



Recent developments in asthma in pregnancy

Annelies L. Robijn^a, Vanessa E. Murphy^a, and Peter G. Gibson^{b,c}

Purpose of review

Asthma affects up to 13% of pregnancies worldwide and has a varying and unpredictable clinical course during pregnancy. Pharmacological asthma treatment is recommended; however, studies show that some pregnant women with asthma cease their medication in early pregnancy. There is likely a large unmet disease burden arising from asthma in pregnancy.

Recent findings

Antenatal and asthma guidelines lack sufficient information on asthma management in pregnant women, and implementation of the current guidelines seems inadequate. Prescription databases provide evidence of cessation of asthma medication during pregnancy on a population level. Population-based databases also provide evidence of rare adverse perinatal outcomes. The risk of childhood asthma in the offspring of women with asthma is reduced by adequate control of maternal asthma during pregnancy. Vitamin D sufficiency during pregnancy could also reduce the risk of childhood asthma.

Summary

The findings of this review demonstrate the need for improved asthma and antenatal guidelines regarding asthma management during pregnancy, and the need of adequate implementation of these guidelines. Furthermore, adequate asthma control during pregnancy is needed to reduce the risk of childhood asthma. To maintain asthma control, prepregnancy medication should be continued throughout pregnancy and adjusted according to the current treatment steps if required.

Keywords

asthma medication, guidelines, self-management skills, vitamin D

INTRODUCTION

Asthma is a common chronic condition among women of childbearing age with a prevalence of 1–13% worldwide. The course of asthma symptoms during pregnancy is unpredictable. Although about one-third of women remain unchanged, one-third experience improved asthma and one-third worsen compared with prepregnancy [1]. Guidelines recommend the same treatment approach for pregnant women as for the general adult asthma population [2,3]. Over the past years, asthma medication has been demonstrated to be well tolerated for use during pregnancy [4]. However, in large population-based databases, prescriptions rates for asthma medication decline in early pregnancy [5,6], suggesting cessation of asthma medication in early pregnancy. This is likely to be inappropriate and puts mothers and their babies at risk of uncontrolled asthma. The prevalence of inhaled corticosteroid (ICS) use among pregnant women with asthma participating in cohort studies or randomized controlled trials (RCTs) varies between countries, from 15% in South Korea to 71% in Brazil [7]. This marked variation in

ICS use remains unexplained. ICS is a highly effective therapy for controlling asthma and reducing asthma exacerbations. Maternal asthma, and especially a maternal asthma exacerbation, has been associated with several adverse perinatal outcomes, such as preeclampsia, preterm birth, and low birth weight [8–10]. There is likely a large unmet disease burden arising from asthma in pregnancy.

In this review, we summarize recent literature in asthma in pregnancy, to indicate novel insights and areas for future research.

^aPriority Research Centre Grow Up Well, School of Medicine and Public Health, ^bPriority Research Centre for Healthy Lungs, Hunter Medical Research Institute, University of Newcastle, Newcastle and ^cDepartment of Respiratory and Sleep Medicine, John Hunter Hospital, New Lambton Heights, New South Wales, Australia

Correspondence to Peter G. Gibson, Locked Bag 1, Hunter Region Mail Centre, NSW 2310, Australia. Tel.: +61 240420143; e-mail: Peter.Gibson@hnehealth.nsw.gov.au

Curr Opin Pulm Med 2018, 24:000–000

DOI:10.1097/MCP.0000000000000538

KEY POINTS

- Current asthma-specific and antenatal guidelines lack evidence-based recommendations regarding optimal asthma management during pregnancy.
- Many pregnant women with asthma are not being prescribed regular asthma medication during pregnancy, and if they do, nonadherence to controller medication remains high (40%).
- Asthma and pregnancy registries are needed to evaluate actual asthma medication behavior among pregnant women with asthma on a population level.
- Good asthma control during pregnancy might reduce the prevalence of childhood asthma in offspring.
- Low vitamin D levels during pregnancy might be a risk factor for asthma exacerbations.

