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ORIGINAL ARTICLE

Posttraumatic stress disorder and trauma characteristics are correlates of premenstrual dysphoric disorder

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Abstract Posttraumatic stress disorder (PTSD) is often comorbid with premenstrual dysphoric disorder (PMDD) in women; however, it is unclear whether this relationship is driven by the trauma that may lead to PTSD or if PTSD is uniquely associated with PMDD. In this study, we examine trauma and PTSD as independent correlates of PMDD. Researchers conducted a cross-sectional, secondary data analysis of 3,968 female participants (aged 18–40) of the Collaborative Psychiatric Epidemiology Surveys. Women who had a history of trauma with PTSD (odds ratio, OR= 8.14, 95% confidence interval, CI=3.56–18.58) or a history of trauma without PTSD (OR=2.84, 95% CI=1.26–6.42) were significantly more likely than women with no history of trauma to report PMDD. This graded relationship was also observed in association with premenstrual symptoms. Among trauma survivors, PTSD was independently associated with PMDD, although characteristics of participants' trauma history partially accounted for this association. Our study demonstrated that trauma and PTSD were independently associated with PMDD and premenstrual symptoms. Clinicians should be aware that women who present with premenstrual symptomatology complaints may also have a history of trauma and PTSD that needs to be addressed. This pattern of comorbidity may complicate the treatment of both conditions.

Keywords Posttraumatic stress disorder · Trauma · Premenstrual dysphoric disorder · Epidemiology · Mental health

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Background

Posttraumatic stress disorder (PTSD) is a disabling mental illness and substantial public health burden: 6.8% of American adults will be diagnosed with PTSD in their lifetimes (Kessler et al. 2005). PTSD is characterized by symptoms of re-experiencing, avoidance and emotional numbing, hyperarousal, and significant functional impairment (criteria B–D, F); these symptoms last at least 1 month (criterion E) and are causally linked to the experience of a traumatic stressor (American Psychiatric Association 1994). The *Diagnostic and Statistical Manual of Mental Disorders IV* (DSM-IV) defines a traumatic stressor as any event directly experienced, witnessed, or confronted by an individual that involves serious threat or injury to the individual or others (criterion A1), and this event elicits intense fear, helplessness, or horror (criterion A2) (American Psychiatric Association 1994). Although 90% of individuals may experience a potentially traumatic event in their lifetimes, only 13.0% of women and 6.2% of men exposed to these events subsequently develop PTSD (Breslau et al. 1998). Research demonstrates that the conditional risk for PTSD following severe traumas, such as rape (49.0%) and assaultive violence (20.9%), is higher than for events that are

more widely prevalent in the population but do not generally provoke such intense emotional reactions. For example, the conditional risk for PTSD after learning about a traumatic event experienced by a loved one is only 3.6% (Breslau et al. 1998).

A large body of research demonstrates that both trauma and PTSD are positively associated with affective, anxiety, and substance abuse disorders (Kessler et al. 1995; Pietrzak et al. 2011). However, there has been little research examining the comorbid relationship between PTSD and premenstrual dysphoric disorder (PMDD), a disorder prevalent among 3–8% of American women (Halbreich et al. 2003). Although existing literature suggests that trauma and PTSD are correlated with PMDD, it is unclear whether this relationship is driven by the trauma that may lead to PTSD or if PTSD is uniquely associated with PMDD. Thus, a closer examination of the independent associations between trauma and PTSD and PMDD is warranted.

Premenstrual symptoms occur cyclically in the week prior to the onset of menses and encompass both affective and somatic changes. Premenstrual symptoms cause only minor to moderate impairment, whereas symptoms of PMDD are of such intensity that a woman's ability to function normally at work, in the home, and in interpersonal interactions is disrupted (American Psychiatric Association 2000). Using Census 2000 data, Halbreich and colleagues estimated the disability adjusted life years (DALYs) attributable to PMDD in the USA to be 14.5 million (Halbreich, et al. 2003). To put this figure into context, the Global Burden of Disease study estimated the DALYs associated with all neuropsychiatric conditions in the USA (calculation excludes PMDD) was 4.8 million in 2004 (WHO 2009).

The psychophysiological mechanisms linking PMDD and PTSD have not been investigated. However, a number of studies have found evidence of autonomic nervous system dysregulation in both patients with PMDD and patients with PTSD. For example, both PTSD and PMDD have been associated with low levels of baseline high-frequency heart rate variability, an indication of resting hyperarousal (Landén et al. 2004; Matsumoto et al. 2007; Pole 2007). However, it is unclear whether the autonomic nervous system dysregulation characteristic of PTSD is a risk factor for PMDD, if PMDD is a risk factor for development of PTSD after a traumatic event, or if the dysregulation of the autonomic nervous system reflects a shared vulnerability to PTSD and PMDD. It is beyond the scope of the present study to fully investigate these potential pathways. However, these findings provide a psychophysiological basis for further epidemiological investigation of the relationship between trauma, PTSD, and PMDD and premenstrual symptoms.

Although PTSD and trauma exposure have been linked to premenstrual symptoms in a number of studies (Golding et al. 2000; Koci and Strickland 2007), only three studies have explicitly examined the association between PTSD and PMDD. All three studies utilized data from a cohort of 1,251 German women (age 14–24 at baseline) who were evaluated prospectively from 1995 to 1999. With these data, investigators demonstrated that baseline PTSD was significantly associated with incident PMDD, independently of age (Perkonigg et al. 2004; Wittchen et al. 2002, 2003). Although the results are provocative, several methodological limitations weaken the results' generalizability and necessitate further research. First, cohort members were relatively homogenous in terms of age, race, marital status, and socioeconomic status. Consequently, the findings from these studies may not apply to more diverse populations. Second, the results of these studies may be dated and not applicable to the current population of women, as the incidence of trauma and women's awareness of PMDD may have changed since these data were collected. A third limitation was the restricted age range of the study cohort, which did not adequately represent the population of women at risk for PMDD (all women of childbearing age). Importantly, PMDD does not typically develop until women reach their mid-20s, and it becomes increasingly prevalent and more severe with age (Stein et al. 2006). Given the young age of the cohort and the brief period of follow-up, the researchers' ability to capture later-onset cases was substantially reduced among this cohort. Similarly, exposure to potentially traumatic events was lower in this young cohort (only 8.2% baseline prevalence) (Perkonigg et al. 2004) than would be observed in the general population of women. For instance, the prevalence of potentially traumatic events among American women aged 20–59 in a nationally representative survey was 80.32% (Grant 2005).

