



# Influence of Childhood Maltreatment, Adulthood Stressful Life Events, and Affective Temperaments on Premenstrual Mental Symptoms of Nonclinical Adult Volunteers

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**Background:** Previous studies have shown that childhood maltreatment is associated with premenstrual dysphoric disorder (PMDD). In this study we analyzed how multiple factors, such as childhood maltreatment, affective temperaments, and adult life events influence the severity of premenstrual mental (PMM) symptoms in nonclinical adult volunteers from the community.

**Methods:** A total of 204 participants were recruited and administered the following self-administered questionnaire surveys: PMDD scale, visual analogue scale, Patient Health Questionnaire-9, Life Experience Survey, Temperament Evaluation of Memphis, Pisa, Paris, and San Diego autoquestionnaire version, and the Child Abuse and Trauma scale. In addition to single and multiple regression analyses, structural equation modeling was used for the statistical analyses.

**Results:** A history of neglect indirectly predicted PMM symptoms through affective temperaments in nonclinical adult volunteers. Three affective temperaments (irritable, cyclothymic, and anxious) directly predicted PMM symptoms.

**Conclusion:** This study is the first to report that childhood maltreatment, particularly neglect, indirectly predicted PMM symptoms through affective temperaments. The results of our study suggest that affective temperament is a mediator of the influence of childhood maltreatment on PMM symptoms.

**Keywords:** premenstrual mental symptoms, neglect, childhood maltreatment, affective temperament, TEMPS-A, structural equation modeling

## Introduction

Premenstrual syndrome (PMS) is common in women during their reproductive years. Premenstrual dysphoric disorder (PMDD), which affects 2–9% of women,<sup>1</sup> is considered to be the most severe form of PMS. Menstruation-associated symptoms can affect a woman's life negatively and have a profound effect on productivity. PMDD increases work absenteeism, and reduces work productivity<sup>2</sup> and quality of life.<sup>3</sup> With the promotion of the social advancement of women, PMDD has drawn further attention. PMDD is characterized by affective and physical symptoms similar to major depressive disorder (MDD), which occur during the last week of the luteal phase of the menstrual cycle and resolve soon after the onset of menstruation. These symptoms include irritability/anger, depression, sadness,

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mood swings, anxiety, tension, fatigue, difficulty concentrating, decreasing interest, overeating, hypersomnia/insomnia, and feeling “out of control.” Distress and/or impairment is present in the areas of work, school, social activities, or relationships with others. PMDD is considered to be a disease showing atypical depressive symptoms before menstruation. It is categorized as a separate diagnostic entity of “depressive disorders” in the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5).<sup>4</sup>

Two major types of environmental factors, i.e., early life stress and adult stressful life events, are risk factors for depressive symptoms or MDDs.<sup>5–9</sup> In particular, childhood maltreatment worsens the course of MDD and treatment response during depressive episodes.<sup>10</sup> Similarly, childhood maltreatment increases the risk of PMS and PMDD.<sup>11–14</sup>

In our previous study using structural equation modeling (SEM), we reported that affective temperaments evaluated by the Temperament Evaluation of Memphis, Pisa, Paris, and San Diego auto-questionnaire version (TEMPS-A)<sup>15</sup> are strong mediators for the effect of childhood maltreatment on depressive symptoms of nonclinical adult volunteers.<sup>16</sup> Affective temperaments are also mediators between childhood maltreatment and well-being in nonclinical adult volunteers.<sup>17</sup> Moreover, there are positive and negative interactions between childhood maltreatment, affective temperaments, and life events in adulthood on depressive symptoms of nonclinical adult volunteers.<sup>18</sup> These results suggest that affective temperament is a mediator and moderator for childhood maltreatment and depressive symptoms in nonclinical adult volunteers.

PMDD is expected to share common pathologies with depression. To our knowledge, there are no studies that have analyzed the association between premenstrual mental (PMM) symptoms, affective temperaments, childhood maltreatment, and adult life events using SEM. Therefore, in this study we investigated how affective temperaments, childhood maltreatment, and adult stressful life events influence the severity of PMM symptoms in nonclinical adult volunteers from the community using SEM and multiple regression analysis.

