**Name of Journal: *Word Journal of Respirology***

**ESPS Manuscript NO: 21287**

**Manuscript Type: Editorial**

**Questions relating to premenstrual asthma**

Pereira-Vega A *et al*. Premenstrual asthma

**Antonio Pereira-Vega, José Luis Sánchez-Ramo**

**Antonio Pereira-Vega,**Pneumology Service, Juan Ramón Jiménez Hospital, 21005 Huelva, Spain

**José Luis Sánchez-Ramo,** University of Huelva, 21071 Huelva, Spain

**Author contributions:** Pereira-Vega A and Sánchez-Ramos JL designed the study and wrote the manuscript.

**Supported by** The grants from Neumosur (7/2003) and the Health Ministry of the Regional Autonomous Government of Andalusia (0074/2005).

**Conflict-of-interest** **statement:** The authors report no conflict of interest.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to: Antonio Pereira-Vega, MD, PhD,** Pneumology Service, Juan Ramón Jiménez Hospital**,** Ronda Norte, s/n, 21005 Huelva, Spain.apv01h@gmail.com

**Telephone:** +34-9-59016240

**Fax:** +34-9-59016060

**Received:** July 4, 2015

**Peer-review started:** July 10, 2015

**First decision:** July 31, 2015

**Revised:** September 22, 2015

**Accepted:** October 12, 2015

**Article in press:**

**Published online:**

**Abstract**

The study of asthma in fertile women needs to consider its potentially recurrent exacerbation in a specific phase of the menstrual cycle. Premenstrual asthma (PMA) refers to the deterioration of asthma in some women of fertile age during the premenstrual phase. Prevalence varies considerably according to studies (11%-47.44%) mainly because there is no standardized definition of the illness. There is a possible link between PMA and Premenstrual Syndrome, which is a set of physical and psychic manifestations that occur in some fertile women during the same premenstrual phase. This relation has been widely studied but there are still several unknowns. PMA etiopathogeny is not known. It involves possible causes such as hormonal variations in the premenstrual phase, the coexistence of atopy, variations during the cycle in substances related to inflammation, like LTC4 leukotrienes, catecholamines, E2 and F2α prostaglandins and certain cytokines. Also considered are psychological factors related to this phase of the menstrual cycle, a high susceptibility to infection or increased bronchial hyperreactivity prior to menstruation. Yet no factor fully explains its etiology, consequently no specific treatment exists. Researchers have investigated hormones, anti-leukotrienes, prostaglandin synthesis inhibitors, diuretics, phytoestrogens and alternative therapies, but none has been shown to be effective.

**Key words:** Premenstrual asthma; Definition; Etiology; Risk factors; Treatment

**© The Author(s) 2015.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** Premenstrual asthma (PMA) refers to the exacerbation of asthma in women of fertile age during the premenstrual phase. Whether or not it is an asthma phenotype, its definition, etiopathogeny and treatment are issues still to be resolved. PMA seems to be a female asthma phenotype despite contradictory results. It can occur at any level of asthma severity and it is usually associated with poorer disease control. Its etiology is not well known, and there is no specific widely recognized treatment. We need new well-designed studies to compare asthmatic women with or without PMA, and good quality clinical trials.

Pereira-Vega A, Sánchez-Ramos JL. Questions relating to premenstrual asthma. *World J Respirol* 2015; In press

**INTRODUCTION**

Unfortunately, there are illnesses or phenotypes of illnesses whose etiopathogeny remains unknown and for which specific treatment is still not available. One such is premenstrual asthma (PMA).

Bronchial asthma in women of fertile age has several specific connotations that include factors such as female sexual hormones and the variations they undergo in the menstrual cycle, women’s psychology and metabolism, aspects related to reproduction and the influence of external factors on certain genetic characteristics, among others.

Several authors have investigated the cyclical exacerbation of asthma in fertile women in a specific phase of menstrual cycle. Deterioration has been described in the periovulatory phase[1,2], in the middle of the preovulatory or luteal phase[3,4] and more frequently in the premenstrual phase, an entity defined as premenstrual asthma[5-9].

As well as PMA, other exacerbations in the premenstrual phase have been described, in acne, psoriasis, porphyria, epilepsy, nasal symptoms[10], multiple sclerosis, migraine, urticarial, Behçet syndrome and myasthenia gravis, among others[11].

All this seems to indicate that there are still more questions than answers concerning the possible influence of the menstrual cycle on women and their health, especially in terms of bronchial asthma

**QUESTIONS RELATING TO PREMENSTRUAL ASTHMA**

***A definition***

The classic definition of PMA continues to be the cyclical deterioration of asthma in some women of fertile age during the premenstrual phase and/or the first days of menstruation[6,7]. Although it can occur at any level of asthma severity according to the Global Initiative for Asthma (GINA) classification[12], it is usually associated with poorer disease control.

***Definition of deterioration***

Deterioration refers to the worsening of the symptoms of asthma, lung function and inflammation markers, or all of these factors together. As a result, the definition of premenstrual asthma varies in the studies of this entity. Early research[7,9,13,14] defined PMA merely on the basis of a “Yes” answer by a female asthma sufferer to the question, “Does your asthma get worse during the premenstrual phase?” This definition is clearly subjective, referring to the patient’s own perception of her asthmatic symptoms in this phase. Authors such as Balzano *et al*[15] comment in their conclusions that it is not clear whether the asthma exacerbation occurring in many women during the premenstrual period is due to an objectively measurable intensification of the disease or to an increased perception of symptoms caused by the particular psychological state occurring shortly before menstruation. Our research group[1] defines this as “PMA from a subjective perspective”.

Later authors sought a definition by formulating a methodology that gathered data on the symptoms and then subjected them to a structured analysis in order to consider whether a patient’s condition conformed to PMA criteria[8,17]. These definitions still retained a subjective component since they asked women about their personal “perception” of asthmatic symptoms. Our research group[16] defines this as “semi-objective PMA”.