A fourth limitation of prior work was the analytic approach, in which investigators failed to present the unique effects of trauma and PTSD on PMDD. In two of the three studies, investigators included PTSD in a multivariate model but did not limit their sample to women exposed to potentially traumatic events (Wittchen et al. 2002, 2003). Thus, the true association between PTSD (as a phenomenon distinct from trauma) and PMDD was likely underestimated in this analysis. In the third study, investigators included indicator variables for PTSD status and trauma history in a multivariate model (Perkonigg et al. 2004). This approach is problematic because trauma exposure is a necessary (but not sufficient) cause of PTSD, and thus, these factors are not truly independent. Consequently, PTSD and trauma should not enter a multivariable model as two separate indicator variables. To more accurately determine the independent effects of potentially

traumatic events and PTSD, researchers have most often characterized exposure as a three-level categorical variable: exposure to trauma without PTSD, exposure to trauma with PTSD, and no exposure to trauma (Löwe et al. 2010; Sledjeski et al. 2008). Investigators have also addressed this issue by restricting their sample to survivors of trauma and including an indicator of PTSD status in their multivariate model (Lawler et al. 2005). We utilized both approaches in the current study.

It was also unclear in these studies whether the effect of PTSD would remain significantly associated with PMDD among trauma survivors if there was adequate statistical control for characteristics of participants' trauma history. Since evidence demonstrates that persons with more numerous and severe experiences of trauma are more likely to develop PTSD (Breslau et al. 1999; Kilpatrick and Saunders 1999; Resnick et al. 1993), trauma characteristics may partially or fully explain the observed association between PTSD and PMDD among trauma survivors.

In the single study of the German cohort that featured simultaneous control for PTSD and trauma exposure, the trauma variable indicated the presence of a history of trauma exposure, rather than the number or severity of exposures (Perkonigg et al. 2004). Nevertheless, while PTSD was significantly associated with PMDD in age-adjusted analysis, the addition of trauma exposure and other covariates (subthreshold PMDD, psychiatric comorbidity, life stress, and self-competence) rendered this relationship non-significant. Since this was not a stepwise analysis (nor was the population limited to survivors of trauma only), the authors could not determine whether it was the effect of trauma exposure or the effects of other model covariates that attenuated the previously significant association between baseline PTSD and incident PMDD. Thus, additional, more nuanced research is needed to determine whether PTSD remains significantly associated with PMDD following statistical control for trauma severity.

The goal of the current study was to untangle the relationship between trauma, PTSD, and PMDD among a larger and more diverse sample of American women, thereby extending the findings of prior studies of PMDD. We included a three-level categorical variable to characterize exposure to trauma and PTSD and investigated the number and severity of traumatic events as possible explanatory factors in the relationship between PTSD and PMDD. Finally, we examined these exposures in relation to the prevalence of premenstrual symptoms, in addition to PMDD.

We predicted that there would be a graded relationship between trauma, PTSD, and PMDD status, with trauma survivors and persons who develop PTSD in the aftermath of trauma having elevated odds for PMDD and premenstrual symptoms compared to the reference group (no trauma exposure). In a second analysis restricted to survivors of trauma, we explored whether the effect of PTSD remained significantly associated with PMDD and premenstrual symptoms after controlling for the severity and number of traumatic experiences reported by participants. On the basis of prior literature demonstrating that PTSD is strongly associated with chronic illness (Schnurr et al. 2007) and psychopathology (Brady, et al. 2000) independently of exposure to trauma, we hypothesized that PTSD would remain significantly associated with PMDD after trauma characteristics were included in our multivariate model. The effect of PTSD would be attenuated, however, suggesting that trauma characteristics partially explained the association between PTSD and PMDD. Because prior evidence has linked trauma exposure to premenstrual symptoms, we hypothesized that if a significant association between PTSD and premenstrual symptoms were observed, it would be fully accounted for by characteristics of trauma.

Methods

Study participants

This study was a secondary data analysis of the Collaborative Psychiatric Epidemiology Surveys (CPES), which combined data from the National Comorbidity Survey-Replication (NCS-R), the National Survey of American Life (NSAL), and the National Latino and Asian American Study (NLAAS). Institutional Review Boards at the host institutions approved study protocols, and verbal informed consent was obtained from all participants (Pennell et al. 2004). The survey instrument was administered by extensively trained non-clinician interviewers who conducted the interviews in person or by telephone (when requested) from 2001 to 2003. Response rates ranged from 71–81% (Pennell et al. 2004). The survey sampling procedures and data collection methods for the CPES have been described at length elsewhere (Pennell et al. 2004).

Participants were eligible for inclusion if they (1) completed both the PTSD module and the PMDD module, (2) reported having regular menstrual cycles, (3) were between the ages of 18 and 40 years, and (4) provided complete data for all study covariates of interest. Of the 11,463 female participants in the CPES, we excluded 1,833 women from NCS-R and 621 from the NSAL who randomly did not receive the PTSD and PMDD modules to reduce study costs. Two hundred forty-nine women were excluded because they did not provide valid data for the PMDD module or the PTSD module. Three thousand two hundred sixty-six women were excluded because they did report having regular menses. Finally, we excluded 1,349

women 41–71 years of age. Women in this age group may experience perimenopausal and menopausal symptoms, which they may misinterpret as premenstrual symptoms. We excluded these older women from our analysis in order to avoid this potential source of bias. Finally, we excluded 164 women who did not provide valid data for all of the study covariates (listed below). Thus, the full sample included 3,698 participants.

