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Dimensionality of the premenstrual syndrome: confirmatory factor analysis of premenstrual dysphoric symptoms among college students

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Abstract

Premenstrual syndrome and premenstrual dysphoric disorder (PMDD) seem to form a severity continuum with no clear-cut boundary. However, since the American Psychiatric Association proposed the research criteria for PMDD in 1994, there has been no agreement about the symptomatic constellation that constitutes this syndrome. The objective of the present study was to establish the core latent structure of PMDD symptoms in a non-clinical sample. Data concerning PMDD symptoms were obtained from 632 regularly menstruating college students (mean age 24.4 years, SD 5.9, range 17 to 49). For the first random half (N = 316), we performed principal component analysis (PCA) and for the remaining half (N = 316), we tested three theory-derived competing models of PMDD by confirmatory factor analysis. PCA allowed us to extract two correlated factors, i.e., dysphoric-somatic and behavioral-impairment factors. The two-dimensional latent model derived from PCA showed the best overall fit among three models tested by confirmatory factor analysis (χ^2_{53} = 64.39, P = 0.13; goodness-of-fit indices = 0.96; adjusted goodness-of-fit indices = 0.95; root mean square residual = 0.05; root mean square error of approximation = 0.03; 90%CI = 0.00 to 0.05; Akaike's information criterion = -41.61). The items "out of control" and "physical symptoms" loaded conspicuously on the first factor and "interpersonal impairment" loaded higher on the second factor. The construct validity for PMDD was accounted for by two highly correlated dimensions. These results support the argument for focusing on the core psychopathological dimension of PMDD in future studies.

Key words
- Premenstrual dysphoric disorder
- Premenstrual syndrome
- Dysphoria
- Factor analysis
- Psychometric properties

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Introduction

Premenstrual dysphoric disorder (PMDD) and premenstrual syndrome (PMS) are considered to be similar premenstrual conditions, although they differ in several respects. However, since the American Psychiatric Association (APA) proposed the research criteria for PMDD in 1994, there has been no agreement about the symptomatic constellation that constitutes this syndrome (1).

According to the DSM-IV (1), PMDD presents a characteristic pattern of symptoms, severity and resulting impairment, i.e., PMDD is regarded as an affective syndrome with social and interpersonal impairment. To meet the diagnosis of PMDD, a woman should present a symptomatic pattern change from the follicular to the luteal phase, with the marked presence of at least one affective symptom (depressive mood, anxiety or tension, affect lability, and anger or irritability) among the 5 symptoms required by the DSM-IV criteria. The change should also include a symptom-free period in the postmenstrual week. Regarded as accessory symptoms, "sense of being out of control" or "sense of being overwhelmed" has been incorporated into the DSM-IV because of its frequency in premenstrual conditions (2). Conversely, interpersonal and social impairment is a criterion of clinical significance that is mandatory for the diagnosis of PMDD. Indeed, there is much uncertainty about the nature of self-reported impairment in PMDD.

A number of scales have been used to rate PMS symptoms and many of them have been validated and examined for their factorial structure (3-7). A review of the literature on PMS revealed wide variability of its construct validity. Demonstrations of its underlying latent structure relied on exploratory factor analysis and researchers identified from 2 to 8 factors to describe its multidimensionality (3,8-11). Only three studies evaluated PMDD according to the APA's criteria (10-12). Indeed, the variability of their scope, symptom items and clinical utility in different settings precludes meaningful comparisons.

The aims of the present study were to investigate the factor structure of PMDD symptoms as derived from DSM-IV criteria by exploratory factor analysis and subsequent cross-validation by confirmatory factor analysis of theoretically sound factor models for PMDD.

Subjects and Methods

Subjects

The original pool of subjects consisted of 865 Brazilian female students from the University of São Paulo in the city of São Paulo, attending courses with a high-female to male student ratio, and mostly from Mathematics, Literature and Language courses. Exclusion criteria were a) women in amenorrhea (non-menstruating, including pregnancy) and b) women with menstrual cycles shorter than 25 days or longer than 35 days, or irregular menstrual cycles. A provisional PMDD diagnosis was not required for an individual to be included in the study, since we were studying the symptomatic profile of premenstrual condition.