Other researchers applied criteria that were more obviously objective. These included the observation of a premenstrual exacerbation in lung function through peak flow[16,18,19] or spirometry[20] (a reduction in lung volume and flow, or lung diffusing capacity, bronchial hyperreactivity[21] to methacholine or to physical exercise), an increase in inflammation markers such as Nitric Oxide (NOx)[22] or eosinophils in the sputum in the premenstrual phase[23]. There is also some controversy over the level of exacerbation that needs to occur in the premenstrual as opposed to the preovulatory phase. Some authors[17] require more than 20% in the objective parameters while for others it must be 40%[19].

Our research group[16] has categorized these three possible definitions of PMA as “PMA from a subjective perspective”, “semi-objective PMA” and “PMA defined by objective criteria”, and analyzed the relation between all three. We found that the biggest differences between the preovulatory and premenstrual phases in asthmatic females occurred within the semi-objective PMA category. On the other hand, there is a greater correlation between the semi-objective exacerbation of the symptoms and perception of the exacerbation of the asthma before menstruation when considering one single menstrual cycle than requiring semi-objective exacerbation in two consecutive cycles. We believe it is too stringent to require that semi-objective criteria apply in two consecutive cycles. Objective criteria, which demand a peak flow variation of 20%, are much more restrictive. Our results lead us to think that the definition by semi-objective criteria in a menstrual cycle is what best defines the problem of PMA.

These disparate definitions are seen in the variation in figures for PMA prevalence that appear in studies (from 11% to 47%) and highlight the need to standardize criteria.

Another aspect that further confuses the issue is the relation between subjective, semi-objective and objective criteria. Pauli *et al*[24] found that 11 asthmatic women who had stated that their asthma did not deteriorate prior to menstruation (non-compliance with subjective criteria) in fact had more symptoms before menstruation when these same symptoms were later analyzed (semi-objective criteria); they also experienced deterioration in premenstrual peak flow (objective criteria according to peak flow). However, there was no deterioration in spirometry or in bronchial hyperreactivity (objective criteria according to other parameters different from peak flow).

***How many cycles?***

While some authors only require that deterioration occurs in a single cycle[17,25,26], others believe that exacerbation of symptoms must be present in several consecutive cycles[14], the question being whether women with PMA fulfill PMA criteria in all menstrual cycles. With this in mind, Agarwal *et al*[9] studied a group of women over four consecutive menstrual cycles and found that 61% of those with PMA showed deterioration in almost every cycle, 39% had worsening once every 2-3 cycles while one patient had an increase in symptoms every 3-4 cycles. These data question how many cycles are required for PMA criteria to be satisfied. They also make us think about whether PMA sufferers vary in their symptoms during different cycles in the same year or whether these symptoms can change over several years. We consider the semi-objective criteria in a complete menstrual cycle as the most valid approximation to real PMA[16].

***At which point in the cycle?***

Why do some women experience deterioration in some pre-existing illnesses during the premenstrual phase and others do not? Why do some women suffer this exacerbation in other phases of the menstrual cycle? Such questions remain to be answered convincingly.

***Questions on the relation between premenstrual asthma and premenstrual syndrome***

Premenstrual syndrome is the cyclical recurrence of a set of physical and psychic symptoms that occur in some women of fertile age following ovulation, in the luteal phase of the menstrual cycle and, in particular, before menstruation, and which is resolved at the beginning of the next menstrual cycle[27,28].

More than 150 clinical manifestations of the syndrome have been described[14,29,30], with congestive and edematous symptoms being predominant in the physical aspect, and mood changes in the psychic aspect. These premenstrual symptoms are relatively frequent in fertile women although their intensity and possible repercussion on quality of life vary significantly (80% experience a slight exacerbation and 3% a severe exacerbation)[31-33]. Their true etiology and physiopathology are unknown[34-36], although the alterations in the balance between sexual hormones and neurotransmitters are noteworthy[37].

Several works have found links between PMA and premenstrual syndrome[17,38]. Our research group[39] has shown a clear connection between PMA and premenstrual syndrome. A detailed analysis of the various symptoms related to premenstrual syndrome reveals that the relation is particularly intense in psychic and edematous symptoms such as abdominal and mammary tension. This could be due to the fact that the generalized nature of the edema in women also occurs in nasal and bronchial mucosa[10] leading to a deterioration of nasal and asthmatic symptoms, and lung function in this premenstrual phase.

Although we believe there exists a relation between PMA and the symptoms related to premenstrual syndrome, the etiology and physiopathology of both is unknown, and not all women with PMA necessarily present with premenstrual syndrome and vice versa.

***Questions relating to the etiology of premenstrual asthma***

Premenstrual asthma’s true etiology is still in doubt. Some authors stress the influence of hormonal factors (premenstrual decline in estrogens or progesterone, or variations in the estrogen/progesterone relation in the premenstrual phase[25,40-46], LH[41], FSH[41]), atopy[47-51], variations during the menstrual cycle of inflammation-related substances (LTC4 leukotrienes LTC4[19,52], the E2 and F2α[53] prostaglandins and cytokines[54]), psychological factors, diminished resistance to infections or increased bronchial hyperreactivity (Table 1)[8,55,56]. The results of studies that have analyzed the possible factors vary and are occasionally contradictory.

For the possible genetic factors involved, Gorovenko *et al*[57] studied aspects related to asthma genetics and found that women with PMA showed a greater frequency of functioning alleles in Glutathione Transferase T1 (GSTT1). This genetic polymorphism (in terms of inactive GSTM1 alleles) relates to the metabolism of prostaglandins (PG), leukotrienes (LTC) and the sexual hormones. The genetic component associated to the atopy could also influence the relation found in some studies between levels of total IgE and premenstrual asthma[47].