## Subjects and Methods

### Subjects

This research was part of a larger study, part of which has been reported,<sup>17</sup> which was conducted between January 2014

and January 2015 on 1020 Japanese adult volunteers from the community. A total of 204 subjects participated in the present study and provided responses to the questionnaires. The inclusion criteria were as follows: a) female, b) 20–45-years old, and c) menstruating (excluding pregnancy or menopause). Finally, 204 female subjects, who provided complete responses, were analyzed. Six questionnaires and a questionnaire on demographic data (age, years of education, employment status, marital status, presence of offspring, past history of psychiatric diseases, presence of physical and gynecological diseases, age of menarche, regularity of menstrual cycle) were distributed. The questionnaires were returned anonymously to researchers by mail. All of the subjects gave us written informed consent. This study was approved by the ethics committees of Hokkaido University Hospital (study approval no. 013–0184) and Tokyo Medical University (study approval no. T2018-0080), and was performed in accordance with the Declaration of Helsinki.

### Questionnaires

Miyaoka et al<sup>19</sup> developed the PMDD scale, which was based on *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) and was modified from the premenstrual symptoms screening tool developed by Steiner et al<sup>20</sup> Women check the severity of their symptoms during the past year retrospectively on a 4-point Likert scale from 1 to 4 (1 = none, 2 = mild, 3 = moderate, 4 = severe). The PMDD scale is divided into 2 parts, section A consists of 12 PMDD symptoms, which we refer to as “PMM symptoms” in this study. If the subject answers “yes”, i.e., 2–4 points, for at least 1 symptom, she is required to answer section B, which consists of 5 items regarding menstruation-associated disruption of activities or relationships. For statistical analyses, we used summary scores of sections A and B, which were sums of the scores of all items in each section. Following the method of the PMDD scale, the following other tests were performed regardless of the timing of testing in relation to menstruation, as the timing was confirmed to not affect the results (data not shown).

The Visual Analogue Scale (VAS) is a self-completed questionnaire that asks subjects to indicate the severity of 11 PMDD symptoms of DSM-5 criteria<sup>4</sup> on a 100-mm line (depression/hopelessness, anxiety/tension, affective lability, irritability/anger, decreased interest, difficulty concentrating, fatigability/lack of energy, change in appetite/specific food cravings, hypersomnia/insomnia, feeling “out of control”,

and physical symptoms) of at 2 timepoints, in the presence of the most severe symptoms during the week before and after their menstrual period. For statistical analyses, percentage changes in the average VAS scores of 11 items from the week after to the week before the menstrual period were used.

The Japanese version of Patient Health Questionnaire-9 (PHQ-9) is a self-administered questionnaire to assess the severity of depressive symptoms.<sup>21,22</sup> This study used a summary score of a total of 9 items, which evaluates the severity of depressive symptoms.

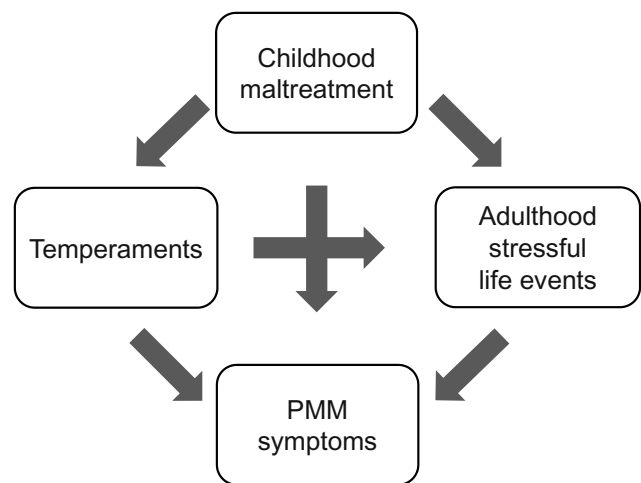
The Japanese version of the Life Experiences Survey (LES), a self-reported questionnaire, was used to evaluate the impact of life events during the past year.<sup>16,23</sup> Subjects evaluate the positive or negative perceived impact of the events at the time of occurrence. Using a 7-point scale (extremely negative [-3] to extremely positive [+3]), a positive-change score and negative-change score are calculated by summing the impact ratings of positive and negative impacts, respectively.

