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Asthma self-management skills and the use of asthma education during pregnancy

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ABSTRACT: During pregnancy, patients with asthma are at risk of poor outcomes, particularly when asthma is poorly controlled. The aim of this study was to determine the level of asthma self-management skills and knowledge among pregnant subjects and describe the implementation of an asthma education programme delivered in an antenatal clinic setting.

Pregnant subjects with asthma were assessed by an asthma educator at 20 (n=211) and 33 weeks gestation (n=149). Lung function, symptoms, medication use, adherence, knowledge and inhaler technique were assessed. They were asked whether they had a written asthma action plan, or performed peak flow monitoring. Asthma was classified as mild, moderate or severe.

At the first visit with the asthma educator, 40% of females reported nonadherence to inhaled corticosteroids, inhaler technique was assessed as inadequate in 16% and 42% had inadequate medication knowledge. Peak flow monitoring was performed by 3% and 15% had a written action plan. There were significant improvements in all aspects of asthma self-management following education. In females with severe asthma, night symptoms and reliever medication use significantly decreased after education.

In conclusion, during pregnancy, patients with asthma have poor asthma knowledge and skills, and may benefit from self-management education as part of their obstetric care.

KEYWORDS: Action plan, asthma, pregnancy, self-management education

Asthma is the most common respiratory disorder to complicate pregnancy, leading to significant morbidity for both mother and foetus in the form of low birth weight [1, 2], pre-term delivery [1, 2], pre-eclampsia [3, 4] and worsening asthma in the mother [5]. Asthmatics who experience moderate-to-severe symptoms [4] or acute episodes of asthma during pregnancy [6] are at particular risk of poor outcomes. Asthmatic females may benefit from closer monitoring of their asthma during pregnancy, in order to ensure optimum treatment and control during this period. Asthma education is a novel way of approaching asthma care in the obstetric population, which may lead to improved outcomes for both mother and child.

Asthma self-management education programmes are an important component of asthma management and have been found to be effective in nonpregnant adults [7, 8]. Successful programmes incorporate education, self-monitoring, regular review with optimisation of pharmacotherapy and a written plan for the management of unstable asthma [7, 8]. Although recommended in asthma guidelines, no studies have reported the use of asthma education programmes for pregnant subjects and the success of self-management education during pregnancy remains unknown.

The aim of the present study was to assess asthma self-management skills and knowledge in a group of pregnant subjects with mild, moderate and severe asthma who were recruited to a research study investigating the effects of asthma on placental function and foetal growth [9–12], and to determine the need for improved self-management during pregnancy.

MATERIALS AND METHODS

Approval for the study was provided by the Hunter Area Health Service and University of Newcastle Human Research Ethics Committees (both NSW, Australia). Written informed consent was given for participation. Pregnant subjects with a doctor diagnosis of asthma (n=211) were recruited through the John Hunter Hospital antenatal clinics (NSW, Australia) and assessed by a nurse with specific training in asthma education [13] (the asthma educator) at ~20 weeks gestation. This was termed the first visit, indicating the first time they were assessed by the asthma educator. A follow-up assessment occurred in 149 females at ~33 weeks gestation (last visit). The same asthma educator saw

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patients for all of their visits. Foetal sex and birth weight were determined after delivery. This group of asthmatic females was recruited as part of an ongoing, prospective, cohort study. Maternal characteristics, maternal corticosteroid use and placental and foetal outcomes have previously been reported for some of these subjects [9–12].