Other factors such as sensibility to aspirin (ASS)[48], use of aspirin or non-steroidal anti-inflammatory drugs[58] or body mass index (BMI)[48] have been related to premenstrual asthma. No clear link has been found between ASS and PMA, and although Rao *et al*[48] found higher BMI scores in asthmatics with PMA, other authors found no link between obesity and premenstrual asthma[59].

A priori, the varying behaviors of the sexual hormones in the premenstrual phase compared to the preovulatory phase would seem to be the best explanation of the mechanism by which to describe why some women with bronchial asthma have PMA and others do not. However, the studies have found no difference between the blood levels of the different hormones between women with and without PMA[40]. Researchers have always explored this relation via hormone levels in the blood but perhaps this relation is more complex, and is found in intermediary mechanisms such as the cyclical variations of substances like cytokines (CK) or leukotrienes (LTC), among others, which are, in turn, influenced by hormone variations.

In short, despite the studies carried out so far and the reviews published on the subject[60-65], the research results are inconclusive and the causal factors of this entity remain unknown.

***Questions related to treatment***

Some women with PMA experience a slight worsening of their asthmatic symptoms before menstruation, which is resolved by increasing the dosage of base medication. However, other women suffer severe exacerbation that require frequent visits to hospital emergency rooms or even hospitalization[48,66]. The latter cases would be those most urgently requiring a treatment specific to the patient’s condition[40,52,67]. Various specific treatments for PMA have been analyzed (Table 2) without agreement as to which is the most effective. Study results continue to be contradictory. The most attractive hypothesis to explain the cause of PMA is hormonal variations in the premenstrual phase, and the proposed treatments involve oral or intramuscular[68] progesterone, estrogens[25,69] and oral contraceptives[18,44,70]. Other treatments tested include gonadotropin analogues[71], which can cause uncomfortable side effects such as amenorrhea or osteoporosis, leukotrienes antogonists[19,41] and sodium meclofenomate[72] among others.

Our research group is currently carrying out a randomized double-blind placebo-controlled clinical trial to analyze the possible benefits of phytoestrogens (Genistein) in cases of premenstrual asthma[73]. Phytoestrogens are natural estrogens that present fewer side effects than human estrogens. They can have an agonistic or antagonistic effect according to the tissue on which they act[74]. It is shown to be useful in treating postmenopausal symptoms[75], premenstrual syndrome[76] and asthma[77,78]. Our study is based on the relation that we have found between PMA and symptoms related to premenstrual syndrome, and it is boosted by the fact that the side effects of these substances are few. The results have not been published yet.

So we can say that due to the absence of a definitive PMA etiology, and despite the various therapeutic interventions proposed[19,25,41,42,70,71], the best approach for this entity remains unknown. Treating this condition requires well-designed randomized double-blind placebo-controlled clinical trials.

**CONCLUSION**

***Definition***

The definition used in studies needs to be clarified in order for results to be compared.

***Relation between premenstrual asthma and premenstrual syndrome***

Although a relation between both events seems to exist, there are still doubts about the type of premenstrual syndrome-related symptoms that can be clearly linked to PMA; and doubts persist as to the etiology of both phenomena.

***Etiology of premenstrual asthma***

The type of relation that exists between hormonal changes throughout the cycle and PMA has yet to be established; this relation would be the most likely hypothesis. Investigators have searched for this link in hormone levels of the blood but the relation seems to be more complex. There are still doubts about PMA etiology, and like Skoczynsky *et al*[23], we believe that close collaboration between medical specialities such as pneumology, gynaecology and endocrinology, among others, could shed light on this issue.

***Specific treatment for premenstrual asthma***

Athough there are several works published on the subject, there is currently no treatment specifically designed for PMA. More studies are needed in this area.

***Final conclusion***

Although the results are contradictory, it seems that PMA can be considered a phenotype specific to asthma in women. Although it can occur at any level of asthma severity classification[16] it is usually associated with poorer disease control[50,79,80]. We still do not know its etiology entirely and no specific treatment exists that has been widely accepted. All this requires new studies to compare groups of asthmatic women with or without premenstrual asthma, with clear criteria regarding definition of the entity.

**ACKNOWLEDGMENTS**

We thank Mr. Noel Byde for his expert revision of the English language version of this text.

**REFERENCES**

1 **van den Akker O**, Steptoe A. The pattern and prevalence of symptoms during the menstrual cycle. *Br J Psychiatry* 1985; **147**: 164-169 [PMID: 4041689 DOI: 10.1192/bjp.147.2.164]

2 **Brenner BE**, Holmes TM, Mazal B, Camargo CA. Relation between phase of the menstrual cycle and asthma presentations in the emergency department. *Thorax* 2005; **60**: 806-809 [PMID: 16192365 DOI: 10.1136/thx.2004.033928]

3 **Wegienka G**, Hasiec E, Boushey H, Johnson CC, Strickler R, Zoratti E, Havstad S. Studying forced expiratory volume at 1 second over menstrual segments in asthmatic and non-asthmatic women: assessing protocol feasibility. *BMC Res Notes* 2012; **5**: 261 [PMID: 22642760 DOI: 10.1186/1756-0500-5-261]

4 **Macsali F**, Svanes C, Sothern RB, Benediktsdottir B, Bjørge L, Dratva J, Franklin KA, Holm M, Janson C, Johannessen A, Lindberg E, Omenaas ER, Schlünssen V, Zemp E, Real FG. Menstrual cycle and respiratory symptoms in a general Nordic-Baltic population. *Am J Respir Crit Care Med* 2013; **187**: 366-373 [PMID: 23204251 DOI: 10.1164/rccm.201206-1112OC]