The Japanese version of TEMPS-A is a self-administered questionnaire (true = 2, false = 1; 109 items for men and 110 for women), measuring the 5 temperament subscales, i.e., cyclothymic, depressive, irritable, anxious, and hyperthymic.<sup>15,24</sup>

The Child Abuse and Trauma Scale (CATS), a 38-item self-rating questionnaire,<sup>25</sup> asks participants to rate how frequently a particular abusive experience occurred to them during their childhood and adolescence, using a scale of 0–4 (0 = never; 4 = always). The CATS consists of 3 subscales—neglect/negative home atmosphere, punishment, and sexual abuse. The average score of each subscale was used for the statistical analysis. This study used the Japanese version of the CATS.<sup>26</sup>

## Data Analysis

A structural equation model (SEM) was designed based on the hypothesis shown in Figure 1. In this model, PMM symptoms are predicted by childhood maltreatment, affective temperaments, and adult stressful life events. The latent variable “TEMPS-A” was composed of 3 observed variables (cyclothymic, anxious, and irritable temperaments). We conducted SEM analysis with the maximum likelihood estimation by Mplus version 7.4 (Muthén & Muthén, Los Angeles, CA, USA). Direct and indirect effects among all of the variables and their statistical significance were obtained. The comparative fit index (CFI), the Tucker-Lewis Index (TLI), and root mean square error of approximation (RMSEA) were used for



**Figure 1** A structural equation model of our hypothesis in this study. In this model, childhood maltreatment affects PMM symptoms directly and indirectly through temperaments and adulthood stressful life events, and the temperaments affect PMM symptoms and adulthood stressful life events.

the evaluation of the model fit. A CFI > 0.95, a TLI > 0.95, and an RMSEA < 0.08 indicated an acceptable fit; and a CFI > 0.97, a TLI > 0.97, and an RMSEA < 0.05 indicated a good fit.<sup>27</sup> The standardized coefficients (with a maximum of +1 and a minimum of -1) were shown for the SEM.

The Wilcoxon rank sum test was used for the comparison of the summary scores of PMDD scale section A between the 2 categories of demographic characteristics. Spearman rank correlation coefficients and multiple regression analysis were used to analyze the correlation between variables.

R 3.2.3 software (The R Foundation for Statistical Computing, Vienna, Austria) was used for multiple regression analysis and the Wilcoxon rank sum test, and to calculate the Spearman rank correlation coefficient.

In this study, we aimed to analyze the effects of multiple variables on PMM symptoms of the PMDD scale by multivariate analysis. Because 20 factors were considered to be independent variables, 200 subjects were required for the analysis.

A *p*-value of less than 0.05 was considered to indicate a statistically significant difference between 2 groups.

## Results

### Characteristics of the Subjects

Demographic characteristics, PMDD scale, PHQ-9, CATS, TEMPS, and LES scores of the 204 subjects are shown in Table 1. Age, summary scores of section B and section A+B on the PMDD scale, percentage change score of total