Each visit consisted of a 30–60 min session where a history of asthma, including medication use, was taken. The asthma management skills assessed were: medication adherence (inhaled corticosteroid (ICS) users only) and knowledge, inhaler device technique, possession of a written action plan and self-monitoring [13]. The assessment of adherence followed a review of the medications which the patient had been using in the previous week. Nonadherence was assessed in a nonjudgemental and nonthreatening manner by asking: ''It can be difficult to remember all of your medicines when things get busy. How many times in the past week have you missed a dose of your preventer?'' Patients were considered adherent if they took 80% of their prescribed doses. Medication knowledge was rated as adequate or inadequate following direct questioning of patients regarding how the reliever and preventer medications work, and specific situations in which a particular inhaler would be used. Inhaler technique was demonstrated by the patient using their own inhaler or placebo and assessed according to the presence of the following criteria: 1) shake inhaler; 2) hold correctly; 3) actuate once only; 4) actuate on inspiration; 5) continue inspiration after actuation; 6) hold breath $\geqslant$3 s; 7) slow inspiration; and 8) deep inspiration. Inhaler technique was rated as: optimal if all criteria were met; adequate when the first five criteria were met; and inadequate if any one of the first five criteria were not met. Patients were asked whether they currently had a written action plan (clarified as meaning written instructions on what to do when asthma gets worse and how to recognise when asthma gets worse) and if they performed peak expiratory flow (PEF) monitoring.

Asthma control was assessed by direct questioning of how many days in the past week the patient had been affected by night-time symptoms, morning symptoms or activity limitation due to asthma and the frequency of β_2-agonist (reliever medication) use. Forced expiratory volume at one second (FEV_1) and forced vital capacity were measured by spirometry in some subjects (Vitalograph, Buckingham, UK). FEV_1 % predicted was calculated based on the patient's age and height using the equations of KNUDSON *et al*. [14].

Study participants received education about asthma control and management skills, including trigger avoidance and smoking cessation counselling where appropriate. Patients were offered two visits, with additional visits available if required. Patients assessed as unstable and requiring medical review were referred to their primary care physician or to a respiratory physician. Urgent medical review was available for patients with an acute exacerbation. Some subjects were provided with a written action plan, which was developed according to evidence based principles [8] by the asthma educator using a standardised template. The supervising physician reviewed each action plan and a written copy was given to the patient and posted to the primary care physician.

Asthma severity was classified as mild, moderate or severe according to symptoms, asthma history and other features including FEV_1 and PEF [15, 16]. Females were assigned to the most severe category which applied for any one of these criteria. Characteristics of mild asthma were: FEV_1 >80% pred; <25% PEF diurnal variability; no night-time or morning symptoms; infrequent β_2-agonist use; daytime symptoms less then four times per week and no severe attacks in the previous year. Characteristics of moderate asthma were: FEV_1 60–80% pred; <25% PEF diurnal variability; night-time symptoms once per week; β_2-agonist use and daytime symptoms most days. Characteristics of severe asthma were: FEV_1 <60% pred; >25% PEF diurnal variability; frequent night-time symptoms; daily morning and daytime symptoms; β_2-agonist use three to four times per day and limited physical activity. Most females used ICS (budesonide, beclomethasone dipropionate or fluticasone propionate). Oral steroid (prednisone) was used periodically by a small number of patients. All subjects used the β_2-agonist, salbutamol for symptom relief when required.

Results are presented as median (interquartile range) for nonparametric data or mean$\pm$SE of the mean for parametric data. Analysis of variance (ANOVA) and the nonparametric equivalent (Kruskal-Wallis test) were used with the appropriate *post hoc* test (Tukey-Kramer multiple comparisons test or Dunn's multiple comparisons test). When comparing two groups, the unpaired t-test or Mann-Whitney U-test was used. Fisher's exact test was used to compare proportions. A p-value <0.05 was considered significant.

RESULTS

Subject characteristics

Table 1 shows the characteristics for subjects with mild (n=108), moderate (n=42) and severe (n=61) asthma. There were no significant differences between the groups for gestational age at first visit, maternal age, weight (Kruskal-Wallis test: $p>0.05$), height and weight gain during pregnancy (ANOVA: $p>0.05$) or proportion of current smokers (Fisher's exact test: $p>0.05$). Gravidity and parity were significantly higher in females with severe asthma compared with females with mild asthma (Kruskal Wallis test and Dunn's multiple comparisons test: $p<0.05$). The percentage of patients using ICS was significantly lower in females with mild asthma compared with moderate and severe asthma (Fisher's exact test: $p<0.0001$).

