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# Childhood abuse and vasomotor symptoms among midlife women

**Mary Y. Carson, BS**[a], **Rebecca C. Thurston, PhD**[a,b,c]

[a]Department of Psychology, University of Pittsburgh, Pittsburgh, PA, USA

[b]Department of Psychiatry, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA

[c]Department of Epidemiology, University of Pittsburgh Graduate School of Public Health, Pittsburgh, PA, USA

## Abstract

**Objective:** Childhood maltreatment is related to adverse health outcomes. However, the relation of childhood maltreatment to the menopause transition, a universal transition for women often accompanied by troubling symptoms such as vasomotor symptoms, is relatively underexplored. This study tested whether childhood abuse and neglect are associated with menopausal vasomotor symptoms, utilizing both physiologic and prospective self-report measures of vasomotor symptoms.

**Methods:** 295 nonsmoking perimenopausal and postmenopausal women aged 40 to 60 years with and without vasomotor symptoms completed psychosocial measures including the Child Trauma Questionnaire, ambulatory physiologic (sternal skin conductance) and self-report measurement of vasomotor symptoms during wake and sleep, and actigraphy measurement of sleep. Relationships between childhood abuse/neglect and vasomotor symptoms during wake and sleep were tested in linear regression models controlling for demographics, body mass index, and menopause stage.

**Results:** 44% of the sample reported abuse or neglect during childhood. Among women reporting vasomotor symptoms, childhood sexual or physical abuse was associated with more frequent physiologically-recorded vasomotor symptoms during sleep (sexual abuse: b(SE)=1.45(0.52), p=0.006; physical abuse: b(SE)=0.97(0.47), p=0.03) in multivariable models. Among these women, women with a physical or sexual abuse history had approximately 1.5-two fold the number of sleep vasomotor symptoms than women without this history.

**Conclusions:** Childhood abuse is associated with more frequent physiologically-detected vasomotor symptoms during sleep.

### Keywords

Menopause; vasomotor symptoms; hot flashes; child abuse; neglect; maltreatment

**Corresponding author:** Mary Y. Carson, BS, University of Pittsburgh, 201 N Craig St, Rm 207, Pittsburgh, PA 15213, Tel: (412) 648-9270; Fax: (412) 687-7160; myc16@pitt.edu.

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## Introduction

Childhood maltreatment (including sexual abuse, physical abuse, emotional abuse, physical neglect, and/or emotional neglect) is prevalent for women; some estimates indicate that over one in four of U.S. women have experienced some form of childhood abuse or neglect.[1,2] Childhood maltreatment has been linked to numerous adverse health outcomes including mental illness, cardiovascular disease, metabolic syndrome, premature mortality, and other chronic illnesses.[3–11] While these studies suggest that childhood maltreatment is associated with adverse health outcomes later in life, studies have yet to fully examine how maltreatment is associated with the menopause transition.

The menopause transition is a universal experience for women and is characterized by symptoms that are both common and for many women bothersome; 60% of midlife women in a population-based study reported seeking healthcare treatment for their menopause symptoms.[12] Vasomotor symptoms (VMS), also known as hot flashes or night sweats, are a cardinal symptom of menopause experienced by over 70% of women.[13] VMS are associated with impairments in quality of life, depressed mood, and sleep disturbance, and in some work are linked to underlying cardiovascular disease risk.[14–18] Despite the prevalence and burden of VMS during the menopause transition, there is still much unknown about factors associated with VMS.