Table 1 presents the demographic characteristics of the study participants, overall and according to PMDD status. Participants were predominantly White, employed, married, never smokers, and educated beyond high school. The average participant was almost 29 years old, had used oral contraceptives in her lifetime, and had an income over four times that of her need (a composite variable provided by the survey designers, the ratio of income to need was calculated as the total family income divided by the poverty threshold for a family of that size, in accordance with US Census procedures). One fourth of participants reported having a mood disorder in her lifetime; however, less than 5% of participants met diagnostic criteria for any mood disorder in the month prior to the interview. Just over half of the participants reported a normal weight for their height. Among trauma survivors, the vast majority of women selected a primary trauma as the worst/only event they had experienced. Less than 10% of trauma survivors reported experiencing a single trauma; the majority of trauma survivors were multiply traumatized.

Measures

The CPES utilized the World Mental Health Composite International Diagnostic Interview (WMH-CIDI), version 3.0. Individual survey modules contained questions that corresponded to the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition* (DSM-IV) criteria, and diagnostic algorithms developed by the survey designers yielded valid and reliable diagnoses of Axis I disorders (Kessler et al. 2004; Kessler and Ustün 2004). The WMH-CIDI also included modules for demographic, cultural, and health information. The methodological details of the CPES have been published previously (Pennell et al. 2004).

Independent variables

Exposure status was a composite, ordinal variable with three categories of response: no history of trauma, history of trauma without PTSD, and history of trauma with PTSD. Participants were asked to indicate whether they had experienced any of 22 potentially traumatic events in their lifetime; typical events were combat, the unexpected death of a loved one, surviving a car accident, and rape. Individuals who did not report any one of these events were characterized as having no history of trauma. Persons who selected at least one potentially traumatic event in their lifetime but who did not meet diagnostic criteria for PTSD were designated as having a history of trauma without PTSD. History of trauma with PTSD characterized persons who developed PTSD following their exposure to trauma. Note that we did not limit our definition of "trauma exposure" to events that met criterion A2, i.e., events which provoked feelings of intense fear, helplessness, or horror. Many studies examining the effects of trauma and PTSD utilize this approach (Pietrzak et al. 2011). Furthermore, recent data indicate that the conditional probability, prevalence, and persistence of PTSD in the presence or absence of criterion A2 are very similar and that the presence of criterion A2 in the aftermath of trauma is associated with the subsequent development of PTSD (Karam et al. 2010). Consequently, researchers suggest that criterion A2 should be redefined as a risk factor for PTSD, rather than a diagnostic requirement.

Participants were asked to identify their "worst event" if they selected more than one traumatic event; for participants who reported multiple events but did not select a "worst event," one event was randomly selected as the "worst event." Symptoms following the worst event were evaluated for the diagnosis of PTSD, which was based on DSM-IV criteria and generated from a diagnostic algorithm provided by the survey designers. In the clinical calibration study for the WMH-CIDI, the trauma inventory and PTSD diagnostic module were found to be acceptably concordant with blind clinical diagnoses using the Structured Clinical Interview for DSM-IV (Kessler et al. 2004).

Dependent variable

Premenstrual dysphoric disorder (PMDD) status was the dependent variable in our analysis with three mutually exclusive levels of response: PMDD, premenstrual symptoms, and the absence of premenstrual symptoms. The lifetime prevalence of PMDD was assessed with the WMH-CIDI "Premenstrual Syndrome" module, which is consistent with DSM-IV criteria for PMDD (American Psychiatric Association 1994). Women who met the case definition for PMDD reported (1) experiencing depressed mood, anxiety, or irritability in the week prior to her period (2) in at least seven of 12 menstrual cycles at the point in her life when symptoms were at their worst, (3) that these mood changes were worse than normal most of the time, and (4) symptoms such as difficulty concentrating, tiredness, change in appetite, or change in sleep were present. She also had to report (5) interference in work, social life, or personal relationships, or (6) impairment in daily activities because of these problems. Women with premenstrual symptoms had at least one of the first four symptoms but

Table 1 Demographic characteristics of the overall sample and according to PMDD status

Study characteristic	Entire sample (n=3,698)		No symptoms (n=2,024)		Premenstrual symptoms (n=1,776)		PMDD (n=168)		p value[c]
	n or mean[a]	% or SE[b]	n or mean[a]	% or SE[b]	n or mean[a]	% or SE[b]	n or mean[a]	% or SE[b]	
Race									<0.001
Asian	558	5.92	306	7.26	228	4.72	24	5.50	
Hispanic	908	16.47	528	22.45	344	11.33	36	11.99	
Black	1,600	15.05	876	17.51	673	13.07	51	11.35	
White	902	62.56	314	52.78	531	70.88	57	71.16	
Employment status									0.009
Employed	2,705	69.95	1,324	64.11	1,264	74.10	117	72.81	
Not employed	397	6.58	221	7.66	158	5.50	18	7.55	
Not in the labor force	866	23.97	479	28.23	354	20.40	33	19.64	
Marital status									0.282
Married/Cohabitating	1,901	51.20	957	49.64	864	52.76	80	49.56	
Separated/Divorced/Widowed	490	10.01	248	8.70	219	10.75	23	15.94	
Never been married	1,577	38.79	819	41.66	693	36.49	65	34.50	
Education									<0.001
Less than high school	692	15.18	418	18.36	249	12.45	26	12.63	
High school	1,145	27.49	616	29.15	489	25.80	40	29.56	
Some college	1,208	33.00	579	33.83	570	32.35	59	31.47	
College and above	923	24.33	411	18.66	469	29.39	43	26.34	
Smoking history									<0.001
Current	783	23.88	317	20.39	410	25.98	56	37.97	
Former	422	13.63	172	10.88	219	16.03	31	15.29	
Never	2,763	62.49	1,535	68.73	1,147	57.99	81	46.74	
History of oral contraceptive use									<0.001
Ever user	2,773	74.58	1,321	68.31	1,313	79.16	139	89.54	
Never user	1,195	25.42	703	31.69	463	20.84	29	10.46	
Lifetime history of mood disorder									<0.001
Yes	985	25.41	378	17.58	530	30.44	77	52.86	
No	2,983	74.59	1,646	82.42	1,246	69.56	91	47.14	
Past-month diagnosis of mood disorder									0.008
Yes	186	4.54	64	3.31	102	5.19	20	10.71	
No	3,782	95.46	1,960	96.69	1,674	94.81	148	89.29	
Body mass index									0.300
<18.5	198	5.53	95	5.22	98	6.02	5	2.93	
18.5–24.9	1,779	51.09	900	49.30	796	53.03	83	47.39	
≥25.0	1,991	43.38	1,029	45.48	882	40.94	80	49.68	
Worst event type[d]									0.001
Primary trauma	2,164	86.41	941	83.05	1,091	88.21	132	94.56	
Secondary trauma	347	13.59	193	16.95	146	11.79	8	5.44	
Number of traumatic events[d]									<0.001
1	219	9.93	122	13.42	94	8.12	3	0.94	
2–3	1,172	47.71	573	49.74	556	47.09	43	38.01	
≥4	1,120	42.36	439	36.84	587	44.79	94	61.05	
Age	28.74	0.24	27.80	0.33	29.50	0.33	30.21	0.73	<0.001
Income	4.58	0.12	4.21	0.14	4.89	0.17	4.94	0.30	0.002
Social desirability	1.60	0.03	1.73	0.07	1.50	0.04	1.31	0.12	0.0130