5 **Frank RT**. The hormonal causes of premenstrual tension. *Arch Neurol Psychiat* 1931; **26**: 1053 [DOI: 10.1001/archneurpsyc.1931. 02230110151009]

6 **Claude F**, Allewany VR. Asthme et menstruation. *Presse Med* 1938; **38**: 755

7 **Rees L**. Anaetiological study of premenstrual asthma. *J Psychosom Res* 1963; **7**: 191-197 [DOI: 10.1016/0022-3999(63)90003-5]

8 **Eliasson O**, Scherzer HH, DeGraff AC. Morbidity in asthma in relation to the menstrual cycle. *J Allergy Clin Immunol* 1986; **77**: 87-94 [PMID: 3944377 DOI: 10.1016/0091-6749(86)90328-3]

9 **Agarwal AK**, Shah A. Menstrual-linked asthma. *J Asthma* 1997; **34**: 539-545 [PMID: 9428300 DOI: 10.3109/02770909709055398]

10 **Pavón M**, Pereira-Vega A, Sánchez JL, Maldonado JA, Bravo JM, Alwakil M. Relación entre asma premenstrual y empeoramiento premenstrual de síntomas otorrinolaringológicos en mujeres con asma. *Revista Española de Patología Respiratoria* 2011; **23**: 299-303

11 **Boggess KA**, Williamson HO, Homm RJ. Influence of the menstrual cycle on systemic diseases. *Obstet Gynecol Clin North Am* 1990; **17**: 321-342 [PMID: 2234747]

12 **Global initiative for asthma**. Global Strategy for Asthma Management and Prevention 2015 Update. Available from: URL: http//www.ginasthma.org/local/uploads/files/GINA\_Report\_2015.pdf

13 **Hanley SP**. Asthma variation with menstruation. *Br J Dis Chest* 1981; **75**: 306-308 [PMID: 7295523 DOI: 10.1016/0007-0971(81)90010-3]

14 **Halbreich U**, Endicott J. Methodological issues in studies of premenstrual changes. *Psychoneuroendocrinology* 1985; **10**: 15-32 [PMID: 3923510 DOI: 10.1016/0306-4530(85)90036-8]

15 **Balzano G**, Fuschillo S, Melillo G, Bonini S. Asthma and sex hormones. *Allergy* 2001; **56**: 13-20 [PMID: 11167347 DOI: 10.1034/j.1398-9995.2001.00128.x]

16 **Pereira Vega A**, Sánchez Ramos JL, Maldonado Pérez JA, Alvarez Gutierrez FJ, Ignacio García JM, Vázquez Oliva R, Romero Palacios P, Bravo Nieto JM, Sánchez Rodríguez I, Gil Muñoz F. Variability in the prevalence of premenstrual asthma. *Eur Respir J* 2010; **35**: 980-986 [PMID: 19897559 DOI: 10.1183/09031936.00045109]

17 **Ensom MH**, Chong E, Carter D. Premenstrual symptoms in women with premenstrual asthma. *Pharmacotherapy* 1999; **19**: 374-382 [PMID: 10212006 DOI: 10.1592/phco.19.6.374.31050]

18 **Murphy VE**, Gibson PG. Premenstrual asthma: prevalence, cycle-to-cycle variability and relationship to oral contraceptive use and menstrual symptoms. *J Asthma* 2008; **45**: 696-704 [PMID: 18951263 DOI: 10.1080/02770900802207279]

19 **Nakasato H**, Ohrui T, Sekizawa K, Matsui T, Yamaya M, Tamura G, Sasaki H. Prevention of severe premenstrual asthma attacks by leukotriene receptor antagonist. *J Allergy Clin Immunol* 1999; **104**: 585-588 [PMID: 10482831 DOI: 10.1016/S0091-6749(99)70327-1]

20 **Farha S**, Asosingh K, Laskowski D, Hammel J, Dweik RA, Wiedemann HP, Erzurum SC. Effects of the menstrual cycle on lung function variables in women with asthma. *Am J Respir Crit Care Med* 2009; **180**: 304-310 [PMID: 19520904 DOI: 10.1164/rccm.200904-0497OC]

21 **Adkisson EJ**, Casey DP, Beck DT, Gurovich AN, Martin JS, Braith RW. Central, peripheral and resistance arterial reactivity: fluctuates during the phases of the menstrual cycle. *Exp Biol Med (Maywood)* 2010; **235**: 111-118 [PMID: 20404025 DOI: 10.1258/ebm.2009.009186]

22 **Antczak A**, Ciebiada M, Kharitonov SA, Gorski P, Barnes PJ. Inflammatory markers: exhaled nitric oxide and carbon monoxide during the ovarian cycle. *Inflammation* 2012; **35**: 554-559 [PMID: 21590323 DOI: 10.1007/s10753-011-9345-1]

23 **Skoczyński S**, Semik-Orzech A, Szanecki W, Majewski M, Kołodziejczyk K, Sozańska E, Witek A, Pierzchała W. Perimenstrual asthma as a gynecological and pulmonological clinical problem. *Adv Clin Exp Med* 2014; **23**: 665-668 [PMID: 25166454 DOI: 10.17219/acem/37250]

24 **Pauli BD**, Reid RL, Munt PW, Wigle RD, Forkert L. Influence of the menstrual cycle on airway function in asthmatic and normal subjects. *Am Rev Respir Dis* 1989; **140**: 358-362 [PMID: 2764371 DOI: 10.1164/ajrccm/140.2.358]

25 **Ensom MH**, Chong G, Zhou D, Beaudin B, Shalansky S, Bai TR. Estradiol in premenstrual asthma: a double-blind, randomized, placebo-controlled, crossover study. *Pharmacotherapy* 2003; **23**: 561-571 [PMID: 12741429 DOI: 10.1592/phco.23.5.561.32201]

