

Quality of life and asthma control related to hormonal transitions in women's lives

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ABSTRACT

Objectives: The aim was to investigate if menstruation and use of exogenous sex hormones influence self-reported asthma related quality of life (QoL) and asthma control.

Methods: The study is based on two asthma cohorts randomly selected in primary and secondary care. A total of 622 female patients 18–65 years were included and classified as premenopausal ≤ 46 years ($n=338$) and peri/postmenopausal 47–65 years ($n=284$). Questionnaire data from 2012 and 2014 with demographics, asthma related issues and sex hormone status. Outcome measures were Mini Asthma Quality of Life Questionnaire (Mini-AQLQ) and asthma control including Asthma Control Test (ACT) and exacerbations last six months.

Results: Premenopausal women with menstruation related asthma worsening, perimenstrual asthma (PMA) (9%), had a clinically relevant lower Mini-AQLQ mean score 4.9 vs. 5.8 ($p<0.001$), lower asthma control with ACT score < 20 , 72% vs. 28% ($p<0.001$) and higher exacerbation frequency 44% vs. 20% ($p=0.004$) compared with women without PMA. Women with irregular menstruation had higher exacerbation frequency than women with regular menstruation ($p=0.023$). Hormonal contraceptives had no impact on QoL and asthma control. Peri/postmenopausal women with menopausal hormone therapy (MHT) had a clinically relevant lower Mini-AQLQ mean score compared to those without MHT, 4.9 vs 5.4 ($p<0.001$), but no differences in asthma control.

Conclusion: Women with PMA had lower QoL and more uncontrolled asthma than women without PMA. Peri/postmenopausal women with MHT had lower QoL than women without MHT. Individual clinical management of women with asthma may benefit from information about their sex hormone status.

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Introduction

Asthma severity in women may change over the life-course and appears to be related to transition periods in women's reproductive lives (1–4). Women might experience changes in the character of asthma symptoms during menstruation, pregnancy and the menopause (2,5,6). Previous research has shown the influence of female sex hormones on asthma development and severity (7,8). Despite a number of studies, it is still unclear if specific female sex hormones

or their imbalance are associated to the development, worsening or improvement of asthma in women (9,10).

It has been estimated that 19–40% of women experience worsening of asthma symptoms in relation to the menstruation, defined as perimenstrual asthma (PMA) (11–13). Several studies have reported increased asthma symptoms, oral corticosteroid use and emergency department visits in this group (1,14). Furthermore, women with irregular menstruation seem to have more asthma symptoms and allergies than those with regular menstruation (15).

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Although sex hormone levels decrease with menopause, post-menopausal women have an increased risk of new-onset asthma (7,16). There are, however, contradictory results on how menopause influences current asthma (17).

Also, previous studies about the influence of hormonal contraceptives and menopausal hormone therapy (MHT or hormone replacement therapy, HRT) on current asthma have shown different results. A recent meta-analysis demonstrated both negative and positive impact of the use of hormonal contraceptives on asthma symptoms, while MHT in postmenopausal women had negative or no impact (17).

In asthma care, the main goal of asthma management and treatment is achieving good asthma symptom control and minimizing the risk of exacerbations (18). Another important clinical outcome is asthma related QoL that captures changes in health status which may not be seen in clinical measures such as lung function and the presence of symptoms (19,20). There is still limited knowledge how these parameters are affected by different hormonal transition periods in women's lives.

The current study was based on questionnaire data including hormonal status, self-reported asthma related QoL and asthma control in women with asthma in a primary and secondary care population. The hypothesis was that endogenous sex hormones during the menstrual cycle in premenopausal women and exogenous sex hormones in pre- and peri/postmenopausal women increase the risk of worsening of QoL and asthma control.