[a] Unweighted n for categorical variables and mean for continuous variables

[b] Weighted percentages for categorical variables and standard error (SE) for continuous variables

[c] p value from Wald chi-squared test

[d] Sample restricted to survivors of trauma (n=3,252)

did not meet the case definition for PMDD, lacking the impairment criterion. Women without symptoms were categorized as having an absence of symptoms.

Covariates

The following correlates of PTSD (Breslau et al. 1998) and PMDD (Cohen et al. 2002; Deuster et al. 1999; Halbreich, et al. 2003) were included in our multivariate models: *race* (Asian, Latina, Black, and non-Latina Whites), *current age* (range 18–40 years), *smoking status* (current smoker, ex-smoker, or never smoker), *history of oral contraceptive use* (never users or ever users), *employment status* (employed, not employed, or not in the labor force), *educational attainment* (less than high school, high school diploma, some college, or college and above), *income* (range 0–18; this value is calculated by dividing the total family income by the poverty threshold for a family of that size, US Census Bureau 2010), *body mass index* (<18.5, 18.5–24.9, ≥25.0), lifetime history of any mood disorder (yes or no; mood disorders included bipolar disorder, dysthymia, hypomania, major depressive disorder, and mania), history of any mood disorder in the past month (yes or no; disorders are the same as those listed above), *worst traumatic event type*, *number of traumatic event types reported*, and a measure of social desirability.

Worst traumatic event was a binary variable with two levels of response, primary trauma and secondary trauma, and was used to characterize the nature of participants' self-identified worst events. Primary traumas happened directly to the participants and included events such as combat trauma, rape, and physical assault. Secondary traumas were witnessed by the participants or happened to someone close to the participants. Secondary traumas included events such as seeing someone die or learning of the unexpected death of a loved one. These categorizations of traumatic event types have been used in prior work (Sledjeski et al. 2008). *Number of traumatic events* was an ordinal variable with three levels of response (one event, two to three events, or four or more events) to denote the number of potentially traumatic events that survivors of trauma reported. The measure of social desirability was based on a 10-item scale developed by Crowne and Marlowe (range 0–10) (Crowne and Marlowe 1960). Social desirability refers to an individual's tendency to report untrue but socially acceptable responses.

Statistical analysis

Data were analyzed with the SUDAAN 10.1 statistical package, which utilizes Taylor Series Linearization to account for the weighting and clustering of the CPES survey data. We used PROC CROSSTAB, PROC DESCRIPT, and PROC REGRESS to generate univariate statistics for categorical and continuous variables, respectively. To test our first hypothesis, we constructed a multivariate multinomial logistic regression model (PROC MULTILOG) with exposure status as the main predictor variable and the following covariates included in the model: race, current age, smoking status, history of oral contraceptive use, employment status, educational attainment, income, body mass index, and social desirability. PMDD status was the dependent variable; outcomes were modeled as PMDD vs. no symptoms and premenstrual symptoms vs. no symptoms. The predictor variable and covariates entered the adjusted model in a single step.

To address our second hypothesis, we first established that the worst event type and the number of traumas were significantly associated with PTSD in a multivariate logistic regression model (PROC RLOGIST) that also included all of the demographic covariates and social desirability. This analysis was restricted to survivors of trauma. We then used stepwise multinomial logistic regression modeling to examine the effect of PTSD on PMDD status after controlling for trauma characteristics; PMDD status was modeled as the dependent variable in the same manner described previously. The Stage 1 model included only our main predictor variable, exposure status (now with only two valid levels of response, history of trauma with PTSD vs. history of trauma without PTSD). In stage 2, we added the demographic covariates and social desirability to the model. Finally, in stage 3, we added the variables for worst traumatic event type and the number of traumatic events reported by participants to the multinomial logistic regression model. We presented unadjusted odds ratios (OR), adjusted odds ratios (AOR), and the 95% confidence intervals (CI) for these analyses. Additionally, we reported the Wald chi-squared test statistic and its corresponding p value for the overall association between each independent variable and PMDD status. For individual parameter estimates, we reported p values from the t test.

Results

The prevalence of PMDD in the sample was 3.87%, which was consistent with estimates taken from other community samples (Halbreich et al. 2003). Over 10% of the sample met DSM-IV criteria for PTSD in their lifetimes. Race, employment status, education, smoking history, history of oral contraceptive use, lifetime history of mood disorder, past-month diagnosis of mood disorder, worst event type, number of traumatic events, age, income, and social desirability were significantly associated with PMDD status in bivariate analysis (p value for Wald X^2 test <0.05; see Table 1).