An emerging literature links childhood maltreatment and other forms of interpersonal aggression to features of the menopause transition. In fact, a large longitudinal study of midlife women (Study of Women's Health Across the Nation) found that child abuse or neglect was associated with a higher likelihood of reporting VMS.[19] Furthermore, in a study of a multiethnic cohort in the Kaiser Permanente Northern California healthcare system, symptoms of post-traumatic stress disorder (PTSD) were associated with increased odds of reporting wake and sleep VMS, while intimate partner violence was associated with increased odds of reporting sleep VMS.[20] However, these studies were limited by their reliance on retrospective reports of VMS that asked women to recall VMS over weeks or longer. These types of reports are subject to memory biases and are correlated with psychological factors such as negative affect.[13,21,22] While retrospective self-reported VMS are important to capturing a woman's overall experience, prospective self-reports of VMS are thought to be superior to retrospective reports as they minimize these memory biases.[22,23] Moreover, physiologic methods of measuring VMS have strengths distinct from those of prospective self-reports. Some data indicate that women tend to underreport VMS as compared to physiologic monitoring.[23,24] Other data indicates that negative mood may be linked to a greater likelihood of reporting VMS that are not physiologically detected.[25] The findings that negative mood is associated with reported VMS are particularly significant given that negative mood is often a sequela of childhood maltreatment.[3,26] Thus, use of both physiologic and prospective self-report measures of VMS may be particularly important when considering links between childhood maltreatment and VMS.

This study investigated the association between childhood maltreatment and VMS in midlife women during the menopause transition, utilizing both prospective self-reported and

physiologically-measured VMS. We hypothesized that a history of childhood maltreatment would be associated with more frequent physiologically recorded and self-reported VMS. Given that both VMS and abuse often differ by race,[13,27–29] we examined any racial/ethnic differences in relations between child abuse and VMS in exploratory analyses. This is the first study to examine the relationship between childhood maltreatment and physiologically-assessed VMS.

## Methods

### Study Sample

This study was conducted among participants of the MsHeart Study, a study originally designed to investigate the relation between VMS and cardiovascular health.[30] The MsHeart study was conducted between January 2012 and May 2015 and included 304 women aged 40 to 60 either reporting daily VMS or no VMS in the prior three months. Women were recruited from the greater Pittsburgh area via advertisements, mailings, fliers, and message boards.

Exclusion criteria included hysterectomy and/or bilateral oophorectomy; a reported history of heart disease, stroke, arrhythmia, gynecological cancer, pheochromocytoma, pancreatic tumor, kidney failure, seizures, Parkinson disease, or Raynaud phenomenon; current pregnancy; or having used the following medications within the past 3 months: estrogen or progesterone, selective estrogen receptor modulators, selective serotonin reuptake inhibitors, serotonin norepinephrine reuptake inhibitors, gabapentin, insulin, beta-blockers, calcium channel blockers, alpha-2 adrenergic agonists, or other antiarrhythmic agents. Women who had undergone endometrial ablation, endarterectomy, or lymph node removal or who were undergoing chemotherapy, hemodialysis, or peritoneal dialysis were excluded.[30]

Of the 304 women, up to 9 women were excluded from analyses due to missing data on a child abuse/maltreatment subscale (sexual abuse n=9, physical abuse n=2, emotional abuse n=3, physical neglect n=1, emotional neglect n=3). Final sample sizes ranged from n=301 (physical neglect) to n=295 (sexual abuse). Women with missing data did not differ from those without missing data on study variables (p’s>.05).

### Design and Procedures

Participants underwent a telephone and in person screening, completed physical measurements, psychosocial questionnaires, and completed ambulatory physiologic and self-report VMS monitoring and actigraph sleep monitoring as they went about their daily activities. Procedures were approved by the University of Pittsburgh Institutional Review Board. Participants provided written informed consent.

### Measures

**Child Trauma Questionnaire—**The Child Trauma Questionnaire was completed at baseline. The Child Trauma Questionnaire is a validated 28 item self-report measure that assesses child abuse and neglect.[31] Examples of questions include “People in my family said hurtful or insulting things to me” and “I got hit so hard by someone in my family that I had

to see a doctor or go to the hospital". Item scores range from 0 (never true) to 5 (very often true). The Child Trauma Questionnaire includes five subscales (sexual abuse, physical abuse, emotional abuse, physical neglect, and emotional neglect). The Child Trauma Questionnaire short form has validated clinical cut off points.[32] Scoring at or above 8 on the sexual abuse subscale, 8 on the physical abuse subscale, 10 on the emotional abuse subscale, 8 on the physical neglect subscale, or 15 on the emotional neglect subscale indicates an instance of abuse/neglect. If a participant scored at or above any clinical threshold for one or more subscale, the participant was classified as having been exposed to any childhood maltreatment. The participant was considered as not exposed to childhood maltreatment if a participant scored below clinical thresholds on all abuse/neglect subscales.