GUIDELINES AND MANAGEMENT

As asthma is common during pregnancy, antenatal guidelines should adequately inform healthcare professionals regarding asthma management in pregnancy. However, in a systematic appraisal of commonly used antenatal guidelines, it was reported that these guidelines lack evidence-based recommendations regarding optimal asthma management [11[¶]]. McLaughlin *et al.* [11[¶]] examined eight clinical practice guidelines, which were specific to antenatal care or asthma management during pregnancy. Guidelines were appraised using the AGREE II tool, a validated assessment tool for guideline quality. The Global Initiative for Asthma guideline had the lowest overall quality score (71%) of all the guidelines appraised (overall scores ranging from 71 to 86%). Despite a high asthma prevalence in Australia and the United Kingdom (12 and 9%, respectively), in four antenatal care guidelines of these countries (three from Australia/New Zealand, one from the United Kingdom), no specific asthma management recommendations could be found. This research identifies an opportunity to improve the quality of guideline recommendations for the management of asthma in pregnancy, both in the context of asthma-specific guidelines and in guidelines for antenatal care.

Guideline implementation has also been identified as an additional important component of asthma management. Nguyen *et al.* [12] reported on the implementation of the GINA guideline in general practice in Vietnam. One of the cases used to assess the implementation was a pregnant woman with partially controlled asthma. Only 20% of the clinicians could adequately classify the case as having partially controlled asthma, and only 12%

would consider the correct adjustment of therapy [12]. Inadequate knowledge about asthma management and asthma control during pregnancy by medical practitioners was also identified in Spain and Australia [13]. These data identify a need to address asthma guideline implementation.

A number of studies have examined the methods used to assess asthma control during pregnancy. The use of a validated questionnaire to assess asthma control was mentioned in the Australian Asthma Handbook of the National Asthma Council Australia [11[¶]]. Lung function testing can also be used as part of the asthma control assessment. The use of regular pulmonary function testing (PFT) to assess asthma control was only mentioned in the National Asthma Education and Prevention Program from the National Heart, Lung, and Blood Institute in the United States. Amaral *et al.* [14] recommend the use of the combination of PFT and validated questionnaires to assess asthma control during pregnancy at the monthly asthma assessments, which are recommended by most guidelines [11[¶]]. In this relatively small study, 42 pregnant women with asthma and rhinitis underwent at least 2 assessments during pregnancy. A lower Control of Allergic Rhinitis and Asthma Test (CARAT) score was associated with the need for step up treatment [14], whereas no significant correlations were found between PFT and CARAT scores [14]. These data support the important role of validated asthma questionnaires in pregnancy.

At the monthly assessments, there is potential for personalized care and support. This should help women understand their asthma and asthma medications. Williamson *et al.* [15] examined the role of personalized support for asthma during pregnancy in a systematic review. The authors reported on five articles, which examined women's experiences of personalized support for asthma during pregnancy and concluded that there is not enough evidence from RCTs to establish the efficacy of personalized asthma care during pregnancy. Two qualitative studies were included in this review and in both the pregnant women reported perceived risk of asthma medication on the fetus, and especially of corticosteroid containing medication [15], which is in line with other studies [14,16[¶]]. The women expressed the desire for self-management and wanted to receive asthma education to do so [15]. Robijn *et al.* [16[¶]] reported on the influence of asthma education on asthma self-management skills in three pregnancy cohorts, including 895 pregnant women with asthma, and found the lack of such skills among pregnant women with asthma. Women remain unaware of the possibility of asthma worsening during pregnancy and are unprepared for

that [15], even though the proportion of women with uncontrolled asthma during pregnancy has increased over the past 15 years [16[¶]]. The possession of a written asthma action plan is low; only two out of 10 women possessed a plan with important information on how to self-manage their asthma symptoms and when to call for help [16[¶]].

Williamson *et al.* [15] also included three quantitative studies with three different interventions, two interventions (one pharmacist-led and one nurse-led) to improve asthma control compared with usual care, and one intervention to describe the implementation of asthma education. All three studies showed significant improvements in asthma control or asthma self-management [15]. Robijn *et al.* [16[¶]] also showed that asthma self-management education during pregnancy is effective in increasing medication knowledge and inhaler technique, skills that are sustained for at least 6 months postpartum (Fig. 1). Asthma education during pregnancy can also be used to reduce perceived risk of asthma medication on the fetus, in particular the corticosteroid containing medications [16[¶]].