Consistent with our first hypothesis, there was a statistically significant, graded relationship between exposure status and PMDD status ($p<0.001$; see Table 2). The effect of exposure status was statistically significant in both unadjusted and multivariate-adjusted models, although its effects were attenuated following statistical control for race, employment status, marital status, educational attainment, smoking history, history of oral contraceptive use, body mass index, current age, income, and social desirability. Furthermore, exposure status was more strongly associated with PMDD than with premenstrual symptoms. Women who had a lifetime history of trauma with PTSD were significantly more likely than women with no history of trauma to report PMDD (AOR=8.14, 95% CI=3.56–18.58) and premenstrual symptoms (AOR=1.97, 95% CI=1.49–2.60) in their lifetimes. Women who had a lifetime history of trauma but did not meet diagnostic criteria for PTSD were also significantly more likely than women with no history of trauma to have PMDD (AOR=2.84, 95% CI=1.26–6.42) and premenstrual symptoms (AOR=1.43, 95% CI=1.95–1.87).

Consistent with our second hypothesis, the independent association between PTSD and PMDD was not fully accounted for by characteristics of trauma, i.e., the worst event type or the number of traumatic experiences (see Table 3). Among trauma survivors, PTSD was significantly associated with premenstrual symptoms and PMDD in the stage 1 model (OR=4.52, 95% CI=2.41–8.46). Although still statistically significant, these effects were attenuated following adjustment for demographic covariates and social desirability in the stage 2 model (AOR=3.15, 95% CI=1.68–5.89). In the stage 3 model, the effect of PTSD on PMDD was further attenuated but remained statistically significant (AOR=2.63, 95% CI=1.36–5.11) following the addition of the trauma characteristics. Although worst event type was not significantly associated with PMDD, the participants' reported number of traumatic events was strongly associated with PMDD. Importantly, the number of reported events was significantly and independently associated with PTSD in multivariate analysis ($p<0.001$). Given these facts, we concluded that the number of reported traumas partially explained the observed association between PTSD and PMDD in this population. However, PTSD remained a strong, independent correlate of PMDD.

PTSD was no longer significantly associated with premenstrual symptoms in the stage 2 model, and this association was further attenuated in the stage 3 model. These findings suggested that demographic covariates and trauma characteristics fully explained the relatively weak association between PTSD and premenstrual symptoms observed in the unadjusted stage 1 model (OR=1.58, 95% CI 1.11–2.23). In support of this explanatory relationship, women reporting four or more traumatic events were more likely than women who reported one event to experience premenstrual symptoms (AOR=1.74, 95% CI=1.01–2.98). Race, education, and the number of reported events were independently associated with PTSD ($p<0.05$).

Discussion

As hypothesized, there was a graded association between trauma exposure, PTSD, and PMDD/premenstrual symptoms, with women who reported a history of trauma and met diagnostic criteria for PTSD the most likely to experience PMDD or premenstrual symptoms in their lifetimes. Women who had a history of trauma, but did not meet diagnostic criteria for PTSD, were also significantly more likely than women with no history of trauma to experience PMDD or premenstrual symptoms in their lifetimes. Consistent with our second hypothesis, PTSD was an independent correlate of PMDD, although the effect of PTSD was attenuated following statistical control for characteristics of participants' trauma history and demographic covariates. In contrast, the effect of PTSD on premenstrual symptoms was fully explained by characteristics of participants' trauma history as well as demographic covariates. This lack of association between PTSD and premenstrual symptoms was consistent with evidence from studies which also failed to find a significant association between PTSD and "subthreshold PMDD," (i.e., premenstrual symptoms) (Perkonigg et al. 2004; Wittchen et al. 2002).

Although the pathways linking trauma and PTSD to premenstrual symptomatology have not been clearly elucidated, evidence suggests three possible explanations for these associations. First, PTSD may be a causal risk factor for the development of PMDD. The positive association between PTSD and PMDD status in the current study was consistent with literature linking PTSD (independently of trauma) to poor mental and physical health (Schnurr and Jankowski 1999). According to an explanatory model proposed by Schnurr and Green (Schnurr et al. 2007; Schnurr and Green 2004), PTSD may disrupt the body's biological response to stress, which may contribute to the development of mental and physical illness. This is supported by evidence suggesting that women with PMDD and a history of trauma show abnormal neuroendocrine functioning compared to women with PMDD but who do not report a history of trauma (Girdler et al. 2004). Moreover, for the majority of incident cases of PMDD identified in the German cohort, exposure to trauma and PTSD predated the onset of PMDD (Wittchen et al. 2003).

Second, women with PMDD may be at greater risk for the development of PTSD following a potentially traumatic

Table 2 Unadjusted and multivariate-adjusted associations between exposure status, study characteristics, and PMDD status