**Vasomotor symptoms (VMS)—**VMS were measured over three days, the first 24 hours of which included physiologic VMS monitoring. Women were provided with a VMS monitor (VU-AMS, VU University Amsterdam, www.vu-ams.nl, Amsterdam, the Netherlands); the VU-AMS measures VMS via sternal skin conductance, a validated physiologic measure of VMS.[33–35] The VU-AMS was worn in a pouch around the waist and measured sternal skin conductance continuously for 24 hours. After 24 hours the participants removed the monitor and stored it in a provided case.

Skin conductance was sampled from the sternum at 1 Hz from 2 Ag-Ag Cl electrodes via the VU-AMS monitor (VU University Amsterdam, Netherlands). VMS were scored via UFI software (DPSv3.7; Morro Bay, CA) in agreement with standard and valid methods.[33–35] Software identified a skin conductance increase of 2 μmho in 30 seconds as a VMS event. VMS events were also visually inspected by expert coders and events showing the characteristic pattern, but less than 2 μmho in 30 second increase were coded as an event and independently verified by two coders. This approach has been shown to be reliable ($\kappa$=0.86).[33,36] VMS were classified as sleep/wake using sleep diary and actigraphy data. To account for variations in monitoring time, VMS rates were calculated as VMS number/monitoring time[30] and were standardized to 17 hour wake and 7 hour sleep times for ease of interpretation.

For prospective self-reported VMS collected over three days, women self-reported VMS by pressing event mark buttons on the VU-AMS and the wrist actigraph. Women also recorded VMS in a Palm Z22 electronic diary (Palm, Inc., Sunnyvale, CA). Collectively, these data provided prospective date- and time-stamped reports of self-reported VMS.

**Sleep—**Sleep was measured over 3 days via wrist actigraphy, a validated objective measure of sleep, and sleep diary.[37] Data were collected with an Actiwatch 2 (Respironics, Inc, Murrysville, PA) in 1-minute epochs and analyzed with Philips Actiware v6.0.0 software (Respironics, Inc, Murrysville, PA). The threshold of wake was 40 epochs and the number of epochs of sleep/wake for sleep onset/offset was 10.[30] Wake after sleep onset (WASO) was considered minutes of wakefulness between sleep onset time and final wake time as defined by actigraphy. Time tried to go to sleep (Bed time) and final wake time (Rise time) were collected via sleep diary. Total sleep time was calculated as [time in bed -sleep onset latency -wake after sleep onset]. We considered total sleep time as our measure of sleep duration and

WASO as a measure of sleep continuity given the importance of VMS to wakening from sleep.[38]

### Covariates

Menopause status, education, race/ethnicity, and age were self-reported at baseline. Menopause status was determined from self-reported bleeding patterns over the year preceding the visit and was categorized as peri-menopausal or post-menopausal using Stages of Reproductive Aging Workshop +10 criteria.[39] Education was evaluated as highest degree attained and was categorized into high school and/or some college or vocational school or college degree or higher. Due to small cell sizes of non-white ethnicities (African American, Hispanic, Asian American), race was coded as white or non-white. Height and weight were measured via a fixed stadiometer and a balance beam scale. Body mass index was calculated ($kg/m^2$).

### Data Analyses

Descriptive statistics, distributions, missing values, and histograms were examined for covariates, predictor variables, and outcome variables. WASO was log transformed to conform to model assumptions of normality. Chi-square analyses and t tests were conducted to determine if women missing childhood maltreatment data differed systematically from women with complete records. Relationships between childhood maltreatment and VMS were considered for the number of VMS over 24 hours as well as during wake and sleep. Associations between abuse/neglect and VMS were evaluated using linear regression with each abuse/neglect type considered separately. Physiologically recorded and self-reported VMS were considered separately. Age, race, education, BMI and menopause status were selected as covariates based on their prior documented associations with VMS.[13,40] These covariates were included in all models. In secondary analyses, racial/ethnic differences in child abuse-VMS associations were tested using cross product terms in linear regression models. Sleep characteristics were considered separately as covariates in secondary analyses. Analyses were performed with R studio version 3.5.1(R Foundation for Statistical Computing, Vienna, Austria). Models were two-sided with $\alpha=0.05$.