**Table 1** Characteristics of the Subjects in This Study

Characteristics or Measures		Value (Number or Mean $\pm$ SD)	Correlation with PMDD Scale (Section A) ( $\rho$ ) or Effect on PMDD Scale (Section A) (Mean $\pm$ SD, Wilcoxon Rank Sum Test)
Age (years)		32.4 $\pm$ 6.8	$\rho = -0.15^*$
Years of education		14.9 $\pm$ 1.7	$\rho = 0.021$
Employment status (Employed: Homemaker)		174: 30	Employed (22.3 $\pm$ 7.7) vs Homemaker: (23.1 $\pm$ 7.3), n.s.
Marital status (Married: Unmarried)		91: 113	Married (21.2 $\pm$ 6.4) vs Unmarried (23.4 $\pm$ 8.4), n.s.
Presence of offspring (Yes: No)		73: 131	Yes (21.0 $\pm$ 6.3) vs No (23.2 $\pm$ 8.2), n.s.
Past history of psychiatric disease (Yes: No)		16: 188	Yes (23.2 $\pm$ 7.9) vs No (22.3 $\pm$ 7.6), n.s.
Comorbidity of physical disease (Yes: No)		24: 180	Yes (23.6 $\pm$ 7.9) vs No (22.3 $\pm$ 7.5), n.s.
Comorbidity of gynecological disease (Yes: No)		14: 190	Yes (24.9 $\pm$ 9.7) vs No (23.2 $\pm$ 8.2), n.s.
Age of first menstruation		12.4 $\pm$ 5.5	$\rho = 0.04$ , n.s.
Regular menstrual period (Yes: No)		152: 52	Yes (21.9 $\pm$ 7.7) vs No (23.9 $\pm$ 6.3), n.s.
PMDD scale	Section A+B	29.2 $\pm$ 9.5	$\rho = 0.98^{**}$
	Section A	22.4 $\pm$ 7.7	
	Section B	6.8 $\pm$ 2.6	$\rho = 0.63^{**}$
Average percentage change scores of 11 items of VAS		313 $\pm$ 445	$\rho = 0.38^{**}$
PHQ-9 score		4.6 $\pm$ 5.0	$\rho = 0.46^{**}$
CATS (average score)	Neglect	0.72 $\pm$ 0.64	$\rho = 0.39^{**}$
	Punishment	1.48 $\pm$ 0.63	$\rho = 0.10$ , n.s.
	Sexual abuse	0.06 $\pm$ 0.23	$\rho = 0.14^*$
TEMPS-A (average score)	Depressive	1.38 $\pm$ 0.16	$\rho = 0.27^{**}$
	Cyclothymic	1.24 $\pm$ 0.20	$\rho = 0.39^{**}$
	Hyperthymic	1.23 $\pm$ 0.17	$\rho = -0.07$ , n.s.
	Anxious	1.23 $\pm$ 0.20	$\rho = 0.39^{**}$
	Irritable	1.16 $\pm$ 0.16	$\rho = 0.37^{**}$
LES (change score)	Negative	1.05 $\pm$ 2.76	$\rho = 0.17^*$
	Positive	0.84 $\pm$ 2.02	$\rho = 0.12$ , n.s.

**Notes:** Data are presented as means  $\pm$  SD or numbers.  $\rho$  = Spearman rank correlation coefficient.  $^*p < 0.05$ ,  $^{**}p < 0.001$ , n.s.: not significant.

VAS scores, neglect and sexual abuse scores on the CATS, depressive, cyclothymic, anxious, and irritable temperament scores on the TEMPS-A, and the negative change score of LES significantly correlated with the summary

scores of PMDD scale section A. Raw data of the VAS scores of 11 items are shown in [Supplementary Table 1](#). In this study, none of the participants were interviewed by psychiatrists. However, based on the diagnostic

algorithmic threshold of the “PMDD scale” for the screening of PMDD proposed by Miyaoka et al (2009),<sup>19</sup> 10 subjects (4.9%) were estimated to have PMDD. This value is similar to the 5.9% reported by Miyaoka et al (2009), who screened 327 women having menstruation aged between 20 and 45 years.