26 **Ensom MH**. Gender-based differences and menstrual cycle-related changes in specific diseases: implications for pharmacotherapy. *Pharmacotherapy* 2000; **20**: 523-539 [PMID: 10809339 DOI: 10.1592/phco.20.6.523.35161]

27 **Moline ML**. Pharmacologic strategies for managing premenstrual syndrome. *Clin Pharm* 1993; **12**: 181-196 [PMID: 8491076]

28 **Korzekwa MI**, Steiner M. Premenstrual syndromes. *Clin Obstet Gynecol* 1997; **40**: 564-576 [PMID: 9328737 DOI: 10.1097/00003081-199709000-00017]

29 **American Psychiatric Association**. Diagnostic and statistical manual of mental disorders. 4th ed. Washington DC: American Psychiatric Association, 1994: 75-18

30 **American College of Obstetricians and Gynaecologists (ACOG)**. Premenstrual Syndrome. Washington DC: ACOG, 2000.

31 **Ramcharan S**, Love EJ, Fick GH, Goldfien A. The epidemiology of premenstrual symptoms in a population-based sample of 2650 urban women: attributable risk and risk factors. *J Clin Epidemiol* 1992; **45**: 377-392 [PMID: 1569434 DOI: 10.1016/0895-4356(92)90039-P]

32 **Sveindóttir H**, Bäckström T. Prevalence of menstrual cycle symptom cyclicity and premenstrual dysphoric disorder in a random sample of women using and not using oral contraceptives. *Acta Obstet Gynecol Scand* 2000; **79**: 405-413 [PMID: 10830769 DOI: 10.1080/j.1600-0412.2000.079005405.x]

33 **Wittchen H -U**, Becker E, Lieb R, Krause P. Prevalence, incidence and stability of premenstrual dysphoric disorder in the community. *Psychol Med* 2002; **32**: 119-132 [PMID: 11883723 DOI: 10.1017/S0033291701004925]

34 **Rubinow M**, Steiner M, Haskett RF. The psychobiology of premenstrual syndromes: the Michigan studies. In: Ginsburg BE, Carter BF. Premenstrual Syndrome. New York: Plenum Pres, 1986: 369-385.

35 **Roca CA**, Schmidt PJ, Bloch M. Implications of endocrine studies of premenstrual syndrome. *Psychiatr Ann* 1996; **26**: 576-580 [DOI: 10.3928/0048-5713-19960901-10]

36 **Eriksson E**, Alling C, Andersch B, Andersson K, Berggren U. Cerebrospinal fluid levels of monoamine metabolites. A preliminary study of their relation to menstrual cycle phase, sex steroids, and pituitary hormones in healthy women and in women with premenstrual syndrome. *Neuropsychopharmacology* 1994; **11**: 201-213 [PMID: 7532413 DOI: 10.1038/sj.npp.1380107]

37 **De Bondt T**, De Belder F, Vanhevel F, Jacquemyn Y, Parizel PM: Prefrontal GABA concentration changes in women-Influence of menstrual cycle phase, hormonal contraceptive use, and correlation with premenstrual symptoms. *Brain Res* 2015; **1597**: 129-138 [PMID: 25481417 DOI: 10.1016/j.brainres.2014.11.051]

38 **Dorhofer DM**, Sigmon ST. Physiological and psychological reactivity in women with asthma: the effects of anxiety and menstrual cycle phase. *Behav Res Ther* 2002; **40**: 3-17 [PMID: 11762425 DOI: 10.1016/S0005-7967(00)00110-8]

39 **Pereira-Vega A**, Sánchez JL, Gil FL, Maldonado JA, Bravo JM, Ignacio JM, Vázquez R, Álvarez F, Romero P, Sánchez I. Premenstrual asthma and symptoms related to premenstrual syndrome. *J Asthma* 2010; **47**: 835-840 [PMID: 20874438 DOI: 10.3109/02770903.2010.495810]

40 **Pereira-Vega A**, Sánchez Ramos JL, Vázquez Oliva R, Maldonado Pérez JA, Olbah MA, Montero Fernández M, Vázquez Rico I, Robles Rodríguez JL, Ignacio García JM, Romero Palacios P, Medina Gallardo JF. Premenstrual asthma and female sex hormones. *J Investig Allergol Clin Immunol* 2012; **22**: 437-439 [PMID: 23101189]

41 **Pasaoglu G**, Mungan D, Abadoglu O, Misirligil Z. Leukotriene receptor antagonists: a good choice in the treatment of premenstrual asthma? *J Asthma* 2008; **45**: 95-99 [PMID: 18350399 DOI: 10.1080/02770900701751799]

42 **Chandler MH**, Schuldheisz S, Phillips BA, Muse KN. Premenstrual asthma: the effect of estrogen on symptoms, pulmonary function, and beta 2-receptors. *Pharmacotherapy* 1997; **17**: 224-234 [PMID: 9085312]

43 **Rubio Ravelo L**, Gago Rodríguez B, Almirall Collazo JJ, Bell Heredia L, Fernández Fernández L. Comparative study of progesterone, estradiol and cortisol concentrations in asthmatic and non-asthmatic women. *Allergol Immunopathol (Madr)* 1988; **16**: 263-266 [PMID: 3228046]

44 **Tan KS**, McFarlane LC, Lipworth BJ. Modulation of airway reactivity and peak flow variability in asthmatics receiving the oral contraceptive pill. *Am J Respir Crit Care Med* 1997; **155**: 1273-1277 [PMID: 9105066 DOI: 10.1164/ajrccm.155.4.9105066]

45 **Mandhane PJ**, Hanna SE, Inman MD, Duncan JM, Greene JM, Wang HY, Sears MR. Changes in exhaled nitric oxide related to estrogen and progesterone during the menstrual cycle. *Chest* 2009; **136**: 1301-1307 [PMID: 19617403 DOI: 10.1378/chest.09-0604]