Inhaled corticosteroid use

Females with mild asthma used significantly less ICS in all trimesters compared with moderate and severe asthmatics (table 2; Kruskal-Wallis test and Dunn's multiple comparisons test: $p<0.05$). The ICS dose significantly increased from first to third trimester in females with moderate and severe asthma (non-parametric repeated measures ANOVA and Dunn's multiple comparisons test: <0.05 and $p<0.001$, respectively).

Self-management skills at the first visit

At their first visit, pregnant asthmatic subjects had poor self-management skills and knowledge. Overall, 40% of females reported nonadherence to ICS medication, inhaler technique was inadequate in 16%, 42% had poor knowledge about asthma medications and 3% were performing regular peak

TABLE 1 Subject characteristics

	Mild asthma		Moderate asthma		Severe asthma	
	Subjects n	Data	Subjects n	Data	Subjects n	Data
Gestational age at first visit weeks	108	23 (18–30)	42	20 (17–30)	61	22 (18–28)
Maternal age yrs	108	23 (22–29)	42	28 (22–33)	61	27 (22–29)
Maternal height cm	102	163.4±0.7	41	163.4±1.0	57	165.2±0.8
Maternal early pregnancy weight kg	101	68.0 (60.0–79.1)	41	72.1 (59.7–86.4)	56	66.6 (58.9–86.6)
Maternal pregnancy weight gain kg	79	12.1±0.6	36	9.9±0.7	44	10.7±0.9
Gravidity	108	2 (1–3)	42	2 (1–3)	60	3 (1–4)#
Parity	108	0 (0–1)	42	1 (0–1)	60	1 (0–2)#
Using inhaled corticosteroids %		42¶		79		87
Using periodic oral corticosteroids %		0		10+		27§
Current smokers %		23		33		28

Data are presented as median (interquartile range), mean±SE, n or %. #: compared with mild asthma (Kruskal-Wallis test and Dunn's multiple comparisons test: $p<0.05$); ¶: compared with moderate and severe asthma (Fisher's exact test: $p<0.0001$); +: compared with mild and severe asthma (Fisher's exact test: $p<0.05$); §: compared with mild asthma (Fisher's exact test: $p<0.0001$).

TABLE 2 Inhaled corticosteroid use during pregnancy

	Mild asthma	Moderate asthma	Severe asthma
Subjects n	108	42	61
First trimester μg/day	0 (0–400)#	375 (0–1000)	400 (0–1000)
Second trimester μg/day	0 (0–450)#	775 (0–1000)	1000 (0–1500)
Third trimester μg/day	0 (0–500)#	800 (250–1000)¶	1000 (450–1600)¶
Average pregnancy intake μg/day	0 (0–450)#	667 (133–1000)	667 (267–1167)

Data are presented as median (interquartile range). #: compared with moderate and severe asthma (Kruskal-Wallis test and Dunn's multiple comparisons test: $p<0.05$); ¶: compared with first trimester (non-parametric repeated measures analysis of variance and Dunn's multiple comparisons test: $p<0.05$).

flow monitoring. Only 15% of the asthmatic females had a written action plan.

Influence of asthma severity on self-management skills at the first visit

In females who used ICS, the rate of medication nonadherence was 31% in the mild asthma group, which was not different from the moderate (46%) or severe asthma groups (45%; fig. 1a; Fisher's exact test: $p>0.05$). Significantly more mild asthmatics had inadequate inhaler technique (23%) compared with moderate (11%) or severe (9%) asthmatics (fig. 1a; Fisher's exact test: $p<0.05$). Medication knowledge was similar among the mild, moderate and severe groups (53, 69 and 58%, respectively). The percentage of patients with a written action plan was not different between groups (14, 8 and 22% in mild, moderate and severe asthma groups, respectively) and few patients were conducting peak flow monitoring (1, 0 and 9% in mild, moderate and severe asthma groups, respectively; Fisher's exact test: $p>0.05$; fig. 1a).