The final sample consisted of 632 regularly menstruating women, with a mean age of 24.4 years (SD = 5.9, range 17 to 49 years). We excluded 233 women from the original sample because 217 (25%) had reported irregular menstrual cycles and 16 (1.8%) were non-menstruating. The majority (86%) of women were single, 13% of the respondents were married and the remaining 1% was either separated or a widow. Most students also had a part-time job (73%) and 27% of them only studied. Almost one third of the sample (27%) was using oral contraceptives, and 12.2% had children. There was no refusal to fill out the questionnaire, and 91% of the respondents were blind to the

study intent at the end of assessment.

The whole sample was split into two random halves for statistical purposes. The first half of the data was used for exploratory factor analysis and the second half for confirmatory factor analysis of the cross-validation procedure. The first and second sample halves did not differ significantly in terms of sociodemographic profile, parity or use of oral contraceptives.

Procedures

In the planning phase, we tested a self-reporting questionnaire on 20 female students to evaluate PMDD symptoms in the previous twelve months (11). PMDD symptoms, as extracted from DSM-IV criteria, were listed as 22 separate items. Item 3 was split into affective lability and sensitivity to rejection, item 4 as anger/irritability and interpersonal conflicts, item 10 as being overwhelmed and out of control, and item 11 as breast tenderness, swelling, headache, joint pain, muscle pain, bloating, and weight gain. Criterion B was split into social avoidance and decreased productivity and efficiency. In order to detect changes between the follicular and luteal phases and to avoid symptom overreporting in the premenstrual phase, respondents were asked to mark the absence (0) or presence (1) of each symptom in the menstrual phase in which it occurred. The 22 items were merged as the original 12 items listed in the DSM-IV for statistical analysis.

Blinding procedures were included in the questionnaire. A generic introductory remark explained that the study aimed to evaluate the "physical and emotional changes related to some natural events" so as not to disclose the intention of the study. Questions concerning sociodemographic, gynecological and obstetric information were also included. The Seasonal Pattern Assessment Questionnaire (13) was added to cover up the real research purpose. At the end of the questionnaire, an open question was included to control for respondent blindness. To be considered as having correctly guessed the research intent, students would have to mention "menstruation", "menstrual cycle" and/or "premenstrual" in their answer. Furthermore, to avoid any additional hint about the purpose of the study, questionnaires were applied in evening classes attended by both female and male students. The participants were asked to voluntarily answer a set of questions in their classrooms at the beginning of their regular classes. There was no refusal to fill out the questionnaire, and 91% of the respondents were blind to the study intent at the end of the assessment.

The study was approved by the University of São Paulo Ethics Committee and was conducted in accordance with the Helsinki Declaration of 1975. Written informed consent was obtained from the participants before the study.

Statistical analysis

First, we calculated full-scale internal consistency (Cronbach's α coefficient) as well as item-total correlation. For the random half of the sample (N = 316) we performed principal component analysis (PCA) to explore the factor structure of PMDD. The correlation matrix for the 12 items was computed first, and the data met the Kaiser-Meyer-Olkin's sample adequacy criteria (0.83, minimum acceptable level 0.60), as well as those for Bartlett's test of sphericity ($\chi^2_{66} = 837.74$, $P < 0.0001$) for the appropriateness of using factorial models. Scree plot criteria were used to determine the number of factors to extract. Loadings higher than 0.40 were retained in a factor. Oblique Oblimin rotation was performed to help interpretation. We used SPSS for exploratory factor analysis.

For the remaining half sample (N = 316), we tested the factor structure of three competing hypothetical models. Data of the tetrachoric matrix were analyzed by un-

weighted least square procedure in confirmatory factor analysis (CFA). The following models were tested:

The one latent dimension model, in which all 12 symptoms for PMDD are assumed to reflect one common factor of general distress (model 1).