46 **Tan KS**, McFarlane LC, Lipworth BJ. Loss of normal cyclical beta 2 adrenoceptor regulation and increased premenstrual responsiveness to adenosine monophosphate in stable female asthmatic patients. *Thorax* 1997; **52**: 608-611 [PMID: 9246131 DOI: 10.1136/thx.52.7.608]

47 **Pereira-Vega A**, Sánchez JL, Maldonado JA, Borrero F, Rico IV, Vázquez R, Alvarez F, Ignacio JM, Romero P, Gil FL. Premenstrual asthma and atopy markers. *Ann Allergy Asthma Immunol* 2010; **105**: 218-222 [PMID: 20800788 DOI: 10.1016/j.anai.2010.06.022]

48 **Rao CK**, Moore CG, Bleecker E, Busse WW, Calhoun W, Castro M, Chung KF, Erzurum SC, Israel E, Curran-Everett D, Wenzel SE. Characteristics of perimenstrual asthma and its relation to asthma severity and control: data from the Severe Asthma Research Program. *Chest* 2013; **143**: 984-992 [PMID: 23632943 DOI: 10.1378/chest.12-0973]

49 **Shibasaki M**, Takeda K, Sumazaki R, Nogami T, Takita H. Premenstrual asthma with seasonal variation. *Ann Allergy* 1992; **68**: 315-318 [PMID: 1348404]

50 **Martinez-Moragón E**, Plaza V, Serrano J, Picado C, Galdiz JB, López-Viña A, Sanchis J. Near-fatal asthma related to menstruation. *J Allergy Clin Immunol* 2004; **113**: 242-244 [PMID: 14767436]

51 **Roby RR**, Richardson RH, Vojdani A. Hormone allergy. *Am J Reprod Immunol* 2006; **55**: 307-313 [PMID: 16533343 DOI: 10.1111/j.1600-0897.2006.00373.x]

52 **Pereira-Vega A**, Sánchez Ramos JL, Maldonado Pérez JA, Vázquez Oliva R, Bravo Nieto JM, Vázquez Rico I, Ignacio García JM, Romero Palacios P, Alwakil Olbah M, Medina Gallardo JF. Premenstrual asthma and leukotriene variations in the menstrual cycle. *Allergol Immunopathol (Madr)* 2012; **40**: 368-373 [PMID: 22115570 DOI: 10.1016/j.aller.2011.09.007]

53 **Eliasson O**, Longo M, Dore-Duffy P, Densmore MJ, DeGraff AC. Serum 13-14-diOH-15-keto-prostaglandin F2 alpha and airway response to meclofenamate and metaproterenol in relation to the menstrual cycle. *J Asthma* 1986; **23**: 309-319 [PMID: 3546255 DOI: 10.3109/02770908609073178]

54 **Agarwal SK**, Marshall GD. Perimenstrual alterations in type-1/type-2 cytokine balance of normal women. *Ann Allergy Asthma Immunol* 1999; **83**: 222-228 [PMID: 10507267 DOI: 10.1016/S1081-1206(10)62644-0]

55 **Mirdal GM**, Petersson B, Weeke B, Vibits A. Asthma and menstruation: the relationship between psychological and bronchial hyperreactivity. *Br J Med Psychol* 1998; **71 ( Pt 1)**: 47-55 [PMID: 9561305 DOI: 10.1111/j.2044-8341.1998.tb01366.x]

56 **Dratva J**, Schindler C, Curjuric I, Stolz D, Macsali F, Gomez FR, Zemp E. Perimenstrual increase in bronchial hyperreactivity in premenopausal women: results from the population-based SAPALDIA 2 cohort. *J Allergy Clin Immunol* 2010; **125**: 823-829 [PMID: 20227756 DOI: 10.1016/j.jaci.2009.12.938]

57 **Gorovenko N**, Ebrahimi, M, Podolskaya S. Genetic polymorphism of glutathione-S transferase M1. T1 and susceptibility to premenstrual asthma in Ukrainian population. *Chest* 2005; **128**: 239S-240S [DOI: 10.1378/chest.128.4\_meetingabstracts.239s-c]

58 **Forbes L**, Jarvis D, Bumey P. Is pre-menstrual asthma related to use of aspirin or non-steroidal anti-inflammatory drugs? *Respir Med* 2000; **94**: 828-829 [PMID: 10955761 DOI: 10.1053/rmed.2000.0790]

59 **Papoutsakis C**, Chondronikola M, Antonogeorgos G, Papadakou E, Matziou V, Drakouli M, Konstantaki E, Papadimitriou A, Priftis KN. Associations between central obesity and asthma in children and adolescents: a case-control study. *J Asthma* 2015; **52**: 128-134 [PMID: 25134781]

60 **Cross S**. Asthma and the menstrual cycle (continuing education credit). *Nurs Stand* 1994; **8**: 22-6; quiz 27-8 [PMID: 8155523]

61 **Haggerty CL**, Ness RB, Kelsey S, Waterer GW. The impact of estrogen and progesterone on asthma. *Ann Allergy Asthma Immunol* 2003; **90**: 284-91; quiz 291-3, 347 [PMID: 12669890 DOI: 10.1016/S1081-1206(10)61794-2]

62 **Karpel JP**, Juliette LW. Asthma and women, Part 3: Perimenstrual asthma, effects of hormone therapy. *J Crit Illnes* 2000; **15**: 265-72

63 **Meyer M**, Griffiths H. The internal plumbing of algal chloroplasts. *Elife* 2015; **4**: [PMID: 25584626 DOI: 10.1081/JAS-200027986]

64 **Vrieze A**, Postma DS, Kerstjens HA. Perimenstrual asthma: a syndrome without known cause or cure. *J Allergy Clin Immunol* 2003; **112**: 271-282 [PMID: 12897732 DOI: 10.1067/mai.2003.1676]