Material and methods

Study population

The study uses part of the Swedish PRAXIS cohort on asthma that started in 2005. A total of 1725 patients aged 18–75 years with a doctor's diagnosis of asthma (ICD-10 J45) were randomly selected at 56 primary health care centers (PHCC) and 14 hospitals in central Sweden. The participants received a postal self-completion questionnaire about their asthma and related issues (21). The cohort from 2005 was followed-up in 2012 whereof 449 women participated (response rate 62%). In 2014, a new cohort of 2803 patients with a doctor's diagnosis of asthma (ICD-10 J45) aged 18–75 years were randomly selected at the same study centers. The same questionnaire as in 2012 was used and 793 women responded (response rate 46%). The present study sample includes a total of 622 female patients aged 18–65 from the follow-up

in 2012 of the 2005 cohort and the 2014 cohort, see Figure 1.

Questionnaire

The study questionnaire included information on age, daily smoking (yes/no), educational level (at or below, the higher level defined as at least three years above Swedish compulsory school of nine years) and body mass index (BMI) categorized as underweight (BMI < 20 kg/m²), normal (BMI 20.0–24.9 kg/m²), overweight (BMI 25.0–29.9 kg/m²) and obese (BMI ≥ 30 kg/m²). Other questions were on asthma onset age (early ≤15 years and late > 15 years), pet- and/or pollen-allergy and depression/anxiety during the previous 12 months. The level of strenuous physical activity was also included (high if daily, medium 4–6 times/week, low if three times or less/week).

Asthma treatment was classified according to GINA guidelines 2018 (18); (Step 1) inhaled short-acting beta-2 agonist (SABA) if needed; (Step 2) daily or periodically inhaled corticosteroids (ICS); (Step 3) ICS and long-acting beta-2 agonists (LABA) and/or anti-leukotriene (LTRA) treatment.

To enable analysis of the influence of endo- and exogenous sex hormones on asthma outcomes five questions regarding menstruation, use of hormone contraceptives and MHT were included:

1. Have you experienced worsening of asthma the week before, during or after menstruation? Yes/No (Another option was, "I don't have menstruation").
2. Do you have regular menstruation? Yes/No
3. Have you used hormonal contraceptives such as oral contraceptives (pill and mini-pill), hormonal intrauterine device, birth control implant or contraceptive injection during the previous 6 months? Yes/No
4. Have you entered menopause (including have not menstruated for at least 6 months?) Yes/No
5. Do you use menopausal hormone treatment (oral or patch)? Yes/No

Pre- and peri/postmenopausal women- definition and comparison

The study group was divided into pre- and peri/postmenopausal women. Women were regarded as premenopausal if they answered no to the question whether they had entered menopause and peri/postmenopausal if the answer was yes. The upper age limit for the premenopausal group was 46 years based