DATABASES AND REGISTRIES

As most clinical trials exclude pregnant women from participating, databases and registries (which are population-based and provide practice-based

data) can provide important findings in this specific population.

Medication use

A French database study from Beau *et al.* [17[¶]] reported data from 2977 women and found that about half of the women, who were prescribed asthma medication in the 3 months prior to pregnancy, were not prescribed asthma medication on a regular basis during pregnancy. The authors also reported a change in the type of medication that was prescribed, with an increase in ICS alone prescription and a decrease in fixed ICS/LABA (long-acting beta-2 agonists) combination prescriptions. These changes do not accord with guideline recommendations to continue the same pre-pregnancy asthma medication use in pregnancy. In addition, the prescribing of montelukast decreased by 87% in trimester three compared with pre-pregnancy, most likely because the safety of montelukast during pregnancy has not been well established. This contrasts with data reported by Caverio-Carbonell *et al.* [18] who found that montelukast was not associated with a significant increase in the risk of congenital malformations compared with women without asthma medication prescriptions. However, among women using montelukast, the prevalence of pre-eclampsia was higher compared with women

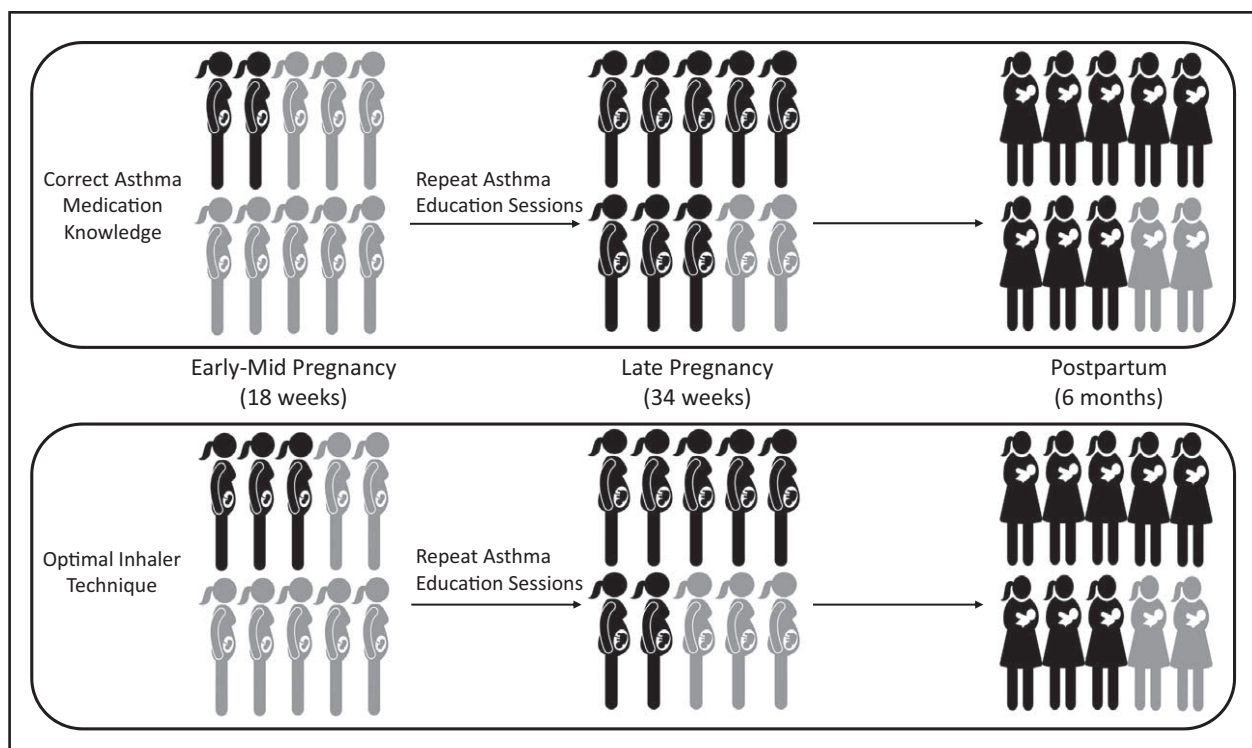


FIGURE 1. Asthma medication knowledge and pressured metered dose inhaler technique improve following asthma education sessions during pregnancy and sustain after 6 months postpartum, Adapted with permission [16[¶]].