65 **Enright T**, Lim DT, Devnani R, Mariano R. Cyclical exacerbation of bronchial asthma. *Ann Allergy* 1987; **58**: 405-46, 405-46, [PMID: 3592310]

66 **Skobeloff EM**, Spivey WH, Silverman R, Eskin BA, Harchelroad F, Alessi TV. The effect of the menstrual cycle on asthma presentations in the emergency department. *Arch Intern Med* 1996; **156**: 1837-1840 [PMID: 8790078 DOI: 10.1001/archinte.156.16.1837]

67 **Martínez Moragón E**. Asma premenstrual. *Espacioasma* 2014; **7**: 65-70

68 **Beynon HL**, Garbett ND, Barnes PJ. Severe premenstrual exacerbations of asthma: effect of intramuscular progesterone. *Lancet* 1988; **2**: 370-372 [PMID: 2899776 DOI: 10.1016/S0140-6736(88)92837-1]

69 **Ensom MH**, Chong G, Beaudin B, Bai TR. Estradiol in severe asthma with premenstrual worsening. *Ann Pharmacother* 2003; **37**: 1610-1613 [PMID: 14565797 DOI: 10.1345/aph.1D090]

70 **Derimanov GS**, Oppenheimer J. Exacerbation of premenstrual asthma caused by an oral contraceptive. *Ann Allergy Asthma Immunol* 1998; **81**: 243-246 [PMID: 9759802 DOI: 10.1016/S1081-1206(10)62820-7]

71 **Murray RD**, New JP, Barber PV, Shalet SM. Gonadotrophin-releasing hormone analogues: a novel treatment for premenstrual asthma. *Eur Respir J* 1999; **14**: 966-967 [PMID: 10573250 DOI: 10.1034/j.1399-3003.1999.14d39.x]

72 **Shimoda T**, Krzanowski J, Lockey R, Martin DF, Perez-Cruet M, Polson J, Duncan R. Lower airway smooth muscle contraction induced by Ptychodiscus brevis (red tide) toxin. *J Allergy Clin Immunol* 1987; **79**: 899-908 [PMID: 3584745 DOI: 10.1016/0091-6749(87)90240-5]

73 **Sánchez Ramos JL**, Pereira-Vega A. Valoración de la eficacia y seguridad de la genisteína, como suplemento dietético, para mejorar los síntomas del asma premenstrual mediante un estudio aleatorizado, doble ciego y controlado por placebo. PI-0311-2013 CISPS 2013 – Proyectos I+I, estancias formativos, intensificación APES. Health Department of the Andalusian Health Service, 2013

74 **Setchell KD**. Soy isoflavones--benefits and risks from nature's selective estrogen receptor modulators (SERMs). *J Am Coll Nutr* 2001; **20**: 354S-362S; discussion 381S-383S [PMID: 11603644]

75 **Moreira AC**, Silva AM, Santos MS, Sardão VA. Phytoestrogens as alternative hormone replacement therapy in menopause: What is real, what is unknown. *J Steroid Biochem Mol Biol* 2014; **143**: 61-71 [PMID: 24583026 DOI: 10.1016/j.jsbmb.2014.01.016]

76 **Lloyd KB**, Hornsby LB. Complementary and alternative medications for women's health issues. *Nutr Clin Pract* 2009; **24**: 589-608 [PMID: 19841247 DOI: 10.1177/0884533609343001]

77 **Bime C**, Wei CY, Holbrook J, Smith LJ, Wise RA. Association of dietary soy genistein intake with lung function and asthma control: a post-hoc analysis of patients enrolled in a prospective multicentre clinical trial. *Prim Care Respir J* 2012; **21**: 398-404 [PMID: 22885561 DOI: 10.4104/pcrj.2012.00073]

78 **Smith LJ**, Kalhan R, Wise RA, Sugar EA, Lima JJ, Irvin CG, Dozor AJ, Holbrook JT. Effect of a soy isoflavone supplement on lung function and clinical outcomes in patients with poorly controlled asthma: a randomized clinical trial. *JAMA* 2015; **313**: 2033-2043 [PMID: 26010632 DOI: 10.1001/jama.2015.5024]

79 **Shames RS**, Heilbron DC, Janson SL, Kishiyama JL, Au DS, Adelman DC. Clinical differences among women with and without self-reported perimenstrual asthma. *Ann Allergy Asthma Immunol* 1998; **81**: 65-72 [PMID: 9690575 DOI: 10.1016/S1081-1206(10)63111-0]

80 **Mitchell I**, Tough SC, Semple LK, Green FH, Hessel PA. Near-fatal asthma: a population-based study of risk factors. *Chest* 2002; **121**: 1407-1413 [PMID: 12006421 DOI: 10.1378/chest.121.5.1407]