## Stepwise Multiple Regression Analysis of Summary Scores of PMDD Scale Section A

Table 2 shows the results of stepwise multiple regression analysis, in which the summary score of PMDD scale section A was the dependent factor, and the following were 20 independent factors: age, years of education, employment status (employed = 1, homemaker = 0), marital status (married = 1, unmarried = 0), presence of offspring (yes = 1, no = 0), past history of psychiatric disease (yes = 1, no = 0), past history of physical disease (yes = 1, no = 0), comorbidity of gynecological disease (yes = 1, no = 0), age of first menstruation, regularity of menstrual period (regular = 1, irregular = 0), average scores of CATS (neglect, sexual abuse, and punishment), average scores of TEMPS-A subscales (depressive, cyclothymic, hyperthymic, anxious, and irritable temperament), and positive and negative change scores of LES. PHQ-9 and VAS were not included in the stepwise multiple regression analysis because these measures of depressive symptoms are similar to the summary score of PMDD scale section A. In stepwise multiple regression analysis, age, cyclothymic and anxious scores on the TEMPS-A, and a negative change score on the LES were significant predictors of a summary score of PMDD scale section A ( $p < 0.001$ ,

**Table 2** Results of Stepwise Multiple Regression Analysis of Summary Scores of PMDD Scale Section A

Positive Variables Selected	Beta	t-value	p-value
Anxious score of TEMPS-A	0.28	3.75	< 0.001
Cyclothymic score of TEMPS-A	0.22	2.93	0.004
Negative change score of LES	0.17	2.72	0.007
Age	-0.13	-2.11	0.036
Adjusted $R^2 = 0.27$			< 0.001

**Notes:** Beta, standardized partial regression coefficient. Dependent factor: summary score of PMDD scale section A (PMM symptoms). Independent factors: age, years of education, employment status (employed = 1, homemaker = 0), marital status (married = 1, unmarried = 0), presence of offspring (yes = 1, no = 0), past history of psychiatric disease (yes = 1, no = 0), comorbidity of physical disease (yes = 1, no = 0), comorbidity of gynecological disease (yes = 1, no = 0), age of first menstruation, regularity of menstrual period (regular = 1, irregular = 0), neglect, sexual abuse and punishment scores on CATS, depressive, cyclothymic, hyperthymic, anxious, and irritable temperament scores on TEMPS-A, and positive and negative change scores of LES.

adjusted  $R^2 = 0.27$ ). Multicollinearity was denied in this multiple regression analysis.

## Correlation Between CATS Subscale Scores and Temperament Scores on the TEMPS-A

Scores of 4 temperaments, excluding the hyperthymic temperament score, had moderate positive correlations with neglect score, and weak positive correlations with punishment score (Table 3). The sexual abuse score was weakly positively correlated with scores of depressive, anxious, and irritable temperaments.

## Analysis of SEM Data

To analyze the association between the scores of CATS, TEMPS-A, LES, and the summary scores of PMDD scale section A, a structural equation model was built from the results of single and multiple regression analyses (Figure 2). The standardized direct path coefficients are shown in Figure 2.

A good fit of the model was obtained as follows: RMSEA = 0.037, CFI = 0.993, and TLI = 0.982. The standardized path coefficients with solid lines in Figure 2 were significant ( $p < 0.001-0.05$ ). Three temperament scores (cyclothymic, anxious, and irritable) on the TEMPS-A and the negative change score on the LES were significant predictors for the severity of PMM symptoms. The effect of the neglect subscale of CATS on summary score of PMDD scale section A was indirect and mediated by 3 temperament scores on the TEMPS-A (indirect standardized path coefficient = 0.337,  $p < 0.001$ ). The effects of the sexual abuse subscale score of CATS on the negative change score on the LES and the effects of the negative change score on the LES on the summary score of PMDD scale section A were significant, but the indirect and direct effects of the sexual abuse subscale score of the CATS on the summary score of PMDD scale section A were not significant (indirect standardized path coefficient = 0.026,  $p = 0.09$ ).

Hyperthymic temperament was not included in the latent variable “TEMPS-A”, as it did not correlate with the summary score of PMDD scale section A (Table 1) or with any subscale of the CATS (Table 3). In another model that added depressive temperament to the latent variable “TEMPS-A”, the fit indices were not satisfactory.