The second model was based on DSM-IV research criteria for PMDD, whereby two latent dimensions are assumed to depict its factorial structure. The first dimension, called here affective dimension, covered the affective symptoms (depressive mood, affective lability, irritability, tension), and the second behavioral dimension covered sleep, appetite and physical symptoms, as well as out of control and interpersonal impairment symptoms (model 2).

The third model was derived from the PCA model of exploratory factor analysis. For this alternative model, the first factor also covered the "out of control" and physical symptoms in addition to affective symptoms. The second latent dimension included behavioral symptoms and interpersonal impairment (model 3).

Model fitting was evaluated by multi-indicator criteria: χ^2 statistics, goodness-of-fit indices (GFI), adjusted GFI (AGFI), root mean square residual (RMSR), and RMS error of approximation (RMSEA). Akaike's information criterion (AIC) was used to compare the fitness of the three models. The model that yields the smallest value of AIC is considered to be the best compromise between goodness-of-fit and parsimony. CFA was carried out using the SAS PROC CALIS package.

Table 1. Frequency, item-total correlation and internal consistency of premenstrual symptoms in a population of college students (N = 632).

DSM-IV PMDD symptom	Frequency (mean ± SD)	Item-total correlation*
1. Depressive mood	0.43 ± 0.50	0.52
2. Anxiety or tension	0.53 ± 0.50	0.54
3. Anger or irritability	0.54 ± 0.50	0.57
4. Affect lability	0.57 ± 0.50	0.62
5. Decreased interest	0.18 ± 0.39	0.44
6. Concentration difficulties	0.16 ± 0.37	0.40
7. Fatigability	0.17 ± 0.38	0.41
8. Appetite change	0.16 ± 0.37	0.33
9. Hypersomnia/insomnia	0.13 ± 0.33	0.35
10. Sense of out of control	0.25 ± 0.43	0.49
11. Physical symptoms	0.73 ± 0.45	0.40
12. Interpersonal impairment	0.21 ± 0.41	0.44
Cronbach's α coefficient		0.81

Data are reported as means ± SD. *Corrected item-total correlation. PMDD = premenstrual dysphoric disorder.

Table 2. Component pattern matrix after direct Oblimin rotation from principal component analysis of premenstrual dysphoric disorder (PMDD) symptoms in a population of college students (N = 316).

DSM-IV PMDD symptom	Dysphoric-somatic Factor 1	Behavioral-impairment Factor 2	h^2
1. Depressive mood	0.73	0.01	0.54
2. Anxiety or tension	0.84	-0.15	0.63
3. Anger or irritability	0.81	-0.05	0.63
4. Affect lability	0.77	0.06	0.64
5. Decreased interest	-0.04	0.71	0.48
6. Concentration difficulties	-0.04	0.72	0.50
7. Fatigability	0.08	0.63	0.40
8. Appetite change	-0.02	0.54	0.28
9. Hypersomnia/insomnia	0.13	0.42	0.24
10. Sense of out of control	0.59	0.06	0.38
11. Physical symptoms	0.42	0.20	0.28
12. Interpersonal impairment	0.02	0.64	0.42
Eigenvalue	3.74	1.65	5.39
% of variance explained*	31.20%	13.72%	44.92%
Correlation between factors			
Factor 1	1.00		
Factor 2	0.37	1.00	

h^2 = final communality estimates.
*Non-rotated solution.

Results

Reliability

Cronbach's α coefficient was 0.81, indicating good internal consistency and appropriate item homogeneity. The mean, standard deviation and corrected item-total correlation of the 12 PMDD items for 632 college students are presented in Table 1. The item-total correlation showed acceptable coefficients for all variables ($P < 0.05$ and higher), ranging from 0.33 to 0.62. The following items, affect lability (item 4) and anger or

irritability (item 3), yielded the highest correlation coefficient. Physical symptoms (item 11) and affective symptoms (items 1, 2, 3, 4) were the major complaints of respondents (ranging from 43 to 73%). Behavioral symptoms (items 5, 6, 7, 8, 9) and interpersonal impairment (item 12) were the least endorsed items; nevertheless they were significantly correlated ($P < 0.05$) with the underlying construct. Therefore, this indicates their relative specificity for the PMDD construct.