Self-management skills after asthma education

In total, 64% of mild, 83% of moderate and 74% of severe asthmatics attended at least two visits with the asthma educator. The 62 patients who were not followed declined to participate further in the study. Patients who were followed-up were not significantly different from those who were not followed in terms of age, height, weight gain, gravidity, parity (Mann-Whitney U-test or unpaired t-test: $p>0.05$), smoking or use of ICS or oral corticosteroids during pregnancy (Fisher's exact test; $p>0.05$; data not shown).

After asthma education, there was an improvement in self-management skills in asthmatic females. Self-reported non-adherence to ICS decreased from 40–21% (Fisher's exact test: $p=0.006$), inadequate inhaler technique decreased from 16–4% (Fisher's exact test: $p=0.005$) and adequate medications knowledge improved from 58–95% of subjects (Fisher's exact test: $p<0.0001$). The percentage of subjects conducting peak flow monitoring increased from 3–35% (Fisher's exact test: $p<0.0001$) and possession of an action plan increased from 15–75% of all asthmatic females (Fisher's exact test: <0.0001).

Influence of asthma severity on self-management skills after asthma education

Among females with severe asthma, there was a significant fall in the percentage of patients who were nonadherent to ICS medication after education (fig. 1b; Fisher's exact test: $p=0.014$). In mild asthmatics, there was a significant decrease in the number of patients with inadequate inhaler technique after education (fig. 1b; Fisher's exact test: $p=0.006$).

Among mild, moderate and severe asthmatics there were significant increases in the proportion of patients with adequate medication knowledge, an asthma action plan and the proportion conducting peak flow monitoring after asthma education (fig. 1b; Fisher's exact test: $p<0.05$). Significantly more severe asthmatics were monitoring peak flow compared with moderate asthmatics (Fisher's exact test: $p=0.016$).