## Discussion

This is the first study to our knowledge showing that a history of neglect indirectly, but not directly, predicts the severity of



**Table 3** Correlation ( $\rho$ ) Between CATS Subscales and Temperament Scores of TEMPS-A

	Neg	Pun	Sex	Dep	Cyc	Hyp	Anx	Irr
Neg	1.00	0.35**	0.19**	0.53**	0.49**	0.02	0.52**	0.54**
Pun		1.00	0.09	0.26**	0.23**	0.10	0.24**	0.22**
Sex			1.00	0.14*	0.11	0.07	0.14*	0.18*
Dep				1.00	0.47**	-0.09	0.56**	0.42**
Cyc					1.00	0.22**	0.56**	0.69**
Hyp						1.00	-0.00	0.13
Anx							1.00	0.59**
Irr								1.00

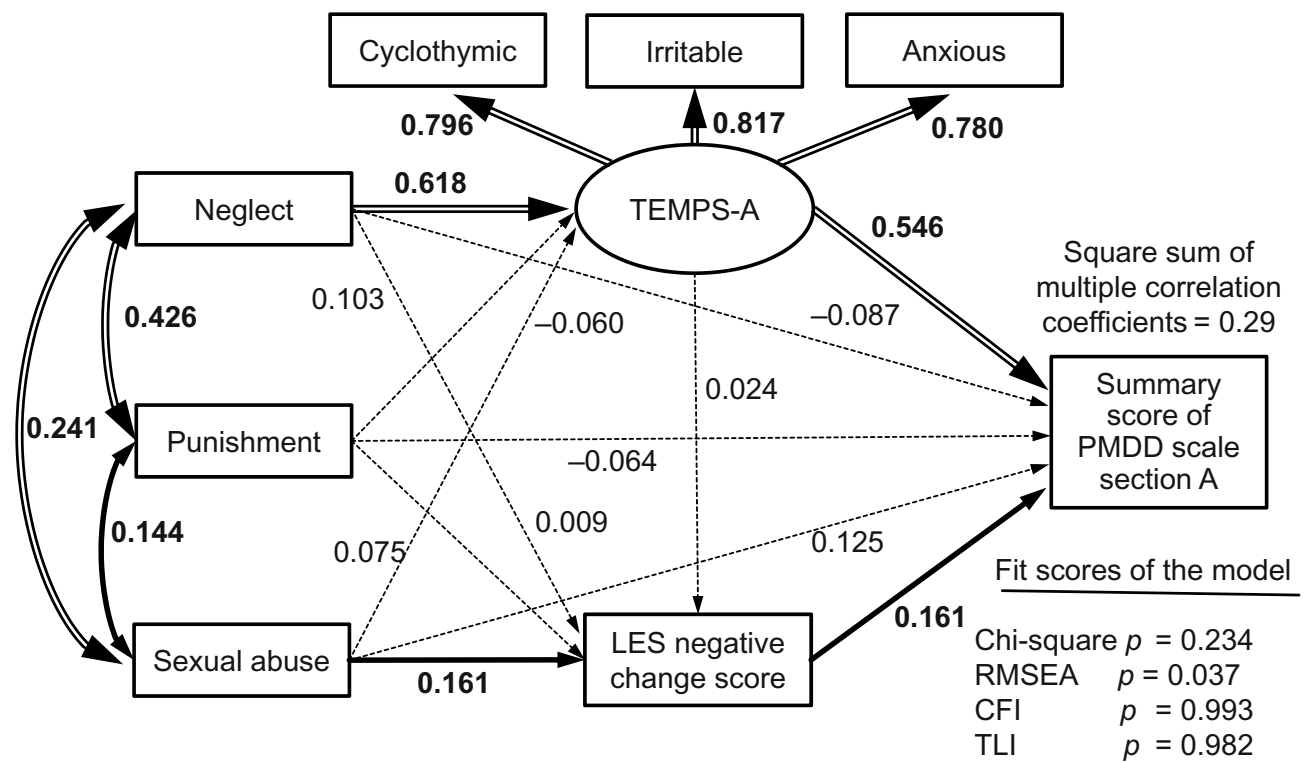
Notes:  $\rho$  = Spearman rank correlation coefficient, \* $p < 0.05$ , \*\* $p < 0.01$ .