Exploratory factor analysis

We performed PCA with the first half of the sample (N = 316) to explore the factor structure of PMDD symptoms among students. The examination of the eigen value >1.0 criteria allowed up to 3 factors, but the scree plot identified 2 factors to be extracted. For the non-rotated solution, two components accounted for 44.91% of the total variance. After Oblimin rotation, all items showed salient standardized regression coefficients for one of the two retained factors (Table 2).

The first factor explained 31.2% of data variance and the second 13.72%. The pattern matrix presented a structure that can be interpreted as a dysphoric-somatic dimension and a behavioral-impairment dimension. The correlation between the two factors was 0.37. Large factor loadings could be observed across all PMDD items, except for hypersomnia/insomnia and physical symptoms (both at 0.42). Inspection of communality estimates (h^2) revealed a lower value (<0.30) for appetite change, hypersomnia/insomnia and physical symptoms. The items "sense of out of control" and "physical symptoms" loaded high on the first component, and the item "interpersonal impairment" loaded higher on the second component.

Confirmatory factor analysis

CFA was performed using the data set for the second half of the sample (N = 316) to compare the fitness of the present model derived from exploratory factor analysis for the first half of the sample and two plausible models (unidimensional and DSM-IV model). The model fit statistics for the three competing models is presented in Table 3.

All three models tested yielded excellent goodness-of-fit indices (GFI, AGFI, RMSR, and RMSEA). Results revealed the best fit for model 3, derived from the PCA of the first half sample, which achieved the only non-significant χ^2 value ($\chi^2_{53} = 64.39$, $P = 0.13$), confirming the null hypothesis (H_o) for model 3. The superiority of model 3 was

Table 3. Fit indices of three models tested on the second half of the sample (N = 316).

Model	χ^2	P	GFI	AGFI	RMSR	RMSEA	AIC
1	104.93	<0.0001	0.94	0.92	0.08	0.05	-3.06
2	87.87	0.0018	0.95	0.93	0.07	0.05	-18.12
3	64.39	0.135	0.96	0.95	0.05	0.03	-41.61

Model 1 = one-factor: general distress items: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. Model 2 = two-factor: affect items: 1, 2, 3, 4; behavioral items: 5, 6, 7, 8, 9, 10, 11, 12. Model 3 = two-factor: affect-somatic items: 1, 2, 3, 4, 10, 11; behavioral-impairment items: 5, 6, 7, 8, 9, 12. GFI = goodness-of-fit indices; AGFI = adjusted GFI: RMSR = root mean square residual; RMSEA = RMS error of approximation; AIC = Akaike's information criterion.

Table 4. Parameter estimates from the results of confirmatory factor analysis of premenstrual dysphoric disorder (PMDD) symptoms in a population of college students (N = 316), alternative two-dimensional model 3.

DSM-IV PMDD symptom	Dysphoric-somatic Factor 1	Behavioral-impairment Factor 2
1. Depressive mood	0.65	
2. Anxiety or tension	0.67	
3. Anger or irritability	0.71	
4. Affect lability	0.75	
5. Decreased interest		0.68
6. Concentration difficulties		0.57
7. Fatigability		0.55
8. Appetite change		0.44
9. Hypersomnia/insomnia		0.45
10. Sense of out of control	0.60	
11. Physical symptoms	0.46	
12. Interpersonal impairment		0.65
Correlation between factors		
Factor 1	1.00	
Factor 2	0.66	1.00

also supported by the highest GFI and AGFI values (0.96 and 0.95, respectively), the lowest RMSR and RMSEA values (0.05 and 0.03, respectively, with 90%CI = 0.00 to 0.05), and the lowest AIC value (-41.61).

Table 4 presents parameter estimates of the relationship between the dysphoric-somatic and behavioral-impairment factor for model 3. Large factor loadings can be observed across all PMDD items, except for appetite change (0.44), hypersomnia/insomnia (0.45), and physical symptoms (0.46). The correlation between the two factors was strong at the 0.66 level.