without asthma medication prescriptions and also compared with women using asthma medications other than montelukast. Around 3.2% of women with asthma medication were prescribed montelukast, similar to the study of Beau *et al.* [17[■]] (3.9% in the first trimester).

A Korean database study reported data of 115 169 women in a cluster analysis of changes in asthma medication around pregnancy, which showed that those with higher levels of asthma medication use in pregnancy had a trend toward a higher number and rate of asthma exacerbations [19]. However, this study did not take into account the timing of the medication use during pregnancy in relation to the exacerbations and did not address the likely confounding by severity.

The changes in asthma medication use around and during pregnancy have been studied in numerous prescription databases, and all show similar trends [6]. The use of these prescription databases is useful to show what happens with medication prescriptions around pregnancy on a population level; however, these data may not represent actual use. Clinical observational studies, such as asthma or pregnancy registers, are needed to describe asthma medication adherence in the specific population of pregnant women with asthma.

Adverse outcomes

Recent database studies have confirmed that maternal asthma is associated with an increased risk of adverse perinatal outcomes which have been observed previously such as small for gestational age (SGA) [20[■],21[■],22[■],23] (Fig. 2). These databases might be helpful to identify less common adverse perinatal outcomes.

In the study of Baghlaf *et al.* [20[■]] in which an American nationwide database of more than 7 million pregnancies was used, the authors report an increased risk of maternal death [odds ratio (OR) 1.68, 95% confidence interval (CI) 1.31–2.15] for women with asthma compared with women without asthma and a decreased risk of intrauterine fetal death [adjusted odds ratio (aOR) 0.85, 95% CI 0.79–0.91]. In contrast, in the Finnish database study of Kempainen *et al.* [21[■]], an increased risk of perinatal mortality, stillbirths, and early neonatal deaths was found for asthmatic women compared with nonasthmatic women (aOR 1.26, 95% CI 1.07–1.48). This difference in risk estimate for perinatal mortality might be driven by the definition. In the study of Baghlaf *et al.* [20[■]] and the study of Vaezi *et al.* [23], risks were estimated for stillbirths (pooled OR 0.92, 95% CI 0.62–1.36), and in the study of Kempainen *et al.* [21[■]] and Shaked *et al.* [24], risks were estimated for a combined definition of stillbirths and neonatal deaths (pooled OR 1.25, 95% CI 1.07–1.46) (Fig. 3). In a previous meta-analysis by Murphy *et al.* [25], this difference in estimates was shown with no increased risk of stillbirth for women with asthma compared with women without asthma (pooled OR 1.06, 95% CI 0.90–1.25) and an increased risk of neonatal death for women with asthma compared with women without asthma (pooled OR 1.49, 95% CI 1.11–2.00). Offspring of women with asthma is at increased risk for death postpartum but not during pregnancy. This increased risk might be related to the increased risk of other neonatal complications, such as neonatal sepsis, among children of women with asthma compared with children of women without asthma [25]. In the study of Kempainen *et al.* [21[■]], results were also stratified on the basis of asthma treatment in