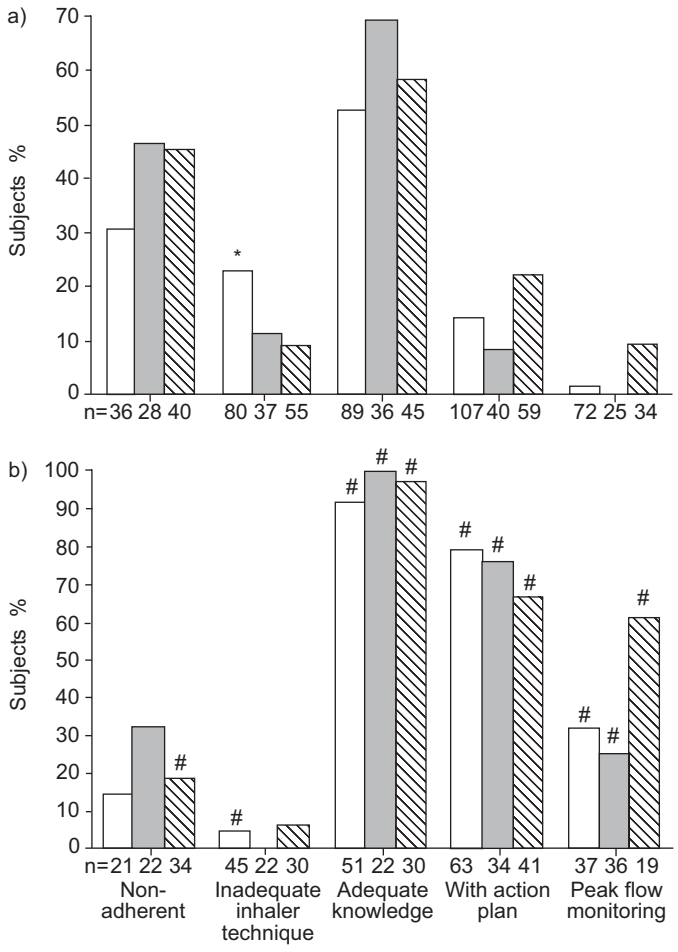

FIGURE 1. Asthma self-management skills of pregnant subjects with mild, moderate and severe asthma. The percentage of patients within mild (□), moderate (■) and severe (▨) asthma groups who were nonadherent (inhaled corticosteroid medication), had inadequate inhaler technique, adequate medications knowledge, a written action plan and performed peak flow monitoring at a) first visit, and b) last visit. *: $p<0.05$ (Fisher's exact test; mild *versus* moderate and severe); #: $p<0.05$ (Fisher's exact test compared with first visit).

Lung function, symptoms and reliever medication use

There were no differences in lung function (unpaired t-test: $p>0.05$), symptom reporting or reliever medication use (Mann-Whitney U-test: $p>0.05$) between the first and last visit for the mild, moderate or severe asthmatics (tables 3–5). In females with severe asthma there was a significant reduction in the number of night-time symptoms (table 5; Mann-Whitney U-test: $p<0.0001$) and in reliever medication use by the last visit (table 5; Mann-Whitney U-test: $p<0.02$).

Asthma action plans and birth weight

Females who received an action plan had neonates with higher birth weight (Mann-Whitney U-test: $p>0.05$). During pregnancies complicated by moderate and severe asthma, female birth weight was significantly lower in those without an action plan (3101 ± 112; n=29), compared with those with an action plan (3481 ± 143; n=17; unpaired t-test: $p=0.043$), while male birth weight was unaffected (3446 ± 84; n=33 with action plan *versus* 3443 ± 143; n=19 no action plan; unpaired t-test: $p>0.05$).

TABLE 3 Changes in lung function, symptoms and reliever medication use from first to last visit in pregnant subjects with mild asthma

	First visit		Last visit	
	Subjects n	Data	Subjects n	Data
Gestational age weeks	108	23 (18–30)	69	34 (30–36)
Maternal FEV_1 L	89	3.14 ± 0.05	41	3.13 ± 0.08
Maternal FEV_1 % pred	86	102 ± 2	40	102 ± 2
Maternal FVC L	89	3.79 ± 0.06	41	3.83 ± 0.09
Maternal FEV_1:FVC	89	0.83 ± 0.01	41	0.82 ± 0.01
Night symptoms days·week^{-1}	108	0 (0–0)	69	0 (0–0)
Morning symptoms days·week^{-1}	108	0 (0–0)	69	0 (0–0)
Activity limitation days·week^{-1}	108	0 (0–0)	69	0 (0–0)
Reliever use days·week^{-1}	107	0 (0–2)	69	0 (0–3)
Reliever use times·day^{-1}	107	0 (0–1)	69	0 (0–1)
Reliever use times·week^{-1}	17	0 (0–2)	69	0 (0–3)

Data are presented as median (interquartile range), mean±SE or n. FEV_1: forced expiratory volume at one second; FVC: forced vital capacity.

DISCUSSION

The present study demonstrated that pregnant subjects with asthma have poor asthma self-management skills and knowledge, regardless of the severity of their asthma. Overall, 40% of patients were nonadherent with ICS medication, <50% had optimal inhaler technique and 42% had inadequate knowledge about their prescribed medications. ICS nonadherence is a particular problem in pregnancy, as many females have misconceptions regarding the safety of these drugs in pregnancy [17, 18]. However, it has been demonstrated that a severe asthma attack presents more of a risk than the use of asthma medications due to the potential for a reduction in the supply of oxygen to the foetus [19, 20] and clinical guidelines emphasise that pregnant subjects should receive similar advice regarding medication use as nonpregnant subjects with asthma [21]. A survey of asthmatic females found that 40% valued the opinion of their obstetrician regarding asthma medication use during pregnancy [18]. Receiving education about their asthma in the setting of the antenatal clinic may give females more confidence that they can use their preventative asthma medication safely during pregnancy.