Study characteristic	Premenstrual symptoms[a]				PMDD[a]			
	OR[b]	95% CI	AOR[c]	95% CI	OR[b]	95% CI	AOR[c]	95% CI
Exposure status								
No history of trauma	1.00	–	1.00	–	1.00	–	1.00	–
History of trauma without PTSD	1.54**	1.17–2.02	1.43**	1.09–1.87	3.53***	1.70–7.35	2.84*	1.26–6.42
History of trauma with PTSD	2.69***	1.99–3.66	1.97***	1.49–2.60	15.61***	7.13–34.17	8.14***	3.56–18.58
Race								
Asian	0.48***	0.36–0.65	0.55**	0.39–0.80	0.56*	0.33–0.96	1.19	0.59–2.38
Hispanic	0.38***	0.28–0.51	0.51***	0.37–0.71	0.40**	0.23–0.69	0.73	0.39–1.38
Black	0.56***	0.42–0.73	0.66**	0.48–0.89	0.48**	0.29–0.79	0.55*	0.32–0.94
White	1.00	–	1.00	–	1.00	–	1.00	–
Employment status								
Employed	1.00	–	1.00	–	1.00	–	1.00	–
Not employed	0.62**	0.44–0.88	0.88	0.61–1.26	0.87	0.48–1.57	1.35	0.71–2.55
Not in the labor force	0.63***	0.48–0.82	0.76	0.56–1.03	0.61	0.34–1.11	0.76	0.44–1.34
Marital status								
Married/Cohabitating	1.00	–	1.00	–	1.00	–	1.00	–
Separated/Divorced/Widowed	1.16	0.82–1.64	1.03	0.74–1.44	1.84	0.98–3.45	1.28	0.66–2.47
Never been married	0.82	0.64–1.06	1.02	0.77–1.36	0.83	0.49–1.42	1.31	0.72–2.39
Educational attainment								
Less than high school	0.77	0.58–1.01	0.98	0.72–1.34	0.68	0.29–1.58	0.74	0.34–1.63
High school	1.00	–	1.00	–	1.00	–	1.00	–
Some college	1.08	0.82–1.43	1.00	0.73–1.36	0.92	0.42–1.99	0.88	0.40–1.91
College+	1.78***	1.34–2.36	1.45*	1.04–2.02	1.39	0.66–2.91	1.12	0.49–2.56
Smoking history								
Current	1.51**	1.16–1.97	1.23	0.90–1.67	2.74***	1.57–4.77	1.68	0.91–3.09
Former	1.75**	1.20–2.55	1.39	0.96–2.01	2.07*	1.13–3.78	1.37	0.73–2.57
Never	1.00	–	1.00	–	1.00	–	1.00	–
History of oral contraceptive use								
Ever user	1.76***	1.41–2.20	1.26	0.99–1.60	3.97***	2.27–6.94	2.79***	1.54–5.06
Never user	1.00	–	1.00	–	1.00	–	1.00	–
Lifetime history of any mood disorder								
Yes	2.05***	1.59–2.65	1.64	1.24–2.15	5.26***	3.42–8.08	2.95***	1.80–4.83
No	1.00	–	1.00	–	1.00	–	1.00	–
Past-month diagnosis of any mood disorder								
Yes	1.60	0.97–2.63	0.92	0.51–1.65	3.51	1.85–6.65***	1.04	0.48–2.25
No	1.00	–	1.00	–	1.00	–	1.00	–
Body mass index								
<18.5	1.07	0.65–1.76	1.23	0.72–2.12	0.58	0.19–1.79	0.67	0.21–2.19
18.5–24.9	1.00	–	1.00	–	1.00	–	1.00	–
≥25.0	0.84	0.68–1.03	0.87	0.70–1.09	1.14	0.62–2.08	1.08	0.60–1.97
Age	1.04**	1.02–1.06	1.03*	1.00–1.05	1.05***	1.02–1.09	1.04	0.99–1.08
Income	1.06***	1.03–1.10	1.02	0.98–1.06	1.07*	1.01–1.13	1.04	0.98–1.10
Social desirability	0.90**	0.83–0.97	0.98	0.91–1.06	0.81	0.69–0.96*	0.88	0.73–1.07

95% CI 95% confidence interval

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

[a] Modeled against the non-event: no premenstrual symptoms

[b] *OR*=unadjusted odds ratio

[c] *AOR*=adjusted odds ratio; model includes exposure status, race, employment status, marital status, educational attainment, smoking history, history of oral contraceptive use, lifetime history of any mood disorder, past month diagnosis of any mood disorder, body mass index, age, income, and social desirability

Table 3 Stepwise multinomial logistic regression modeling among survivors of trauma; the role of exposure status, demographic covariates, and trauma characteristics in association with PMDD status

Stepwise models	Premenstrual symptoms[a]		PMDD[a]		*p* value[b]
Stage 1 model	OR	95% CI	OR	95% CI	
Exposure status					<0.001
History of trauma without PTSD	1.00	–	1.00	–	
History of trauma with PTSD	1.58*	1.11–2.23	4.52***	2.41–8.46	
Stage 2 model	AOR	95% CI	AOR	95% CI	
Exposure status					
History of trauma without PTSD	1.00	–	1.00	–	0.002
History of trauma with PTSD	1.28	0.90–1.83	3.15***	1.68–5.89	
Demographic covariates[c]	–	–	–	–	–
Stage 3 model	AOR	95% CI	AOR	95% CI	
Exposure status					0.014
History of trauma without PTSD	1.00	–	1.00	–	
History of trauma with PTSD	1.18	0.83–1.67	2.63**	1.36–5.11	
Demographic covariates[c]	–	–	–	–	–
Worst event type					0.807
Primary trauma	1.06	0.71–1.60	1.36	0.50–3.70	
Secondary trauma	1.00	–	1.00	–	
Number of traumatic events					<0.001
1 event	1.00	–	1.00	–	
2–3 events	1.39	0.80–2.42	7.89**	2.11–29.47	
≥4 events	1.74*	1.01–2.98	11.93***	3.09–46.00	

OR unadjusted odds ratio, *AOR* adjusted odds ratio, *95% CI* 95% confidence interval

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

[a] Modeled against the non-event: no premenstrual symptoms

[b] p value from Wald chi-squared test

[c] Demographic covariates include: race, employment status, marital status, educational attainment, smoking history, history of oral contraceptive use, lifetime history of any mood disorder, past month diagnosis of any mood disorder, body mass index, age, income, and social desirability

event. Women with PMDD may be likely more than controls to appraise this event as frightening, horrifying, and uncontrollable, and they may also perceive themselves as less able to cope with a potentially traumatic event. In support of this explanation, one study found that women with PMDD perceived daily stressors as more stressful, undesirable, and unpredictable compared to controls (Fontana and Palfai 1994). Since a negative appraisal of the event (criterion A2) is a risk factor for PTSD (Karam et al. 2010), women with PMDD would be more susceptible to the development of PTSD following trauma, compared to controls. Finally, the comorbidity of PTSD and PMDD may not reflect an underlying causal relationship. Rather, the co-occurrence of these disorders may indicate a predisposition to autonomic, behavioral, and affective dysregulation, which may confer greater vulnerability to both PMDD and PTSD (Breslau 2002).

Our study had several strengths. First, this study population was more racially diverse, encompassed a greater range of ages, and had more varying socioeconomic resources and educational backgrounds compared to the cohort utilized in the prior research on this topic. Second, we characterized study participants according to both trauma history and PTSD status to study the unique effects of trauma and PTSD on PMDD status. Finally, we investigated the effect of PTSD while statistically controlling for the effect of trauma characteristics. Trauma characteristics had not been fully explored as explanatory factors in the association between PTSD and PMDD status prior to this study.