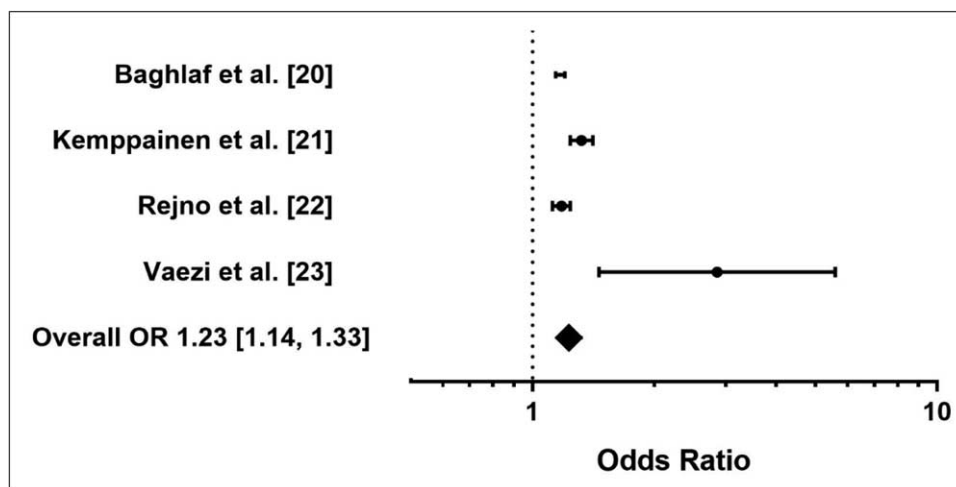


FIGURE 2. Meta-analysis of adjusted odds ratios for small for gestational age comparing asthmatic women to nonasthmatic women.

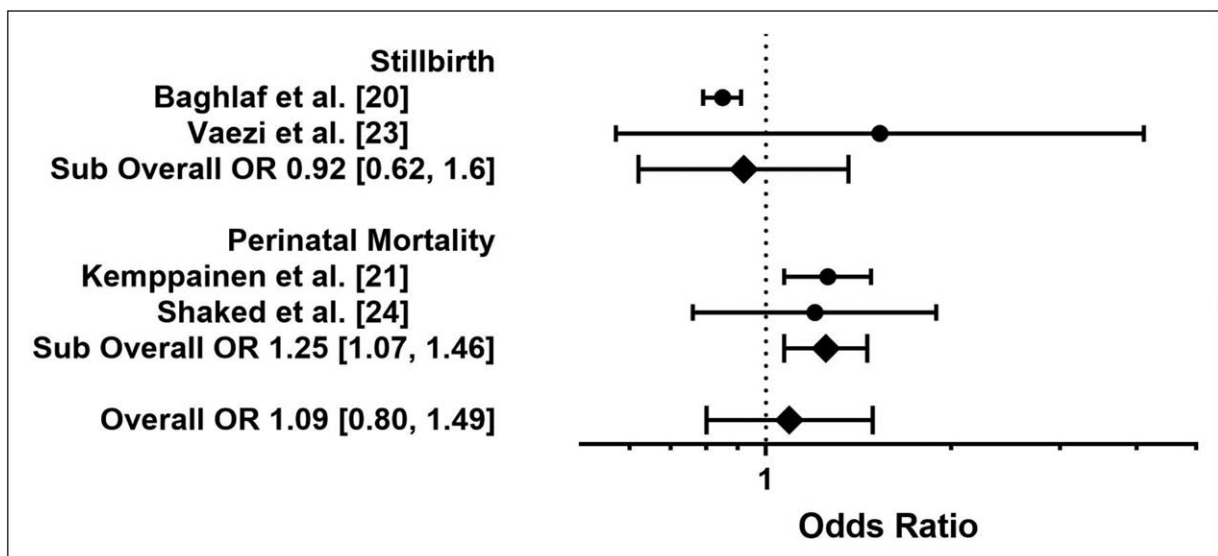


FIGURE 3. Meta-analysis with adjusted OR for perinatal mortality categorized on the basis of definition (estimate for Shaked *et al.* [24] crude OR). Perinatal mortality includes both stillbirths and early neonatal deaths from pregnancies with and without asthma. OR, odds ratios.

the 12 months prior to delivery. The authors report that the risk of SGA was higher for treated asthmatics compared with untreated asthmatics (aOR 1.25, 95% CI 1.09–1.44) [21^{***}]. The risk for SGA increased with increasing number of asthma medication type used in the 12 months prior to delivery. These results are likely to be confounded by asthma severity or exacerbations, which may have increased the number of medications used.