There is an expressed need for education and improved asthma management skills by females. Many pregnant subjects have concerns about the effect their asthma may have on the foetus and many would like more medical care, support and education [17, 18]. A survey of 501 asthmatic females of childbearing age reported that 82% of females who used ICS were concerned about their effects on the foetus as well as the

TABLE 4 Changes in lung function, symptoms and reliever medication use from first to last visit in pregnant subjects with moderate asthma

	First visit		Last visit	
	Subjects n	Data	Subjects n	Data
Gestational age weeks	42	20 (17–30)	35	33 (30–36)
Maternal FEV_1 L	37	2.87±0.08	18	2.91±0.12
Maternal FEV_1 % pred	36	95±3	17	96±3
Maternal FVC L	37	3.61±0.07	18	3.80±0.11
Maternal FEV_1:FVC	37	0.80±0.02	18	0.76±0.02
Night symptoms days·week^{-1}	42	0 (0–2)	34	0 (0–1)
Morning symptoms days·week^{-1}	42	1 (0–7)	34	0 (0–2)
Activity limitation days·week^{-1}	42	0 (0–4)	34	0 (0–1)
Reliever use days·week^{-1}	42	7 (2–7)	33	7 (1–7)
Reliever use times·day^{-1}	42	2 (1–3)	33	2 (1–2)
Reliever use times·week^{-1}	42	12 (2–21)	33	7 (1–14)

Data are presented as median (interquartile range), mean±SE or n. FEV_1: forced expiratory volume at one second; FVC: forced vital capacity.

TABLE 5 Changes in lung function, symptoms and reliever medication use from first to last visit in pregnant subjects with severe asthma

	First visit		Last visit	
	Subjects n	Data	Subjects n	Data
Gestational age weeks	61	22 (18–28)	45	32 (30–35)
Maternal FEV_1 L	46	2.87±0.09	22	2.95±0.10
Maternal FEV_1 % pred	42	91±3	22	95±3
Maternal FVC L	46	3.57±0.09	22	3.68±0.11
Maternal FEV_1:FVC	46	0.80±0.01	22	0.80±0.02
Night symptoms days·week^{-1}	61	5 (2–7)	45	0 (0–3)#
Morning symptoms days·week^{-1}	61	4 (0–7)	45	2 (0–7)
Activity limitation days·week^{-1}	61	1 (0–5)	44	0 (0–6)
Reliever use days·week^{-1}	61	7 (7–7)	45	7 (2–7)#
Reliever use times·day^{1}	61	3 (2–5)	45	2 (1–3)#
Reliever use times·week^{-1}	61	21 (7–35)	45	7 (3–14)#

Data are presented as median (interquartile range), mean±SE or n. FEV_1: forced expiratory volume at one second; FVC: forced vital capacity. #: compared with first visit (Mann-Whitney U-test; $p<0.05$).

consequences of discontinuing medication on their own health [18]. Despite this, 39% had discontinued medication while pregnant, without consultation with their physician [18]. Cessation of ICS therapy together with poor management skills could lead to significant deterioration in asthma control during pregnancy. The present data quantifies significant deficiencies in asthma self-management skills among these females and the current authors suggest that knowledge and skills may be greatly improved by a specific asthma education programme.

There is a strong link between asthma which is poorly controlled leading to hospitalisation and adverse perinatal outcomes [22, 23]. Programmes which improve asthma control and medication adherence could, therefore, be of benefit to both mother and foetus. Asthma self-management education is associated with significant improvements in healthcare utilisation, especially in hospital-based programmes [7]. The current study adapted an asthma education programme to an antenatal clinic setting. This presented its own challenges, including brief consultation times, patient needs, fitting in with the structure of the clinic and encouraging staff to see the value of asthma education during pregnancy. In addition, the asthma educator needed to be flexible to accommodate patient and clinic demands and access to a respiratory specialist or primary care physician was required for patients needing alterations to their asthma medications. Despite these challenges, the data indicate that there are likely to be clinical benefits for both mother and child from an asthma education programme in this setting. The present authors believe that integrating asthma education with routine antenatal care will increase the participation rate, which is a recognised problem in asthma education programmes [24]. This model also integrates well with a shared care system, where asthma education occurs as part of the antenatal visits with communication with the primary care physician.