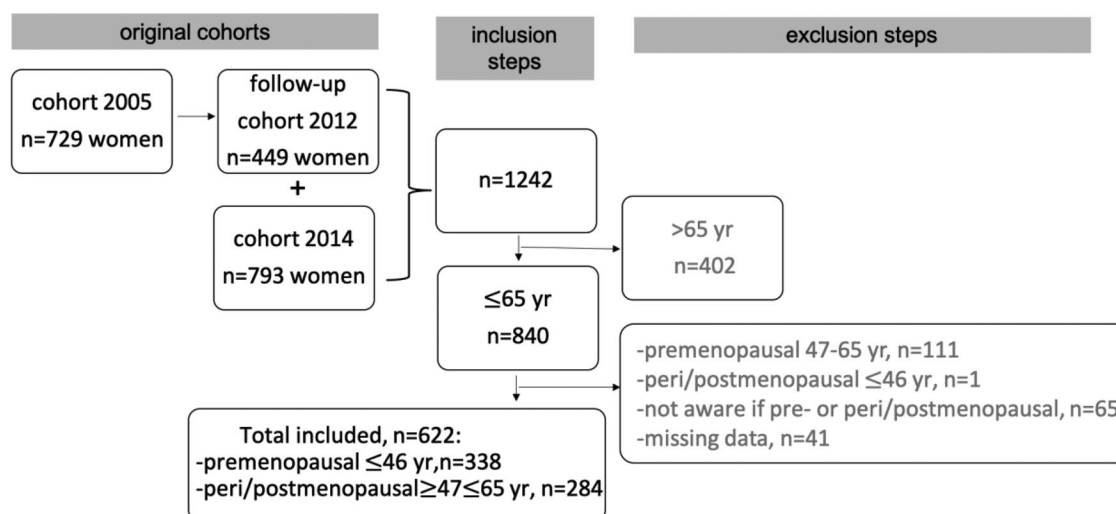


Figure 1. Flow diagram showing eligibility criteria to the study.

on a classification used in earlier studies, where 94% of women aged ≤ 46 years were premenopausal (22,23). Consequently, the lower age limit in the peri/postmenopausal group was 47 years, while the upper age limit of 65 years was set to include women more likely to have MHT.

A flow diagram of inclusion and exclusion steps is shown in Figure 1, resulting in two groups of premenopausal women 18 to ≤ 46 years old ($n=338$) and peri/postmenopausal women ≥ 47 to ≤ 65 years old ($n=284$).

Asthma worsening in relation to menstruation is in this study defined as perimenstrual asthma (PMA) (11,12). The premenopausal women were compared with regard to PMA vs. no PMA, regular vs. irregular menstruation and use of hormonal contraceptives vs. no use of hormonal contraceptives. The peri/postmenopausal women were compared with regard to use of MHT vs. no use of MHT.

Outcome measures

The outcome measures included the Swedish versions of the Mini-Asthma Quality of Life Questionnaire (Mini-AQLQ), the Asthma Control Test (ACT) and the exacerbation frequency.

The Mini-AQLQ contains 15 questions divided into four domains that concern asthma symptoms, environmental factors, emotional functions and asthma related activity limitations during the last two weeks. The questions have responses on a seven-point scale, from severe (1) to no (7) impairment. A mean was calculated for each of the domains and the total score, where a clinically relevant difference was considered at a difference of 0.5 (24). A mean score over six

indicates that asthma does not have a significant impact on the quality of life (25). The ACT includes five questions about the asthma symptom control in the past four weeks, yielding a maximum of 25 points. A total score of ≥ 20 points indicates sufficient asthma symptom control and < 20 points poor asthma symptom control (26).

In this study, an asthma exacerbation was defined as an emergency visit and/or a course of oral steroids due to asthma worsening during the previous six months (27).

Statistics

Data were analyzed with the SPSS (version 26.0) statistical package. Summary statistics such as means, proportions and measures of dispersion were computed with standard statistical methods. Differences in proportions were calculated with the chi-square test. Analysis of variance was used to calculate differences in the mean of the total score and domains of Mini-AQLQ. The multivariate analyses of the Mini-AQLQ used ANCOVA with adjustment for potential confounders which were chosen if $p < 0.05$ for the association with the Mini-AQLQ in the univariate analysis. These variables were BMI, pet and/or pollen allergy and educational level in analyses of premenopausal women with and without PMA and BMI and depression/anxiety in analyses with peri/postmenopausal women with and without MHT. Logistic regression was used to estimate the risk of exacerbations in premenopausal women with PMA with adjustment for pet and/or pollen allergy, daily smoking and educational level and in women with irregular menstruation with adjustment for pet and/

or pollen allergy and educational level. To enable adjustment for clinically relevant confounders variables were chosen if the univariate associations had p values < 0.10 . Logistic regression was also performed to estimate the risk of ACT < 20 in premenopausal women with PMA with adjustment for pet and/or pollen allergy and educational level (chosen with p values < 0.10 for associations in the univariate analysis). P values less than 0.05 and 95% confidence intervals that do not include 1.00 were considered to indicate statistical significance.

Ethics approval and consent to participate

The study was approved by the Regional Ethical Review Board in Uppsala, Sweden (number 2011/318). Written informed consent was given by all patients.