OFFSPRING ASTHMA RISK

Maternal asthma is recognized to be a significant risk factor for the development of infant wheeze and childhood asthma. Furthermore, there are now recognized to be several different patterns of early life wheezing illness in infants, each with a different asthma risk. Liu *et al.* [26^{***}] examined these relationships and demonstrated that the increased risk of asthma in offspring was modified by maternal asthma severity, control, and asthma exacerbations during pregnancy. Asthma severity was determined on the basis of maternal asthma medication use and by exacerbations during pregnancy, and asthma status was categorized as mild controlled, mild uncontrolled, moderate-to-severe controlled, and moderate-to-severe uncontrolled asthma. The authors also separated offspring asthma into three phenotypes: early onset transient, early onset persistent, and late onset asthma. The results suggest that children from asthmatic mothers are at an increased risk of asthma compared with children

from nonasthmatic mothers, especially the early-onset persistent asthma phenotype (adjusted prevalence risk 2.11, 95% CI 2.03–2.20). The authors suggest that maintaining asthma control during pregnancy might reduce the prevalence of childhood asthma. Data supporting this were reported in a recent article by Morten *et al.* [27^{***}], in which the authors demonstrated that active management of asthma during pregnancy using a fractional exhaled nitric oxide (F_ENO)-based algorithm to adjust treatment significantly reduced the odds of childhood asthma at age 4–6 years (OR 0.46, 95% CI 0.22–0.96). Previously, the F_ENO-based algorithm has been shown to be effective in reducing the number of exacerbations during pregnancy by 50% compared with symptom-based management of asthma during pregnancy [27^{***}]. Given that this inflammation and symptom-based management approach have benefits in both pregnant mothers with asthma and their offspring, further research should focus on the implementation of such management in clinical practice.

VITAMIN D AND ASTHMA

Maternal vitamin D levels during pregnancy also affect the risk of offspring asthma. The Vitamin D Antenatal Asthma Reduction Trial (VDAART) was a RCT to prevent asthma in children after maternal use of vitamin D compared with placebo and included 327 pregnant women with asthma [28^{***}]. Women with uncontrolled asthma at enrolment in

early-mid pregnancy (10–18 weeks gestation) had lower vitamin D serum levels compared with women with controlled asthma, 19.6 ± 8.8 ng/ml and 23.0 ± 10.4 ng/ml, respectively ($P = 0.04$). After adjustment for potential confounders, they reported an uncontrolled maternal asthma risk reduction of 80% for each 10 ng/ml increase in vitamin D serum level (aOR 0.19, 95% CI 0.04–0.90) [28[■]]. However, in a predictive model for uncontrolled asthma, vitamin D serum level was not a predictor in the adjusted model. Jensen *et al.* [29[■]] reported data on serum vitamin D levels in 52 pregnant women with asthma who participated in a RCT of asthma management during pregnancy. The authors grouped women on the basis of their levels of vitamin D during pregnancy, low (<75 nmol/l) at both 16 and 35 weeks of gestation and high (≥ 75 nmol/l) at both or either time point. The prevalence of exacerbations during pregnancy was higher among pregnant women in the low vitamin D group compared with the high vitamin D group, 45 versus 24%; however, this difference was not statistically significant [29[■]]. Persistent low levels of vitamin D during pregnancy were associated with increased parent-reported wheeze in offspring and with increased healthcare utilization for wheeze during the first year of life [29[■]].

In both studies, vitamin D levels at enrolment in early-mid pregnancy were low, Mirzakhani *et al.* [28[■]] 22.6 ± 10.2 ng/ml (pooled) and Jensen *et al.* [29[■]] approximately 24.4 ng/ml (range 10.4–44.1 ng/ml). These levels indicate high proportions of vitamin D insufficiency among pregnant asthmatics (60% in Jensen *et al.* [29[■]]). The results of these two studies indicate that a low vitamin D level in pregnancy is a risk factor for asthma exacerbations during pregnancy in asthmatic women. However, no study has investigated the association between this modifiable risk factor and asthma exacerbations during pregnancy.