**P-Reviewer:** Chen GS, Mohamed Emam AA, Pedro XE, Wang HY **S-Editor:** Qiu S **L-Editor: E-Editor:**

**Table 1 Etiological factors in premenstrual asthma**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Group** | **Factor** | **Ref.** | **Design** | **Level of factor in PMA** | **Level of factor in non PMA** | ***p*** | **Evidence level\*** |
| Hormones | Estrogen | Pasaoglu[41] | Pre-post study | PM: 89.3 pg/mL | PM: 72 pg/mL | N/A | 4 |
|  | Estrogen | Pereira[40] | Cross-sectional study | PO: 111.49 pg/mLPM: 95.9 | PO: 131.31 pg/mLPM: 123.83 | (for change)0.845 | 4 |
|  | Progesterone | Pasaoglu[41] | Pre-post study | PM: 7.3 pg/mL | PM: 9.2 pg/mL | N/A | 4 |
|  | Progesterone | Pereira[40] | Cross-sectional study | PO: 0.83 pg/mLPM: 6.82 | PO: 1.39 pg/mLPM: 6.31 | (for change) 0.225 | 4 |
|  | Estrogen/Progesterone | Pereira[40] | Cross-sectional study | PO: 219.26PM: 35.53 | PO: 356.6PM: 355.22 | 0.8650.371 | 4 |
|  | LH | Pasaoglu[41] | Pre-post study | PM: 3.5 mU/mL | PM: 4.9 mU/mL | N/A | 4 |
|  | FSH | Pasaoglu[41] | Pre-post study | PM: 13.3 mIU/mL | PM: 3.3 mIU/mL | N/A | 4 |
| Inflammation | Leucotriene C4  | Nakasato[19] | Pre-post study | PO: 24.0 pg/mLPM: 69.0 pg/mL | PO: NA**1**PM: NA**1** | NA | 4 |
|  | Leucotriene LTC4 | Pereira[52] | Cross-sectional study | PO: 1.5 ng/mLPM: 1.31 | PO: 1.4 ng/mLPM: 1.29 | NS | 4 |
|  | Prostaglandin F2α | Eliasson[53] | Cross-sectional study | Early cycle: 143 pg/0.1 mLLate cycle: 15.9 pg/0.1 mL | 169.3 pg/0.1mL9.5 pg/0.1mL | NS**1**NS**1** | 4 |
| Atopy | Total IgE (geometric mean) | Pereira[47] | Cross-sectional study | 206.31 | 87.99 | 0.01 | 4 |
|  | Total IgE (% > 100kU/L) | Pereira[47] | Cross-sectional study | 84 | 43 | 0.001 | 4 |
|  | Total IgE (mean) | Rao[48] | Cross-sectional study | 208.4 | 292.2 | 0.06 | 4 |
|  | Phadiatop (% +) | Pereira[47] | Cross-sectional study | 68 | 50 | 0.17 | 4 |
|  | Skin prick test + | Rao[48] | Cross-sectional study | 60 (76%) | 297 (88%) | 0.01 | 4 |
| Others | Aspirin sensitivity | Rao[48] | Cross-sectional study | 23 (39%) | 36 (10%) | < 0.0001 | 4 |
|  | Use of aspirin or non-steroidal anti-inflammatory drugs | Forbes[58] | Cross-sectional study | 14/38 (36.8%) | 172/421 (40.9%) | NS | 4 |

# N/A: Not available; PMA: Premenstrual asthma; 1: Oxford Centre for Evidence-based Medicine-Levels of Evidence (March 2009, http://www.cebm.net/oxford-centre-evidence-based-medicine-levels-evidence-march-2009/).Table 2 Specific treatments used in premenstrual asthma

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Group** | **Treatment** | **Ref.** | **Design** | **patients** | **Outcome** | **Results** | ***p*** | **Evidence level\*** |
| Hormonal | Oral or intramuscular progesterone | Beynon[68] | Case-series | 3 | Premenstrual dips in peak flow | 3 eliminated premenstrual dips in peak flow | NS | 4 |
|  | Estrogen | Ensom[25] | Cross-over trial | 12 (mild severity) | Asthma Quality of life questionnaire, FEV1 | No differences | NS | 1b |
|  |  | Ensom[69] | Case report | 1 (severe asthma) | Symptoms, pulmonary function, peak flow. | Improved | N/A | 4 |
|  | OC | Murphy[18] | Case-series | 28 (16 with PMA) | OC use (%)  | 5.42% in Non PMA 6.38% in PMA | NS | 4 |
|  |  | Tan[44] | Cross-sectional study | 18 (9 taking OC) | Changes between follicular and luteal phases in Airway reactivity and Peak Flow | Changes in patients not taking OC; No changes in patients taking OC | 0.03NS | 4 |
|  |  | Derimanov[70] | Case report | 1 | Deterioration of asthma, decline of pulmonary function tests | After discontinuing the contraceptives, her condition returned to baseline. | N/A | 4 |
|  | Gonadotropin analogues | Murray[71] | Case report | 1 | Respiratory symptoms, PEFR dips premenstrual and prednisolone dosage and hospital admissions  | Improvement | N/A | 4 |
| Anti-inflamma-tory | Anti-leukotrienes: pranlukast | Nakasato[19] | Pre-post study | 5 | Respiratory symptoms, PEFR  | Improvedasthma symptom scores,inhibited maximal decreases in PEFR | < 0.05< 0.01 | 4 |
|  | Anti-leukotrienes: montelukast | Pasaoglu[41] | Pre-post study | 24 mild asthma-tics (11 with PMA) | Peak expiratory flow rate (PEFR) and symptomscores  | Improvement in PEFR variability and symptom scoresin women with PMA. No differences in women without PMA | 0.0050.002 | 4 |
|  | Prostaglandin synthesis inhibitors: sodium meclofenomate  | Eliasson[72] | Crossover trial | 17 PMA | Peak flow, symptoms score | Improvement in peak flow during the early premenstrual period. No effect on the exacerbation of asthma during the late premenstrual period and early menstruation. | 0.025NS | 2 |
| Others | Phytoestrogens soy genistein  | Bime[77] | Case series | 300 poorly controlled asthma | (FEV1)) and asthma control | Participants with little or no genistein intake had a lower baseline FEV1 and poorer asthma control than thosewith a moderate or high intake | 0.010.001 | 4 |
|  | Phytoestrogens soy isoflavone | Smith[78] | Clinical trial | 386 poorly controlled asthma | FEV1 at 24 weeks symptoms, episodes of poor asthma control, Asthma control test score | Not result in improved lung function or clinical outcomes | NS | 1b |

# N/A: Not available; NS: Not significant; PEFR: Peak expiratory flow rate; PMA: Premenstrual asthma; OC: Oral contraceptives.