Results

Premenopausal women

Descriptive characteristics

The mean age of the premenopausal women ($n=338$) was 35 years ($\pm$ SD 7.3), of them 58% had early asthma onset, 81% had pet and/or pollen allergy and 7% were daily smokers (Table 1). Among 307 premenopausal women who menstruated 9% experienced PMA and 21% stated they had an irregular cycle. Of all premenopausal women, 41% had used hormonal contraceptives during the last six months, with 51% using oral contraceptives, 11% birth control implants

and 38% hormonal intrauterine devices. The characteristics of the subgroups of premenopausal women are presented in Table 1. Apart from daily smoking being more prevalent in women with irregular menstruation there were no notable differences in the characteristics between all subgroups.

Mini-AQLQ

In women with PMA, the total mean score of the Mini-AQLQ was statistically significantly lower, with a clinically relevant difference, compared to women without PMA, 4.9 vs 5.8 ($p<0.001$). There were statistically significantly and clinically relevant differences in all domains of the Mini-AQLQ, also with adjustment for pet and/or pollen allergy, BMI and educational level (Table 2). The total mean scores of the Mini-AQLQ were not statistically significantly different between women with regular and irregular menstruation 5.8 vs. 5.5 ($p=0.104$) or between women using or not using hormonal contraceptives, 5.8 vs. 5.7 ($p=0.589$).

Asthma control

Of women with PMA 72% had an ACT score < 20 , whereas this proportion was 28% in those without PMA ($p<0.001$); adjusted OR 6.7 (95% CI 2.63–17.16). Pet and/or pollen allergy and lower education were associated with a higher risk of an ACT score < 20 . Exacerbations were also more frequent in women with PMA, 44% compared to 20% ($p=0.004$), producing an

Table 1. Characteristics of all premenopausal women ≤ 46 years, with and without perimenstrual asthma (PMA), with regular and irregular menstruation and with and without hormonal contraceptive treatment.

	Premenopausal all $n=338$	PMA		p	Regular menstruation		p	Hormonal contraceptive treatment		p
		Yes $n=28$	No $n=279$		Yes $n=241$	No $n=65$		Yes $n=135$	No $n=203$	
Age, mean ($\pm$ SD)	35 (7.3)	34.2 (7.9)	34.6 (7.3)	0.783	34.5 (7.2)	34.5 (8.0)	0.964	33.3 (7.8)	35.4 (6.9)	0.008
Asthma onset n (%)										
< 15 years	191 (58)	17 (61)	156 (57)	0.716	135 (57)	38 (59)	0.729	84 (63)	105 (54)	0.094
16–45 years	139 (42)	11 (39)	117 (43)		102 (43)	26 (41)		49 (37)	90 (46)	
BMI n (%)				0.309			0.602			0.338
Underweight	21 (6)	1 (4)	19 (7)		17 (7)	3 (5)		6 (5)	15 (8)	
Normal	139 (43)	10 (36)	116 (43)		103 (44)	23 (37)		62 (47)	77 (40)	
Overweight	83 (26)	6 (21)	71 (26)		59 (25)	18 (29)		35 (27)	48 (25)	
Obesity	83 (26)	11 (39)	63 (23)		55 (24)	18 (29)		29 (22)	54 (28)	
Daily smoking n (%)	24 (7)	4 (14)	18 (7)	0.129	13 (5)	9 (14)	0.020	10 (8)	14 (7)	0.838
Physical activity n (%)				0.072			0.087			0.524
High	65 (20)	9 (32)	47 (17)		48 (20)	8 (12)		27 (20)	38 (19)	
Medium	193 (58)	16 (57)	161 (58)		141 (59)	36 (55)		80 (60)	113 (56)	
Low	76 (23)	3 (11)	68 (25)		49 (21)	21 (32)		26 (20)	50 (25)	
Education, high ¹ n (%)	279 (83)	22 (79)	237 (85)	0.376	203 (84)	56 (86)	0.703	116 (87)	163 (80)	0.136
Allergy, pet/pollen n (%)	272 (81)	24 (86)	225 (81)	0.514	197 (82)	52 (80)	0.749	106 (79)	166 (82)	0.460
Depression/anxiety n (%)	74 (22)	7 (25)	61 (22)	0.703	51 (21)	16 (25)	0.550	33 (24)	41 (20)	0.380
Asthma treatment n (%)				0.210			0.354			0.518
Step 1 ²	108 (33)	5 (19)	93 (34)		81 (34)	16 (25)		39 (30)	69 (35)	
Step 2 ³	81 (25)	7 (26)	70 (26)		58 (25)	19 (30)		32 (24)	49 (25)	
Step 3 ⁴	141 (43)	15 (56)	111 (41)		97 (41)	29 (45)		61 (46)	80 (40)	