CONCLUSION

Current guidelines for asthma management during pregnancy need to improve the quality of recommendations and be implemented. Women with asthma tend to change their prescribed asthma medication during pregnancy, which may lead to uncontrolled asthma. The offspring of women with asthma is at increased risk of neonatal death, but not of stillbirth. The modifiable risk factor of low levels of vitamin D during pregnancy for asthma exacerbations needs to be further investigated.

Acknowledgements

None.

Financial support and sponsorship

A.L.R. received a scholarship from The University of Newcastle Priority Research Centre GrowUpWell. V.E.M. received a Career Development Fellowship from the NHMRC (grant number 1084816). P.G.G. received a Practitioner Fellowship from the NHMRC (grant number APP1058552) reports personal fees from AstraZeneca, GlaxoSmithKline, Novartis, and grants from AstraZeneca, GlaxoSmithKline, outside the submitted work.

Conflicts of interest

There are no conflicts of interest.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

1. Schatz M, Harden K, Forsythe A, *et al.* The course of asthma during pregnancy, post partum, and with successive pregnancies: a prospective analysis. *J Allergy Clin Immunol* 1988; 81:509–517.
 2. Global Initiative for Asthma. Global strategy for asthma management and prevention 2017. Available from: <http://www.ginasthma.org> [last accessed 28 June 2018]
 3. Australian Asthma Handbook (online publication) [Internet]. Available from: <http://www.astmahandbook.org.au>. [Accessed 28 June 2018]
 4. Namazy JA, Chambers C, Schatz M. Safety of therapeutic options for treating asthma in pregnancy. *Expert Opin Drug Saf* 2014; 13:1613–1621.
 5. Enriquez R, Wu P, Griffin MR, *et al.* Cessation of asthma medication in early pregnancy. *Am J Obstet Gynecol* 2006; 195:149–153.
 6. Charlton RA, Pierini A, Klungsøyr K, *et al.* Asthma medication prescribing before, during and after pregnancy: a study in seven European regions. *BMJ Open* 2016; 6:e009237.
 7. Murphy VE, Jensen ME, Gibson PG. Asthma during pregnancy: exacerbations, management, and health outcomes for mother and infant. *Semin Respir Crit Care Med* 2017; 38:160–173.
 8. Rejnö G, Lundholm C, Gong T, *et al.* Asthma during pregnancy in a population-based study: pregnancy complications and adverse perinatal outcomes. *PLoS One* 2014; 9:e1047.
 9. Murphy VE, Namazy JA, Powell H, *et al.* A meta-analysis of adverse perinatal outcomes in women with asthma. *BJOG* 2011; 118:1314–1323.
 10. Wang G, Murphy VE, Namazy J, *et al.* The risk of maternal and placental complications in pregnant women with asthma: a systematic review and meta-analysis. *J Matern Neonatal Med* 2014; 27:934–942.
 11. McLaughlin K, Foureau M, Jensen ME, Murphy VE. Review and appraisal of ■ guidelines for the management of asthma during pregnancy. *Women Birth* 2018. [Epub ahead of print]
- This appraisal is the first to examine the quality of clinical guidelines related to asthma management during pregnancy and indicates a lack of recommendations.
12. Nguyen VN, Nguyen QN, Le An P, Chavannes NH. Implementation of GINA guidelines in asthma management by primary care physicians in Vietnam. *Int J Gen Med* 2017; 10:347–355.
 13. Namazy JA, Schatz M. Pharmacological difficulties in the treatment of asthma in pregnant women. *Expert Rev Clin Pharmacol* 2017; 10:285–292.
 14. Amaral L, Martins C, Coimbra A. Use of the control of allergic rhinitis and asthma test and pulmonary function tests to assess asthma control in pregnancy. *Aust New Zeal J Obstet Gynaecol* 2017; 58:1–5.
 15. Williamson GR, O'Connor A, Kayleigh E-J. Women's experiences of personalised support for asthma care during pregnancy: a systematic review of the literature. *BMC Pregnancy Childbirth* 2017; 17:69.
 16. Robijn AL, Jensen ME, Gibson PG, *et al.* Trends in asthma self-management ■ skills and inhaled corticosteroid use during pregnancy and postpartum from 2004 to 2017. *J Asthma* 2018. [Epub ahead of print]
- This study is the first study to report asthma self-management skills among pregnant women with asthma in three population cohorts over the course of more than 15 years.
17. Beau AB, Didier A, Hurault-Delarue C, *et al.* Prescription of asthma medications before and during pregnancy in France: an observational drug study using the EFEMERIS database. *J Asthma* 2017; 54:258–264.
- This study shows the changes in asthma medication prescriptions around pregnancy indicating discordance with guidelines.