Discussion

Reliability analysis revealed good homogeneity and internal consistency for the PMDD scale. Affect lability and anger or irritability were the items most correlated with the construct of PMDD. Conversely, appetite change and sleep disturbance had the weakest item-total correlation, as these items are also nonspecific markers of some mental disorders. Physical symptoms (item 11) and affective symptoms (items 1, 2, 3, 4) were the major complaints of respondents. These two sets of symptoms are regarded as the most stable ones across PMS cycles (14).

Until this point, there was no consistent confirmation of the factorial structure of PMS. Previous studies have reported 2 to 8 dimensions for PMS. The number of identified factors can be attributed primarily to sampling and measure differences across studies rather than true differences in symptomatic manifestations themselves (14-17). This discrepancy of results may be attributed to methodological differences such as use of different scales to record premenstrual symptoms, recruitment method, retrospective *vs* prospective design, and technical difference in the distinct factor analytic methods employed.

The PCA results suggest that our questionnaire assesses two symptom clusters, and that most of the explained variance was due to a common dysphoric-somatic factor (31.2%) rather than to a behavioral-impairment factor. The highest factor loadings (>0.70) of the dysphoric-somatic dimension were found for the items anxiety or tension, anger or irritability, affect lability, and depressive mood. Interestingly, two secondary symptoms for the diagnosis of PMDD in DSM-IV - sense of out of control and physical symptoms - also loaded significantly on the first factor, together with emotional symptoms. This may suggest that both affective symptoms and physical distress could result from the same endocrine change or physiological pathway in PMDD (16). Irrespective of the presence of depressed mood, previous studies (17) have regarded some correlated symptoms, such as anger, irritability, tension, and nervousness, as the core elements of PMS. Disregarding the sample's cultural background, PMDD could be viewed as a distinct diagnostic entity, with irritability and affect lability rather than depressed mood and anxiety being its most characteristic features (6).

Behavioral symptoms and interpersonal impairment loaded higher on the second dimension, and explained 13.7% of data variance. Although self-reported social and interpersonal relationship impairment is mandatory for the diagnosis of PMDD in the DSM-IV system, this item loaded conspicuously on the secondary factor. In agreement with this suggested structure, Bloch et al. (14) have demonstrated that dysphoric mood is strongly associated with functional impairment, so that the latter symptom should be viewed as correlated to the former. The majority of PMS sufferers will report low subjective distress (17), while pure PMDD sufferers will complain of dysphoric mood and severe functional impairment.

Neglected in previous validity studies of PMS, the dysphoric-somatic and behavioral-impairment dimension seemed to be correlated. The vast majority of factor analytic

studies on this topic have assumed an independent relationship between postulated multidimensional constructs, performing orthogonal rotation without testing an alternative oblique solution that may better describe their relationship. Our PCA yielded a substantial correlation of 0.37 after oblique rotation. In a previous study, we also tested the orthogonal structure of the PMDD construct, which yielded a similar factor loading distribution (11). Indeed, some researchers have claimed that the oblique structure should always be tested because it might be closer to the observed population's latent structure. Only four studies have tested the oblique structure for PMS (4,5,8,15).

While the PCA identifies possible factors that account for co-variation among items, this technique may only give a very rough idea of the true underlying dimensions in the population. On the other hand, CFA is a robust multivariate method and has the advantage of allowing a structural comparison between theoretically sound competing models.

The results of our CFA indicated that model 3, a two-factor model derived from exploratory factor analysis, produced an excellent fit to the data on several indicators. In other words, model 3 produced an estimated co-variance matrix very close to the observed co-variance matrix for this selected population. Statistically speaking, all three models tested displayed pretty good results, with close goodness-of-fit indices. Model 1 (unidimensional) and model 2 (DSM-IV model) also yielded acceptable fit to the data, but the χ^2 difference and AIC revealed that model 3 had a better overall fit. This means that all tested models may be representative of the observed symptom co-variance structure in this population, but model 3 should be viewed as more plausible among them. Previous structural exploratory studies (9,12,18), which described a similar two-dimensional structure for PMS and late luteal premenstrual dysphoric disorder, agree with our findings.