¹Upper secondary school and above.

²Short-acting beta-2 agonist when needed.

³Inhaled corticosteroids (ICS) regularly or periodically.

⁴ICS and long-acting beta-2 agonist (LABA) and/or leukotriene antagonist.

Table 2. The Mini-AQLQ total and domain mean scores and 95% CI in premenopausal women ≤ 46 years with and without PMA.

Mini-AQLQ	PMA mean (95% CI)	No PMA mean (95% CI)	p	PMA* mean (95% CI)	No PMA* mean (95% CI)	p
Asthma symptoms	4.6 (4.11-5.05)	5.7 (5.52-5.82)	<0.001	4.7 (4.22-5.13)	5.7 (5.53-5.82)	<0.001
Activity limitations	5.5 (5.08-5.94)	6.1 (5.99-6.27)	0.007	5.6 (5.17-6.01)	6.1 (5.99-6.26)	0.016
Emotional function	4.6 (4.10-5.14)	5.8 (5.68-6.01)	<0.001	4.7 (4.17-5.21)	5.9 (5.68-6.01)	<0.001
Environmental factors	4.9 (4.40-5.34)	5.7 (5.51-5.81)	0.002	5.0 (4.49-5.41)	5.7 (5.50-5.80)	0.005
Total	4.9 (4.48-5.30)	5.8 (5.70-5.96)	<0.001	5.0 (4.58-5.37)	5.8 (5.70-5.96)	<0.001

* With adjustment for pet and/or pollen allergy, BMI and educational level.

Table 3. Characteristics of peri/postmenopausal women with and without hormone replacement therapy (MHT+ and MHT-).

	All n = 284	MHT+ n = 36	MHT- n = 245	p
Age, mean ($\pm$ SD)	58 (4.6)	57 (5.2)	59 (4.5)	0.101
Asthma onset age n (%)				0.649
< 15 years	61 (22)	6 (17)	54 (23)	
16-45 years	146 (53)	19 (53)	125 (52)	
> 46 years	71 (26)	11 (30)	60 (25)	
BMI n (%)				0.331
Underweight	8 (3)	0	8 (3)	
Normal	84 (30)	15 (42)	68 (29)	
Overweight	106 (38)	12 (33)	93 (39)	
Obesity	79 (29)	9 (25)	69 (29)	
Daily smoking n (%)	26 (9)	2 (6)	22 (9)	0.489
Physical activity n (%)				0.589
High	43 (15)	4 (11)	39 (16)	
Medium	166 (59)	24 (67)	140 (58)	
Low	71 (25)	8 (22)	62 (26)	
Educational level, high ¹ n (%)	142 (50)	22 (63)	120 (49)	0.125
Allergy, pet/ pollen n (%)	216 (76)	26 (72)	187 (77)	0.562
Depression/anxiety n (%)	36 (13)	7 (19)	28 (11)	0.174
Asthma treatment n (%)				0.492
Step 1 ²	63 (22)	6 (17)	57 (24)	
Step 2 ³	53 (19)	9 (25)	44 (18)	
Step 3 ⁴	165 (59)	21 (58)	141 (58)	

¹Upper secondary school and above.

²Short-acting beta-2 agonist when needed.