Although there are deficiencies in study design, the analysis indicated a significant improvement in asthma self-management skills following the implementation of the education programme. The lack of a comparison group of pregnant asthmatic subjects who did not receive asthma education makes interpretation of the present findings difficult. The time which elapsed between the two education visits was ~3 months and changes in skills and asthma control may have been confounded by the stage of pregnancy and other factors associated with asthma such as season of the year. From the literature, one third of asthmatic females would be expected to experience a subjective improvement during pregnancy [25] and these females may have biased the results. Nonetheless, this study is the first to demonstrate the potential of asthma education delivered in the antenatal clinic to provide patients with the skills and knowledge they require for self-management. Future studies should address the level of education which is required to provide a clinical benefit for mother and child.

While the benefits of self-management education on asthma control could only be measured in females with severe asthma, improvements in self-management skills occurred in females with mild, moderate and severe asthma. By the end of the study, only 21% of subjects were reporting nonadherence to ICS medication and among severe asthmatics there was a significant improvement in adherence. The same asthma educator saw the patients at both of their visits and was not blinded. There may have been some bias towards patients answering positively to these questions at the last visit. However, previous studies support improved medication adherence with education [26]. At the last visit, inhaler technique was inadequate in only 4% of pregnant subjects as assessed by eight objective criteria. A previous study found that 38% of female adult patients demonstrated correct inhaler technique and 57% could provide accurate reasons for the use of different medications [27]. At the last visit it was found that, 95% of women had adequate medications knowledge, 35% were performing peak flow monitoring and 75% had a written asthma action plan.

Asthma is more likely to worsen during pregnancy in females with severe asthma [5]. The present study found a significant fall in nocturnal asthma symptoms as well as a significant reduction in β_2-agonist use from first to last visit in females with severe asthma. Despite the limitations of the before-after analysis, these results suggest that asthma education for pregnant subjects with severe asthma may lead to better asthma control. The lack of effect observed in mild and moderate asthma may be due to the lower levels of symptoms in these groups.

Since females with severe asthma are most likely to exacerbate and require an action plan, this should be a target group for self-management education in the future. Overall, only 15% of pregnant asthmatic females had a written action plan when they entered the current study. This is less than reported in some other Australian studies, which found that 30–35% of asthmatic adults had a written asthma management plan [28, 29]. However, the present data is similar to that reported by the Australian Centre for Asthma Monitoring (NSW, Australia) in 2003, which found that the proportion of females aged between 20–40 yrs with a written action plan was $\leqslant$20% [30]. When subjects with moderate and severe asthma were examined, female birth weight was significantly higher in those who had an action plan compared with those who did not. The current authors have previously investigated the placental mechanisms leading to reduced foetal growth in asthmatic pregnancies [9–12] and have speculated that the female foetus is more sensitive to the underlying inflammation associated with maternal asthma, which may lead to changes in foetal growth through alterations in placental function [11]. The present data suggests that having knowledge about what to do when asthma worsens is an important skill which has the potential to lead to improved foetal outcome.

In conclusion, pregnant subjects with asthma have poor self-management skills regardless of asthma severity, and the use of asthma education may improve outcomes for both the mother and their child. Self-management education is an important asthma management tool, which can be delivered in an antenatal clinic setting. Asthma education was associated with an increase in asthma medication knowledge, skills and adherence and the provision of a written asthma action plan was an essential component of the education programme. Asthma self-management education should be considered an important aspect of obstetric care.

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