Our findings must be considered in light of several design issues of the CPES. First, because this was a cross-sectional study, neither the temporality of events nor the nature of these associations as causal could be conclusively established. Although we discuss the possible pathways that may explain the observed associations, it was beyond the scope of this study to test any causal mechanisms. Second, reporting bias may have influenced the results of this survey. To minimize this possibility, we excluded menopausal and perimenopausal women from the sample

to ensure that participants would draw from recent memory or current experiences in their report of premenstrual symptoms (and not menopausal or perimenopausal symptoms). Furthermore, we included a measure of social desirability in our multivariate models. This gave us greater confidence that our findings were not due to participants' desire to provide socially desirable responses rather than truthful ones.

A final limitation of this study concerned the WMH-CIDI assessment of PMDD. Although the diagnosis was based on DSM-IV criteria, criterion C (the symptoms were not an exacerbation of an existing mood or anxiety disorder) and criterion D (symptoms were confirmed by prospective ratings over two consecutive symptomatic cycles) could not be satisfied given the format of the survey, since symptoms were assessed retrospectively in a single interview (American Psychiatric Association 1994). In light of these limitations, the diagnosis should be considered provisional only, in accordance with DSM-IV recommendations. However, it should be noted that the prevalence of PMDD obtained in this sample is comparable to prevalence estimates obtained in similar populations using measures that more closely adhere to DSM-IV diagnostic criteria (Pearlstein and Steiner 2008). This suggests that the WMH-CIDI measure of PMDD was a valid one. Future research using a more comprehensive diagnostic assessment of PMDD is needed to confirm these preliminary associations.

In conclusion, we have demonstrated for the first time that there was a graded relationship between trauma history, PTSD, and PMDD and premenstrual symptoms in a diverse sample of American women, independently of demographic factors and social desirability. Furthermore, PTSD was independently associated with PMDD among trauma survivors, even after accounting for demographic covariates and characteristics of the participants' trauma history. The findings from this study have important implications for clinicians. For example, given the high comorbidity and overlapping symptomatology of these conditions, clinicians should consider screening for PMDD among patients presenting with trauma and/or PTSD. The Premenstrual Symptoms Screening Tool is a fast, easy to use tool that would be appropriate for this purpose (Steiner et al. 2003). Clinicians may be unaware or skeptical of PMDD as a diagnostic entity in light of the controversy that surrounds the inclusion of PMDD in previous and forthcoming versions of the DSM. However, the failure to asses and identify PMDD in affected patients may thwart clinicians' attempts to treat their PTSD. Furthermore, clinicians are advised to have patients track their symptoms of PTSD and PMDD over the course of treatment, especially in relation to the patient's menstrual cycle. Given the considerable overlap between PTSD and PMDD symptomatology, remitted PTSD symptoms may seem to reappear every few weeks during the premenstrual phase, when in fact these symptoms are attributable to PMDD. Thus, if comorbid PMDD is either undiagnosed or ignored, the efficacy of PTSD treatment cannot be determined, and patients' PMDD remains unaddressed. In summary, the comorbidity of PTSD and PMDD may complicate the treatment of both conditions; women presenting with PTSD should be screened for PMDD, and clinicians should be attuned to variations in PTSD symptomatology over the course of the menstrual cycle. Finally, future research that utilizes prospective designs and physiological measures of autonomic nervous system regulation, such as heart rate variability, may provide more insight into the mechanisms that link trauma and PTSD to PMDD and premenstrual symptoms.

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References

American Psychiatric Association (1994) Diagnostic and statistical manual of mental disorders DSM-IV. American Psychiatric Association, Washington, DC

American Psychiatric Association (2000) Diagnostic and statistical manual of mental disorders DSM-IV-TR (fourth edition (text revision)). American Psychiatric Publishing, Inc., Arlington

Brady K, Killeen T, Brewerton T, Lucerini S (2000) Comorbidity of psychiatric disorders and posttraumatic stress disorder. J Clin Psychiatry 61(Suppl 7):22–32

Breslau N (2002) Epidemiologic studies of trauma, posttraumatic stress disorder, and other psychiatric disorders. Can J Psychiatry 47(10):923–929

Breslau N, Kessler R, Chilcoat H, Schultz L, Davis G, Andreski P (1998) Trauma and posttraumatic stress disorder in the community: the 1996 Detroit Area Survey of Trauma. Arch Gen Psychiatry 55(7):626–632

Breslau N, Chilcoat HD, Kessler RC, Davis GC (1999) Previous exposure to trauma and PTSD effects of subsequent trauma: results from the Detroit Area Survey of Trauma. Am J Psychiatry 156(6):902–907

Cohen L, Soares C, Otto M, Sweeney B, Liberman R, Harlow B (2002) Prevalence and predictors of premenstrual dysphoric disorder (PMDD) in older premenopausal women. The Harvard Study of Moods and Cycles. J Affect Disord 70 (2):125–132

Crowne DP, Marlowe D (1960) A new scale of social desirability independent of psychopathology. J Consult Psychol 24(4):349–354

Deuster P, Adera T, South-Paul J (1999) Biological, social, and behavioral factors associated with premenstrual syndrome. Arch Fam Med 8(2):122–128

Fontana A, Palfai T (1994) Psychosocial factors in premenstrual dysphoria: stressors, appraisal, and coping processes. J Psychosom Res 38(6):557–567

