthma during pregnancy. *Obstet Gynecol.* 2004;103(1):5-12.
15. Macmullen NJ, Shen JJ, Tymkow C. Adverse maternal outcomes in women with asthma versus women without asthma. *Appl Nurs Res.* 2010;23(1):e9-e13.
16. Zugaib M, Bittar RE. *Protocolos assistenciais.* 3ª ed. São Paulo: Atheneu; 2007.
17. Arduini D, Rizzo G. Normal values of Pulsatility Index from fetal vessels: a cross-sectional study on 1556 healthy fetuses. *J Perinat Med.* 1990;18(3):165-72.
18. Alexander GR, Himes JH, Kaufman RB, Mor J, Kogan M. A United States national reference for fetal growth. *Obstet Gynecol.* 1996;87(1):163-8.
19. Murphy VE, Zakar T, Smith R, Giles WB, Gibson PG, Clifton VL. Reduced 11beta-hydroxysteroid dehydrogenase type 2 activity is associated with decreased birth weight centile in pregnancies complicated by asthma. *J Clin Endocrinol Metab.* 2002;87(4):1660-8.
20. Rocklin RE. Asthma, asthma medications and their effects on maternal/fetal outcomes during pregnancy. *Reprod Toxicol.* 2011;32(2):189-97.
21. Nemer DS, Nomura RM, Ortigosa C, Liao AW, Zugaib M. Computerized cardiotocography in pregnancies complicated by maternal asthma. *J Matern Fetal Neonatal Med.* 2012;25(7):1077-9.
22. Nomura RM, Alves EA, Zugaib M. Maternal complications associated with type of delivery in a university hospital. *Rev Saúde Pública.* 2004;38(1):9-15.
23. Nelson-Piercy C, Waldron M, Moore-Gillon J. Respiratory disease in pregnancy. *Br J Hosp Med* 1994;51(8):398-401.
24. Shariatzadeh MR, Marrie TJ. Pneumonia during pregnancy. *Ann J Med.* 2006; 119(10):872-6.
25. Lim A S, Stewart K, Abramson M J, George J. Management of asthma in pregnant women by general practitioners: a cross sectional survey. *BMC Fam Pract.* 2011;12:121.
26. Schatz M, Dombrowski MP, Wise R, Thom EA, Landon M, Mabie W, et al. Asthma morbidity during pregnancy can be predicted by severity classification. *J Allergy Clin Immunol.* 2003;112(2):283.
27. Holland SM, Thomson KD. Acute severe asthma presenting in late pregnancy. *Int J Obstet Anesth.* 2006;15(1):75-8.
28. National Asthma Education and Prevention Program Expert Panel Report. Managing asthma during pregnancy: recommendations for pharmacologic treatment-2004 update. *J Allergy Clin Immunol.* 2005;115(1):34-46.
29. Hanania N, Belfort M. Acute asthma in pregnancy. *Crit Care Med.* 2005;33(10 Suppl):S319-24.