Although cultural variability in the factor structure of PMS could be expected, well-conducted factor analysis was used to replicate a similar structure. Probably, different factor structures found in previous studies on North-American (5,6,10,15,18), Asian (19), European (12,20), and Australian populations (9) were due to technical differences in sample collection and statistical approach (17). The premenstrual symptom structure in culturally diverse samples may be slightly different, but the findings in the present Brazilian sample are consistent with some previous factor analytic studies reported in the literature. de la Gándara-Martin and de Diego-Herrero (12) extracted two meaningful common factors for a stratified community sample in Spain (N = 225), with a retrospective questionnaire based on the DSM-III-R criteria for late luteal premenstrual dysphoric disorder. The authors concluded that dysphoria (43.5% variance explanation) represented the first general factor and physical exhaustion (11%) was a secondary factor. Focusing on PMS and using different symptom scales, Condon (9) and York et al. (18), in studies on the US and Australian populations, respectively, also extracted 2 factors in their exploratory factor analysis. They described a first strong emotional-dysphoric factor and a second behavioral-physical symptom factor. Different from DSM-IV criteria, the data analysis of the present Latin-American sample indicated that physical symptoms loaded higher on the first common factor together with dysphoric symptoms. This indicates that complaints of physical symptoms may be more important for premenstrual Brazilian women.

An important finding of our CFA, however, was that dysphoric-somatic and behavioral-impairment latent factors were highly related (correlation = 0.66). Consistent with clinical experience, this is an elegant demonstration that within the dimensions of the PMDD construct there is probably no strong

line to be drawn (17,21,22). Previous investigations have attempted to subtype PMS in terms of spasmodic and congestive dysmenorrhea (3,23). Searching for core psychological dimensions of PMDD may prove more fruitful than searching for differences between PMDD subtypes.

The dimensional construct of the present PMDD model has uncovered the relative importance of each symptom for its clinical picture. In addition, using structural equation modeling or dimensional models offers considerable methodological and analytical advantages in the analysis of the core psychopathological structure of PMDD since it is no longer necessary to resort to common but problematic research strategies like analyzing specific samples (e.g., analyzing "pure PMDD cases", low prevalence disorders in the community) to avoid confounding, or disregarding, comorbidity when analyzing particular disorders. Future research may greatly benefit from using such a dimensional approach, where PMS and PMDD might be regarded as distinct endpoints of the same premenstrual condition continuum with no clear-cut boundary.

The methodological limitations of the present results should be pointed out. First, our data were collected from a retrospective self-reporting questionnaire, which could only detect provisional cases of PMDD. A very time-consuming prospective study of a large sample is warranted (6,8,24). Second, we did not recruit the subjects by a random sampling method from the community and our sample was representative of regularly menstruating women. Last, whether our questionnaire can detect PMDD in the general population is yet to be confirmed. Considering that our questionnaire has been developed to agree with DSM-IV's criteria, once its validity (sensitivity, specificity, misclassification rate) as a screening instrument is established, this kind of retrospective instrument will be a useful tool for the detection of PMDD in a variety of situations (22).

In the present study, we examined the core factor structure of DSM-IV PMDD symptoms in a non-clinical student sample in Brazil and sought to establish the model that provided the best fit for the diagnostic category of PMDD. This is a demonstration of the construct validity of the alternative two-factor model derived from PCA. The construct validity of PMDD may be represented by two highly interrelated common factors. The confirmatory factor analytic cross-validation revealed a broad dimension of dysphoric-somatic symptoms, in which the symptom "sense of out of control" was included, and a secondary behavioral-impairment latent factor, on which interpersonal impairment loaded high. Replication studies with more inclusive sampling would be necessary to strengthen the results of the present hypothesis testing in a CFA study of non-clinical women, and to indicate the necessity to further revise the diagnostic criteria of PMDD.

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