Abbreviations: Neg, neglect subscale; Sex, sexual abuse subscale; Pun, punishment subscale; Dep, depressive temperament; Cyc, cyclothymic temperament; Hyp, hyperthymic temperament; Anx, anxious temperament; Irr, irritable temperament.

PMM symptoms of nonclinical adult volunteers. Furthermore, the effect was mediated by affective temperaments on TEMPS-A in a SEM. Cyclothymic, irritable, and anxious temperaments directly predicted the severity of PMM symptoms, and the negative change score of the LES

mildly, but significantly, predicted the severity of PMM symptoms.

The first concern of these results is the impact of childhood maltreatment on PMM symptoms. In this study, neglect and sexual abuse on the CATS were



**Figure 2** Results of covariance structure analysis of the SEM. Childhood maltreatment (CATS), affective temperament (TEMPS-A), adult stressful life events (LES), and severity of PMM symptoms (summary score of PMDD scale section A) of 204 nonclinical adult volunteers were analyzed. Rectangles indicate the observed variables and the latent variable is shown as an oval. The arrows with solid lines represent statistically significant paths (single solid lines:  $p < 0.05$ , double solid lines:  $p < 0.001$ ), and the broken lines show nonsignificant paths. The numbers beside the arrows show the standardized coefficients (minimum: -1, maximum: 1).

significantly and positively correlated with the severity of PMM symptoms in nonclinical adult volunteers upon single regression analyses. However, in multiple regression analysis, none of the scores of the childhood abuse subscales predicted the severity of PMM symptoms. On the other hand, in the SEM of this study, a neglect score on the CATS indirectly predicted the severity of PMM symptoms, although a direct effect was not significant. This result is consistent with the hypothesis of previous studies that childhood maltreatment is associated with the etiology of PMDD.<sup>11,13</sup> Soydas et al reported that patients with PMDD had higher total Childhood Trauma Questionnaire scores as well as higher scores of emotional abuse/emotional neglect, physical abuse, and sexual abuse than healthy controls.<sup>13</sup> Bertone-Johnson et al suggested that childhood maltreatment, particularly emotional abuse and physical abuse, increases the risk of moderate-to-severe PMS.<sup>11</sup> It is unclear why only neglect was associated with PMM symptoms in our present study, but these findings are consistent with our previous studies on nonclinical depressive symptoms and major depression. In our previous studies on the nonclinical general adult population<sup>16</sup> and MDD patients,<sup>28</sup> only a neglect score on the CATS significantly predicted the severity of depressive symptoms and MDD diagnosis on multiple regression analysis and multiple logistic regression analysis, respectively. The results of recent meta-analysis suggested that psychological abuse and neglect, as well as physical abuse, were strongly associated with the outcome of depression, and sexual abuse was less strongly associated.<sup>29</sup> These findings highlight the potential impact of the more “silent” types of childhood maltreatment (other than physical and sexual abuse) on the development of depression.

The second concern is the association between childhood maltreatment and affective temperaments. In our previous studies of a nonclinical general adult population<sup>16</sup> and MDD patients,<sup>28</sup> neglect score, but not punishment or sexual abuse scores on the CATS was a significant predictor of depressive, cyclothymic, irritable, and anxious temperaments on multiple regression analyses. On the other hand, hyperthymic temperament was not significantly correlated with any subscale of childhood maltreatment in these studies.<sup>16,28</sup> Pompili et al reported that psychiatric inpatients with a history of childhood maltreatment had a higher incidence of irritable temperament traits than nonabused patients.<sup>30</sup> Consistent with previous studies, our present study showed an association between childhood maltreatment and depressive,

cyclothymic, irritable, and anxious temperaments on univariate analyses.