³Inhaled corticosteroids (ICS) regularly or periodically.

⁴ICS and long-acting beta-2 agonist (LABA) and/or leukotriene antagonist.

adjusted OR of 3.0 (95% CI 1.29–6.97). In all four subgroups of women with regular and irregular menstruation and with and without hormonal contraceptives a third had an ACT score < 20. Twenty percent of women with regular menstruation reported exacerbations whereas 33% of those with irregular menstruation did so ($p=0.023$); adjusted OR 2.1 (95% CI 1.14–4.00). Pet and/or pollen allergy and lower level of education were associated with higher risk of exacerbations in women with irregular menstruation comparing to those with regular menstruations. There were no differences in exacerbation frequency in women with and without hormonal contraceptives, 21% vs. 23% ($p=0.624$).

Peri/postmenopausal women

Descriptive characteristics

The mean age of the peri/postmenopausal women was 58 years ($\pm$ SD 4.6), of them 22% had asthma with

early onset, 76% had pet and/or pollen allergy and 9% were daily smokers. There were no significant differences in characteristics between women with and without MHT (Table 3).

Mini-AQLQ

Women with MHT had significantly lower total mean Mini-AQLQ scores than women without MHT; 4.9 vs. 5.4 ($p=0.031$), which was also a clinically relevant difference. In the activity limitations and emotional functions domains, statistically significant and clinically relevant differences were found depending on whether the women used MHT or not (Table 4). Even after adjustments for BMI and depression/anxiety there were significant and clinically relevant differences in the total mean score of Mini-AQLQ ($p=0.046$) and emotional function domain ($p=0.035$), (Table 4).

Asthma control

The differences between proportions of women with and without MHT that had ACT scores < 20 was not significant, 50% vs. 41% ($p=0.345$) and the exacerbation frequency was also similar, 33% vs. 31% ($p=0.765$).

Comparing all subgroups in premenopausal and peri/postmenopausal women

Mini-AQLQ, ACT and exacerbations

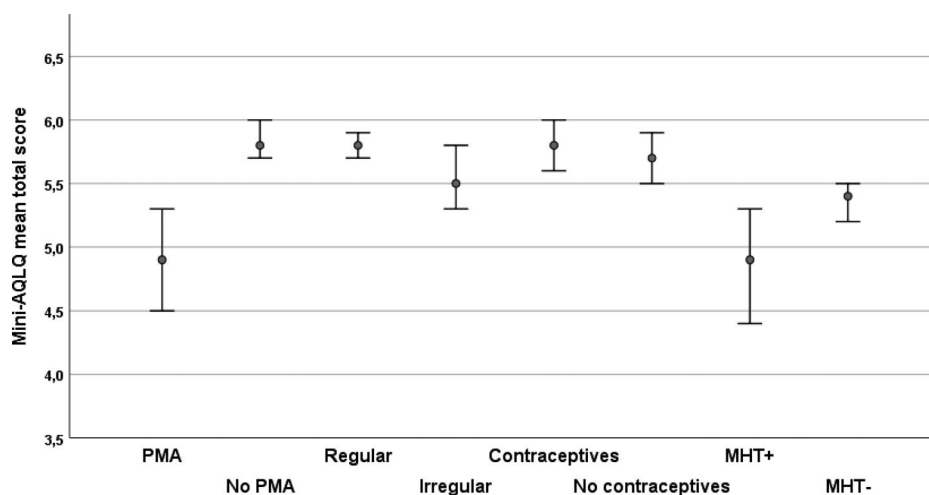
The Mini-AQLQ total mean scores were < 6 in all the studied subgroups (Figure 2). Premenopausal women with PMA and peri/postmenopausal women with MHT had the lowest scores 4.9 (95%CI 4.48–5.30) and 4.9 (95% CI 4.42–5.31), respectively.