## Results

Participants on average were 54 years old, white, overweight, and postmenopausal. See Table 1. Approximately a quarter of women (N=63) identified as African American. One hundred twenty-nine women (44% of the sample) reported some form of abuse or neglect, emotional abuse (23%) was the most common form of abuse/neglect. As reported previously, non-white women were more likely to report abuse/neglect (any abuse/neglect: non-white, 56%; white, 41%; p=0.02), particularly physical abuse (non-white, 29%; white, 17%; p=0.03) and physical neglect (non-white, 29%; white, 17%; p=0.045).[41] As previously reported,[30] women reporting daily VMS were younger, less educated, and more often non-white than women not reporting VMS during the three months prior to enrollment. Among the women who reported VMS at baseline, an average of 5 VMS/24 hours were reported (wake: 4 VMS; sleep: 1 VMS) and 13 VMS/24 hours were detected on physiologic

monitoring (wake: 11 VMS; sleep: 3 VMS). The tendency to underreport VMS relative to physiologic monitoring is consistent with previous findings.[23,24]

The study by design enrolled women reporting daily VMS (N=152) and reporting no VMS (N=152). Rates of childhood maltreatment did not differ significantly between these two groups of women (childhood maltreatment among women with daily VMS: n=67, 45%; among women not reporting VMS at baseline: n=67, 45%; p=ns). However, significant interactions by VMS reporting at baseline and childhood maltreatment (physical/sexual abuse) in relation to physiologically-monitored VMS frequency were observed (physical abuse: p=0.04, sexual abuse: p=0.006). Among the women who reported VMS at baseline (N=152), a history of sexual abuse or physical abuse was associated with more frequent physiologically-assessed VMS during sleep (Table 2; Figure 1). Associations persisted controlling for covariates. In women reporting VMS at baseline, women with a physical or sexual abuse history had approximately 1.5-two fold the number of sleep vasomotor symptoms than women without this history (Yes sexual abuse: 4.49; No sexual abuse: 2.45; Yes physical abuse: 3.78; No physical abuse: 2.47). A history of abuse or neglect was not associated with the frequency of self-reported VMS.

We conducted several additional analyses. Given that both VMS and abuse often differ by race,[13,27–29] we considered race as a potential modifier of associations between childhood abuse/neglect and VMS. Race significantly modified the relationship between physical abuse (p=0.01) and physiologically-assessed VMS during sleep, such that relations between physical abuse and more frequent physiologic VMS during sleep were primarily observed among non-white women (white: B(SE)= −0.12 (0.56), p=0.83, non-white: B(SE)=2.28 (0.81), p=0.007). Further, given that relations between abuse and VMS were observed solely for sleep VMS, we also considered the role of sleep in relation to abuse and sleep VMS. The association between physical abuse/sexual abuse and physiologically-assessed sleep VMS remained significant when adjusting for actigraphically-assessed sleep time or continuity (data not shown).

## Discussion

Among a well characterized sample of midlife women who underwent state-of-the-art physiologic and prospective measurement of VMS, 44% of the cohort experienced a history of childhood abuse or neglect. A childhood history of physical or sexual abuse was associated with more frequent physiologically-detected VMS during sleep among women reporting VMS. Associations persisted when controlling for a range of potential confounders and explanatory factors.

These findings contribute to the literature on child abuse/neglect and adverse health. The negative effects of childhood maltreatment reach far past childhood and are related to mental illness, cardiovascular disease, premature mortality, and other chronic illnesses in adulthood.[3–11] However, childhood maltreatment as it relates to the menopause transition is underexplored. One prior study has indicated a relationship between childhood abuse/neglect and retrospective self-reports of VMS, finding increased odds of reporting VMS for the women with a history of abuse.[19] Another study looked at PTSD and intimate partner

violence in relation to reported menopausal symptoms.[20] However, no prior studies have utilized both state of the art physiologic and prospective self-report VMS monitoring. Examining associations using physiologic indices of VMS is necessary, as these indices avoid the influences of mood and memory that impact VMS reporting.[22,25] As childhood abuse is associated with increased frequency of subsequent mood disorders, minimizing the influence of mood on VMS indices is of particular importance.[3,26] Precise reporting of VMS is particularly difficult during sleep and is influenced by sleep quality, further highlighting the utility of using physiologic VMS measures.[22,23] Thus, this study represents an important contribution to the literature by documenting associations between childhood abuse and VMS using physiologic measures of VMS.