18. Cavero-Carbonell C, Vinkel-Hansen A, Rabanque-Hernández MJ, *et al.* Fetal exposure to montelukast and congenital anomalies: a population based study in Denmark. *Birth Defects Res* 2017; 109:452–459.
19. Koo S-M, Kim Y, Park C, *et al.* Effect of pregnancy on quantitative medication use and relation to exacerbations in asthma. *Biomed Res Int* 2017; 2017:1–15.
20. Baghlaf H, Spence AR, Czuzoj-Shulman N, Abenhaim HA. Pregnancy outcomes among women with asthma. *J Matern Neonatal Med* 2017. [Epub ahead of print]
This study was the first to show the reduced risk of intrauterine fetal death among women with asthma compared to women without asthma in a large population-based database.
21. Kempainen M, Lahesmaa-Korpinen A-M, Kauppi P, *et al.* Maternal asthma is associated with increased risk of perinatal mortality. *PLoS One* 2018; 13:e0197593.
This study was the first large database study comparing perinatal outcomes between treated and untreated asthma during pregnancy.
22. Rejnö G, Lundholm C, Larsson K, *et al.* Adverse pregnancy outcomes in asthmatic women: a population-based family design study. *J Allergy Clin Immunol Pract* 2017; 6:916–922.
This is the first study to use a family-design analysis to study the effect of maternal asthma on perinatal outcomes. This study is the first to show that adverse perinatal outcomes in women with asthma and their offspring are not confounded by genetic or environmental factors.
23. Vaezi A, Haghighi L, Beigmohammadi F, Nojomi M. Maternal asthma, pregnancy, delivery and birth outcomes: a retrospective cohort study. *Iran J Allergy Asthma Immunol* 2017; 16:92–98.

24. Shaked E, Wainstock T, Sheiner E, Walfisch A. Maternal asthma: pregnancy course and outcome. *J Matern Neonatal Med* 2017. [Epub ahead of print]
25. Murphy VE, Wang G, Namazy JA, *et al.* The risk of congenital malformations, perinatal mortality and neonatal hospitalisation among pregnant women with asthma: a systematic review and meta-analysis. *BJOG* 2013; 120:813–822.
26. Liu X, Agerbo E, Schlünsen V, *et al.* Maternal asthma severity and control during pregnancy and risk of offspring asthma. *J Allergy Clin Immunol* 2018; 141:886.e3–892.e3.
This study was the first study to use a large database to show increased risks of early-onset asthma in offspring among women with uncontrolled asthma compared to women with controlled asthma during pregnancy.
27. Morten M, Collison A, Murphy VE, *et al.* Managing Asthma in Pregnancy (MAP) trial: F₂NO levels and childhood asthma. *J Allergy Clin Immunol* 2018. [Epub ahead of print]
This is the first study to show the influence of maternal asthma management on the development of childhood asthma.
28. Mirzakhani H, O'Connor G, Bacharier LB, *et al.* Asthma control status in pregnancy, body mass index, and maternal vitamin D levels. *J Allergy Clin Immunol* 2017; 140:1453.e7–1456.e7.
This study indicates that correction of low vitamin D levels in early pregnancy might reduce uncontrolled asthma development later in pregnancy.
29. Jensen ME, Murphy VE, Gibson PG, *et al.* Vitamin D status in pregnant women with asthma and its association with adverse respiratory outcomes during infancy. *J Matern Neonatal Med* 2018. [Epub ahead of print]
This study supports the body of evidence and best-practice guidelines in maternal health in regards to vitamin D supplementation during pregnancy and the associated outcomes.