Regarding the association between affective temperaments and PMM symptoms, to our knowledge, there has been only 1 study that noted an association between cyclothymic temperament, but not other affective temperaments, on the Affective and Emotional Composite Temperament Scale and PMDD screened by a questionnaire.<sup>31</sup> Partly consistent with their study, in the multiple regression analysis of the present study, cyclothymic and anxious temperaments on the TEMPS-A were significant predictors for high scores of PMM symptoms. Depressive, cyclothymic, irritable, and anxious temperaments significantly and positively correlated with PMM symptoms in single regression analyses whereas hyperthymic temperament did not. Similar findings of depressive symptoms have been reported in nonclinical subjects and patients with MDD in earlier studies.<sup>16,28,32</sup> Rovai et al noted that hyperthymic temperament, which is considered the most functional and desirable of the temperaments, is different from cyclothymic, depressive, irritable, and anxious temperaments, which are closer to mood, anxiety, and substance use disorders, and are associated with difficulty in emotional and behavioral adaptation to somatic diseases and life stressors.<sup>33</sup> An epidemiological study in Lebanon reported that hyperthymic temperament has a uniquely protective effect on most mental disorders.<sup>34</sup> Our previous study also suggested that hyperthymic temperament, in contrast to cyclothymic, irritable, and anxious temperaments, improves positive and negative affects and interpersonal sensitivity.<sup>17,35</sup> Taken together, cyclothymic, irritable, and anxious temperaments may moderate PMM symptoms and the onset of PMDD.

In the SEM of this study, the effects of the sexual abuse subscale score of CATS on a negative change score on the LES and a negative change score on the LES on the severity of PMM symptoms were significant, but the sexual abuse subscale did not show a significant indirect effect on PMM symptoms. These results indicate the absence of positive mediation by a negative change score on the LES, but suggest a major role of increased appraisal of negative life events during the past year on current severity of PMM symptoms. Consistent with our results, a significant role of trauma history on the onset of PMDD has been reported.<sup>36,37</sup> Interestingly, Gonda et al reported that women manifesting a more marked increase in symptoms from the late follicular through the late-luteal phase of the menstrual cycle are more likely to notice negative

subjective life events and are less likely to notice positive subjective life events.<sup>38</sup> Hence, not only the objective severity of stress but also the subjective perception or severity of stress may contribute to PMM symptoms, as observed for depressive and anxiety symptoms.<sup>23</sup>

Childhood maltreatment causes persistent hyperactivity of the hypothalamic-pituitary-adrenal axis, brain structural changes, and epigenetic changes in the amygdala and hippocampus.<sup>39–41</sup> These biological effects may result in heightened stress responses. The biological reasons underlying the effects of childhood maltreatment can thus be explained.

The results of this study should be considered in light of the following limitations. Firstly, in our SEM model, the square sum of the multiple correlation coefficients was 0.29, suggesting that there might be other predictors (i.e., steroid hormones, other personality traits, etc.) associated with the severity of PMM symptoms. However, we did not perform hormonal tests to analyze the biological effects of menstruation on PMM symptoms. Secondly, there is the possibility of memory bias of childhood trauma, because childhood maltreatment was estimated retrospectively. Thirdly, although different effects have been reported between extrafamilial and intrafamilial abuse,<sup>42</sup> we did not investigate these different effects. Finally, as this study only analyzed nonclinical adult volunteers from the community, the findings may not be generalizable to PMDD patients. In the future, the association between childhood maltreatment, affective temperaments, and adult life events should be prospectively studied using a large number of PMDD patients.

## Conclusion

Analysis using the structural equation model showed that childhood maltreatment, particularly neglect, indirectly predicted PMM symptoms through affective temperaments. A major role of affective temperaments on the effect of childhood maltreatment on PMM symptoms was suggested.

## Acknowledgements

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## Author Contributions

YW and TI designed the study and wrote the protocol. YW collected the data. All authors contributed to data analysis, drafting and revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

## Disclosure

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