The association between childhood maltreatment and VMS was seen primarily during sleep. Importantly, the relationship between childhood abuse/neglect and sleep VMS was not explained by objectively-assessed sleep characteristics. The underlying pathophysiology of sleep and wake VMS is thought to be comparable. However, relationships between VMS and health outcomes such as heart rate variability and white matter hyperintensities are often more pronounced for sleep VMS,[42,43] indicating some specificity to sleep VMS. Furthermore, increasing research indicates that trauma exposure may be particularly important for nocturnal physiology. Indeed, trauma significantly impacts multiple aspects of sleep (e.g., duration and continuity)[44,45] as well as the hypothalamic-pituitary-adrenal axis (HPA axis) and heart rate variability,[46–48] which are known to be important to sleep physiology.[49,50] Further research should consider the role of nocturnal physiology in relations between childhood maltreatment and VMS.

The mechanisms linking childhood maltreatment to VMS are not yet known, as the underlying physiology of VMS has not yet been fully elucidated. However, previous research implicates the sympathetic nervous system in VMS physiology.[42,51] Changes in the HPA axis have also been associated with VMS physiology.[52,53] Notably, childhood maltreatment is associated with sympathetic nervous system dysregulation,[54] as well as marked changes in the HPA axis.[46,47] Thus, it is possible that the impact of childhood maltreatment on the autonomic nervous system and HPA axis may render women more susceptible to VMS. Further delineation of these mechanisms is an important next step of this work.

Several additional findings are notable. Associations between childhood maltreatment and VMS were found only for those who experienced physical or sexual abuse and not emotional abuse or emotional or physical neglect. These differences may arise in part because both childhood physical and sexual abuse may be more precisely recalled than other forms of abuse or neglect.[55,56] The specificity of relations of subtypes of abuse to VMS should be replicated in future work. Childhood abuse/neglect were found to be associated with physiologic VMS but not self-reported VMS, which is surprising given prior work on this topic.[19] This discrepancy may be due in part to differences in self-report methodology; previous studies utilized retrospective reporting of VMS while the present study utilized event markers at the time of VMS, which have greater precision and incorporate fewer recall biases.[22] Finally, significant interactions by race/ethnicity indicated that the association between physical abuse and VMS was seen primarily in the racial/ethnic minority women in

the sample. The reasons for this racial/ethnic difference are not entirely clear. However, it is notable that there are higher rates of VMS as well as child abuse/neglect in African American women as compared to white women that may increase the likelihood of observing an association in this group.[29,40,57] Racial/ethnic differences in abuse-VMS associations should be tested in additional studies including a greater number of minority women.

This study should be interpreted in light of several limitations. This cross-sectional study does not allow for causal relationships between childhood maltreatment and VMS. Childhood maltreatment was measured by retrospective self-report, which is prone to underreporting. Although a quarter of the sample was non-white, Asian and Hispanic women were underrepresented. The relationship between childhood abuse and sleep VMS was observed only in symptomatic women. Further, this study considered women with daily VMS and women not reporting VMS in the past three months. Findings cannot be generalized to women with lower levels of symptomatology (i.e. less than daily VMS); future work should consider whether findings extend to less symptomatic women.

The present study had several strengths. This study addressed a novel question rarely considered in the literature. It was conducted in a well-characterized sample of midlife women who underwent extensive measurements of abuse, VMS, and sleep. A well-validated measure of abuse/neglect was employed. This is the first study to examine the relationship between child abuse and VMS using both ambulatory physiologic and prospective self-report measures of VMS, which further advances the literature on the long-term sequelae of childhood abuse.