Figure 3 shows the proportions of women with ACT scores < 20 and exacerbations in all subgroups. In three subgroups more than 40% women had an ACT score < 20: premenopausal women with PMA (72%), peri/postmenopausal women with MHT (50%) and without MHT (41%). Four subgroups had an exacerbation frequency over 30%: premenopausal women with PMA (44%), premenopausal women with irregular menstruation (33%), and peri/postmenopausal women with MHT (33%) and without MHT (31%).

Table 4. The Mini-AQLQ total and domain mean scores and 95% CI in peri/postmenopausal women 47–65 years old with and without menopausal hormone therapy (MHT+ and MHT-).

Mini-AQLQ	MHT+ mean (95% CI)	MHT- mean (95% CI)	p	MHT+* mean (95% CI)	MHT-* mean (95% CI)	p
Asthma symptoms	4.7 (4.18–5.13)	5.2 (4.97–5.33)	0.056	4.7 (4.25–5.17)	5.2 (4.98–5.32)	0.077
Activity limitations	5.1 (4.65–5.59)	5.6 (5.45–5.80)	0.049	5.2 (4.70–5.63)	5.6 (5.45–5.79)	0.071
Emotional function	4.8 (4.27–5.35)	5.5 (5.26–5.66)	0.027	4.9 (4.32–5.39)	5.5 (5.27–5.67)	0.035
Environmental factors	4.9 (4.39–5.46)	5.4 (5.16–5.56)	0.140	5.0 (4.43–5.51)	5.3 (5.14–5.55)	0.198
Total	4.9 (4.42–5.31)	5.4 (5.22–5.54)	0.031	4.9 (4.48–5.34)	5.4 (5.22–5.54)	0.046

* With adjustment for BMI and depression/anxiety last 12 months.

**Figure 2.** The Mini-AQLQ total mean score and 95% CI in premenopausal women with and without PMA, with regular and irregular menstruation, with and without hormonal contraceptives and peri/postmenopausal women with and without MHT.

Discussion

The main results of our study were that premenstrual women with PMA had lower QoL, poorer asthma symptom control and more frequent exacerbations and peri/postmenopausal MHT use was associated with lower QoL but not poorer asthma control.

The difference in QoL in women with PMA was clinically relevant, also after adjustment for pet and/or pollen allergy, BMI and educational level. Women with PMA had almost seven times higher risk of uncontrolled asthma and a threefold higher risk of exacerbations.

These findings are in line with earlier studies where aggravation of asthma in relation to the menstrual cycle has been associated with poorly controlled disease and higher frequency of urgent healthcare visits compared to women without PMA (12,14,28). We have not found studies of asthma related QoL in this group in earlier research.

It has been suggested that PMA is a specific asthma phenotype in women characterized by frequent symptoms, exacerbations and associated with aspirin sensitivity, sinus symptoms, less atopy and lower lung capacity (11,13,28). However, a meta-analysis showed no difference in total IgE levels in women with and

without PMA (13). Results from a previous study have confirmed that women have an increased airway resistance during the premenstrual period (5), and this indicates that PMA is not only due to the perception of symptoms. In our study, women with PMA had no differences in BMI and prevalence of depression/anxiety in comparison with women without PMA. In some earlier studies though, a higher BMI and depression/anxiety have been independently associated to a lower QoL in asthma (29,30). The prevalence of women with PMA varies between studies due to different methods used (i.e. surveys or lung function measures) and selections of study population (11,12). The small number of women with PMA in our study may be a result of the method as we only used a self-completion questionnaire, with a risk for interpretation and/or recall difficulties.