Girdler SS, Thompson KS, Light KC, Leserman J, Pedersen CA, Prange AJ (2004) Historical sexual abuse and current thyroid

axis profiles in women with premenstrual dysphoric disorder. Psychosom Med 66(3):403–410
Golding J, Taylor D, Menard L, King M (2000) Prevalence of sexual abuse history in a sample of women seeking treatment for premenstrual syndrome. J Psychosom Obstet Gynaecol 21(2):69–80
Grant, B. F. (2005). Wave 2 national epidemiologic survey of alcohol and related conditions (NESARC)
Halbreich U, Borenstein J, Pearlstein T, Kahn L (2003) The prevalence, impairment, impact, and burden of premenstrual dysphoric disorder (PMS/PMDD). Psychoneuroendocrinology 28 (Suppl 3):1–23
Karam EG, Andrews G, Bromet E, Petukhova M, Ruscio AM, Salamoun M et al (2010) The role of criterion A2 in the DSM-IV diagnosis of posttraumatic stress disorder. Biol Psychiatry 68 (5):465–473
Kessler R, Ustün T (2004) The World Mental Health (WMH) survey initiative version of the World Health Organization (WHO) Composite International Diagnostic Interview (CIDI). Int J Methods Psychiatr Res 13(2):93–121
Kessler R, Sonnega A, Bromet E, Hughes M, Nelson C (1995) Posttraumatic stress disorder in the National Comorbidity Survey. Arch Gen Psychiatry 52(12):1048–1060
Kessler R, Abelson J, Demler O, Escobar J, Gibbon M, Guyer M et al (2004) Clinical calibration of DSM-IV diagnoses in the World Mental Health (WMH) version of the World Health Organization (WHO) Composite International Diagnostic Interview (WMHCIDI). Int J Methods Psychiatr Res 13(2):122–139
Kessler RC, Berglund P, Demler O, Jin R, Merikangas KR, Walters EE (2005) Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. Arch Gen Psychiatry 62(6):593–602
Kilpatrick DG, Saunders BE (1999) Prevalence and consequences of child victimization. Results from the national survey of adolescents. Medical University of South Carolina, National Crime Victims Center, Charleston
Koci A, Strickland O (2007) Relationship of adolescent physical and sexual abuse to perimenstrual symptoms (PMS) in adulthood. Issues Ment Health Nurs 28(1):75–87
Landén M, Wennerblom B, Tygesen H, Modigh K, Sörvik K, Ysander C et al (2004) Heart rate variability in premenstrual dysphoric disorder. Psychoneuroendocrinology 29(6):733–740
Lawler C, Ouimette P, Dahlstedt D (2005) Posttraumatic stress symptoms, coping, and physical health status among university students seeking health care. J Trauma Stress 18(6):741–750
Löwe B, Kroenke K, Spitzer RL, Williams JB, Mussell M, Rose M et al (2010) Trauma exposure and posttraumatic stress disorder in primary care patients: cross-sectional criterion standard study. J Clin Psychiatry 72:304–312
Matsumoto T, Ushiroyama T, Kimura T, Hayashi T, Moritani T (2007) Altered autonomic nervous system activity as a potential etiological factor of premenstrual syndrome and premenstrual dysphoric disorder. Biopsychosoc Med 1:24
Pearlstein T, Steiner M (2008) Premenstrual dysphoric disorder: burden of illness and treatment update. J Psychiatry Neurosci 33(4):291–301
Pennell B, Bowers A, Carr D, Chardoul S, Cheung G, Dinkelmann K et al (2004) The development and implementation of the National Comorbidity Survey Replication, the National Survey of American Life, and the National Latino and Asian American Survey. Int J Methods Psychiatr Res 13(4):241–269
Perkonigg A, Yonkers K, Pfister H, Lieb R, Wittchen H (2004) Risk factors for premenstrual dysphoric disorder in a community sample of young women: the role of traumatic events and posttraumatic stress disorder. J Clin Psychiatry 65(10):1314–1322
Pietrzak RH, Goldstein RB, Southwick SM, Grant BF (2011) Prevalence and axis I comorbidity of full and partial posttraumatic stress disorder in the United States: results from Wave 2 of the National Epidemiologic Survey on Alcohol and Related Conditions. J Anxiety Disord 25(3):456–465
Pole N (2007) The psychophysiology of posttraumatic stress disorder: a meta-analysis. Psychol Bull 133(5):725–746
Resnick H, Kilpatrick D, Dansky B, Saunders B, Best C (1993) Prevalence of civilian trauma and posttraumatic stress disorder in a representative national sample of women. J Consult Clin Psychol 61(6):984–991
Schnurr PP, Green BL (2004) Understanding relationships among trauma, posttraumatic stress disorder, and health outcomes. In: Schnurr PP, Green BL (eds) Trauma and health: physical health consequences of exposure to extreme stress. American Psychological Association, Washington, DC, pp 247–275
Schnurr P, Jankowski M (1999) Physical health and post-traumatic stress disorder: review and synthesis. Semin Clin Neuropsychiatry 4(4):295–304
Schnurr P, Green B, Kaltman S (2007) Trauma exposure and physical health. In: Friedman MJ, Keane TM, Resick P (eds) Handbook of PTSD. Science and Practice. The Guilford Press, New York, pp 406–424
Sledjeski EM, Speisman B, Dierker LC (2008) Does number of lifetime traumas explain the relationship between PTSD and chronic medical conditions? Answers from the National Comorbidity Survey-Replication (NCS-R). J Behav Med 31 (4):341–349
Stein DJ, Kupfer DJ, Schatzberg AF (2006) The American psychiatric publishing textbook of mood disorders. American Psychiatric Publishing, Inc., Arlington
Steiner M, Macdougall M, Brown E (2003) The premenstrual symptoms screening tool (PSST) for clinicians. Arch Womens Ment Health 6(3):203–209
U.S. Census Bureau (2010) Poverty—how the census bureau measures poverty. http://www.census.gov/hhes/www/poverty/about/overview/measure.html. Accessed 18 Jul 2011
WHO (2009) Death and DALY estimates for 2004 by cause for WHO Member States: females, 3 age groups. In gbddeathdalycountryestimates_female_age_2004.xls (ed.)
Wittchen H, Becker E, Lieb R, Krause P (2002) Prevalence, incidence and stability of premenstrual dysphoric disorder in the community. Psychol Med 32(1):119–132
Wittchen H, Perkonigg A, Pfister H (2003) Trauma and PTSD-an overlooked pathogenic pathway for premenstrual dysphoric disorder? Arch Womens Ment Health 6(4):293–297