## Conclusion

This study found that childhood abuse was prevalent in this study of midlife women and was associated with more frequent physiologically-assessed VMS during sleep. Our findings highlight the importance of a lifespan perspective when considering symptoms of the menopause transition. Childhood abuse may have implications for physical health well into midlife. This work also underscores the importance of clinicians routinely screening for trauma history when considering women's midlife health.

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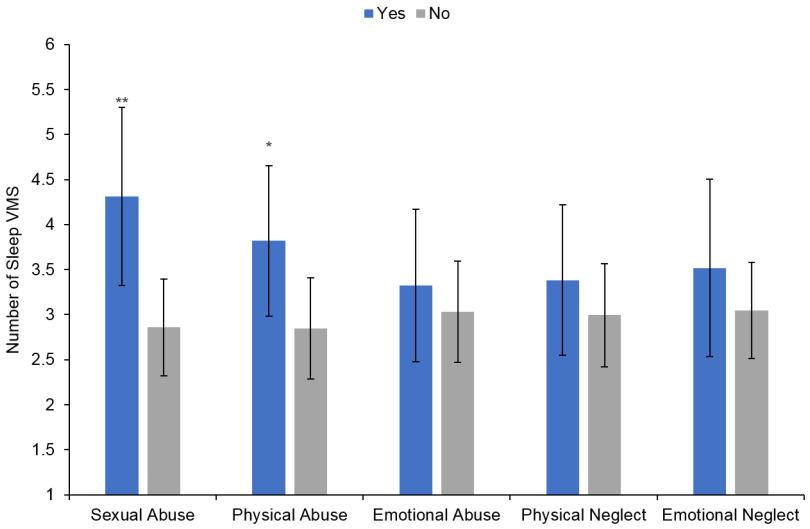


**Figure 1. Adjusted sleep VMS by abuse or neglect history.**

*p<.05; **p<.01; Mean values adjusted for age, race, education, body mass index (BMI), and menopause status; error bars represent 95% confidence interval

**Table 1.**

Sample characteristics

| | |
|---|---|
| N | 295 |
| Age, y, mean (SD) | 54.02 (4.01) |
| Race, no. (%) | |
| White | 216 (73.22) |
| Non-white | 79 (26.78) |
| Education, no, (%) | |
| < College | 123 (41.69) |
| ≥ College | 172 (58.31) |
| Menopause status, no. (%) | |
| Perimenopausal | 49 (16.61) |
| Postmenopausal | 246 (83.39) |
| Body mass index, kg/m$^2$ mean (SD) | 28.99 (6.81) |
| Physiologically-detected VMS, mean (SD) | |
| 24 Hour | 8.72 (8.94) |
| Wake (17hr) | 6.73 (7.35) |
| Sleep (7hr) | 2.15 (2.44) |
| Any Abuse/Neglect, no. (%) | 129 (43.73) |
| Physical Abuse | 59 (20.00) |
| Sexual Abuse | 40 (13.56) |
| Emotional Abuse | 69 (23.39) |
| Emotional Neglect | 51 (17.29) |
| Physical Neglect | 58 (19.66) |

No. = number, SD = standard deviation, VMS = vasomotor symptoms

**Table 2.**

Associations between child abuse/neglect and sleep and wake VMS among women reporting VMS at baseline

| | Wake VMS | Sleep VMS |
|---|---|---|
| **Variable** | **B (SE)** | **B (SE)** |
| Sexual Abuse | 1.11 (1.64) | 1.45 (0.52) *b* |
| Physical Abuse | 1.37 (1.46) | 0.97 (0.47) *a* |
| Emotional Abuse | −0.56 (1.42) | 0.29 (0.46) |
| Physical Neglect | 1.33 (1.46) | 0.39 (0.47) |
| Emotional Neglect | −1.02 (1.60) | 0.47 (0.51) |

*a* p<.05;

*b* p<.01

Each type of abuse considered as presence versus absence according to Child Trauma Questionnaire clinical cut points

Covariates: age, race, education, body mass index, menopause status

VMS = vasomotor symptoms