Our second important result was that peri/postmenopausal women who used MHT had a statistically significantly and clinically relevant lower asthma related QoL than those without MHT, also with adjustment for potential confounders. Earlier studies including a recent meta-analysis demonstrated negative or no impact on asthma symptoms in postmenopausal women using MHT (17,31). Also, a longer use of MHT has been associated with a higher risk of

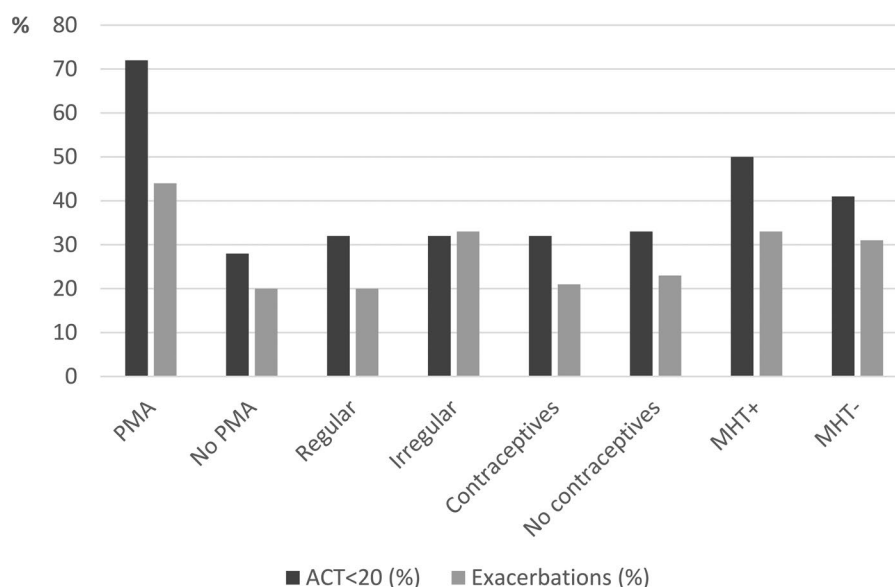


Figure 3. Proportions of participants with ACT < 20 and exacerbations last six months in premenopausal women with and without PMA, with regular and irregular menstruation, with and without hormonal contraceptives and peri/postmenopausal women with and without MHT.

exacerbation and hospital admission (32). This may be a result of a selection bias as women with more symptoms during menopause might be more prone to have MHT. In our study there were no differences in characteristics between those with and without MHT. Other research similar to ours, has not distinguished between different types of MHT. It thus remains unclear whether MHT with estrogen, progesterone or combination of hormones have different effects on asthma. The relatively small number of women with MHT in our study may be due to an international trend in avoiding MHT following research showing that MHT may increase the risk of breast cancer (34).

Another finding in this study was that women with irregular menstruation had a doubled risk of exacerbations compared to women with regular menstruation. In a European population study irregular menstruation was associated with increased asthma, allergy symptoms and lower lung function (35).

We found no difference in asthma related QoL, asthma symptom control or exacerbation rate by use of hormonal contraceptives. In previous studies treatment with hormonal contraceptives had mixed results with both higher, equal and lower risk of asthma worsening episodes (17). In another study, the risk of increased asthma symptoms related to oral contraceptives was greater in normal and overweight, but not lean women (36). A recently published large 17-year follow-up cohort study in the UK demonstrated that combined hormonal contraceptives were

associated with reduced risk of severe asthma exacerbation compared with no contraceptive use (37).

Strengths and weaknesses in the study

A strength of this study is the that it included randomly selected women with all severity stages of asthma. We assessed self-reported asthma related QoL life and asthma control in females of different ages measured by well-validated instruments in the same study.

The potential limitations include the small number of some subgroups, which was a consequence of strict inclusion/exclusion criteria. Additionally, collecting data via questionnaires may be biased by recall; e.g. inaccurate reporting of menstruation patterns may have led to some misclassification. Furthermore, we did not use objective measures such as lung function data or sex hormone level analyses.

Conclusion

In this cross-sectional study of randomly selected women with asthma we found that premenopausal women with PMA had lower QoL and poorer asthma control. Among peri/postmenopausal women MHT use was not associated with worse asthma control, but with lower QoL than women without MHT. This study highlights the possible need for guidelines related to management of women with asthma,

including use of personalized questions on sex hormone status and the use of exogenous hormones.

Declaration of interest

The authors report no conflicts of interest.

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