# Ambulatory Cardiovascular Activity and Hostility Ratings in Women with Chronic Posttraumatic Stress Disorder

Jean C. Beckham, Amanda M. Flood, Michelle F. Dennis, and Patrick S. Calhoun

**Background:** The objective of the current study is to evaluate the relationship between hostility and ambulatory cardiovascular activity in women with and without posttraumatic stress disorder (PTSD).

**Methods:** One hundred and one women completed 24 hours of ambulatory monitoring and standardized diagnostic and hostility measures. Generalized estimating equations analysis was used to examine the effects of group and hostility factor scores (hostile beliefs, overt hostility, and covert hostility) on ambulatory heart rate (AHR) and ambulatory systolic (ASBP) and diastolic (ADBP) blood pressure.

**Results:** After controlling for covariates, there was an interaction between PTSD and both hostile beliefs and overt hostility for AHR. Increases in hostility were associated with greater increases in heart rate among women with PTSD relative to those without PTSD. There was a similar interaction between hostile beliefs and group for ADBP.

**Conclusions:** Increased AHR and blood pressure have been linked to poor cardiovascular outcomes in nonpsychiatric populations. Individuals with PTSD display increased hostility, a construct that has also been linked to poorer cardiovascular outcomes. Increases in hostile beliefs were associated with a greater increase in ADBP among women with PTSD as compared with control subjects. These data suggest that PTSD might in part moderate the relationship between hostility and cardiovascular outcomes.

**Key Words:** Ambulatory monitoring, cardiovascular health, hostility, PTSD, women

Posttraumatic stress disorder (PTSD) is a psychiatric condition that affects approximately 6%–8% of the adult population (1), and women are twice as likely to develop PTSD as men (2). Women with chronic PTSD are of particular interest in the current study, because of the extensive literature linking this psychiatric diagnosis to adverse health outcomes (3). Studies have consistently found that individuals with PTSD report increased somatic complaints, health care use, functional impairment, and morbidity due to physical health problems (3–7). Furthermore, PTSD has been linked to cardiovascular health problems such as hypertension, increased incidence of cardiac events, and sudden death from cardiac-related problems (4,5).

Although the majority of studies examining PTSD and health have been conducted in male samples, there is increasing evidence that PTSD is associated with poor health in women (6,7). It is unclear, however, whether PTSD is associated with cardiovascular health and functioning among women with PTSD. Cardiovascular health is the leading cause of death among women of all races and is a significant public health concern (8). Knowledge that PTSD might place women at even greater risk for cardiovascular health problems is important in managing the global health needs of this vulnerable population.

Cardiovascular ambulatory monitoring studies provide a unique opportunity to examine physiological reactivity and its relationship to affect. Studies including nonpsychiatric populations have demonstrated that increased ambulatory heart rate (AHR) and blood pressure are significantly related to poorer cardiovascular health, including both intermittent and long-term outcomes such as arterial stiffness (9,10) , target organ damage (11,12), and mortality (13,14). Ambulatory studies have shown that male PTSD participants demonstrate higher AHR than those without PTSD (15,16), but there have been no such studies in women with PTSD.

A separate line of research has shown a link between other negative affective states, including anger and hostility, and cardiovascular parameters and health risk (17,18). Hostility has been linked to adverse health outcomes, including cardiac death (19,20). Anger and hostility are common symptoms reported in the aftermath of trauma exposure. In fact, meta-analysis of the extant 39 studies indicates that anger and hostility are significantly elevated in individuals with PTSD (21). Additionally, studies have found that compared with individuals without PTSD, individuals with PTSD have greater cardiovascular responsivity when reliving an anger-provoking event from their past (22). Although hostility has been strongly linked to PTSD, relatively few of the studies documenting this link have been conducted in female samples.

The interconnections between PTSD, hostility, and health outcomes are significant, and a plausible model for understanding these interrelationships have been presented elsewhere in more detail (23). Recent evidence suggests that the relationship between hostility and health outcomes might be moderated by PTSD (22). The relationships among PTSD, hostility, and cardiovascular parameters, however, have not been well examined in women.

Thus, the current study had two aims: 1) evaluate ambulatory cardiovascular activity among women with and without PTSD, and 2) determine whether the association between hostility and cardiovascular parameters is moderated by PTSD. It was expected that women with PTSD would demonstrate increased physiological arousal (e.g., higher heart rate, blood pressure) than women without PTSD and that women with PTSD would

From the Mental Health Service Line (JCB, PSC), Durham Veterans Affairs Medical Center; Veterans Affairs Mid-Atlantic Mental Illness Research Education and Clinical Center (MIRECC) (JCB, PSC); and the Department of Psychiatry (JCB, AMF, MFD, PSC), Duke University Medical Center, Durham, North Carolina.

Address reprint requests to Jean C. Beckham, Ph.D., Durham VAMC, 116B, 508 Fulton Street, Durham, NC 27705; E-mail: beckham@duke.edu.

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**Table 1.** Participant Characteristics

| | PTSD ($n = 67$) | Control ($n = 50$) | |
|---|---|---|---|
| | Mean (SD) | Mean (SD) | Test Statistic |
| Age | 41.45 (11.44) | 34.30 (11.30) | $F(1,116) = 11.29, p = .001$ |
| Education | 14.43 (2.64) | 16.76 (2.73) | $F(1,116) = 21.60, p < .0001$ |
| Hollingshead Rating | 45.55 (17.87) | 31.80 (14.53) | $F(1,116) = 19.82, p < .0001$ |
| % Minority | 58 | 52 | $\chi^2(1) = .45, p = .504$ |
| % Married | 46 | 30 | $\chi^2(1) = 3.17, p = .075$ |
| % Veteran | 24 | 6 | $\chi^2(1) = 6.73, p = .010$ |
| % Employed | 61 | 94 | $\chi^2(1) = 16.53, p < .0001$ |
| % Current Smokers | 36 | 14 | $\chi^2(1) = 7.00, p < .01$ |
| % Current Other Anxiety Disorder | 46 | 12 | $\chi^2(1) = 15.55, p < .0001$ |
| % Lifetime Substance Abuse/Dependence | 45 | 10 | $\chi^2(1) = 16.52, p < .0001$ |
| % Lifetime Major Depressive Disorder | 76 | 0 | $\chi^2(1) = 67.47, p < .0001$ |
| % Taking Cardiac Effecting Medication | 30 | 4 | $\chi^2(1) = 12.53, p < .001$ |

PTSD, posttraumatic stress disorder.

demonstrate a stronger association between hostility and ambulatory cardiovascular parameters than women without PTSD.

## Methods and Materials

### Participants

A total of 193 women were screened for this study between 2001 and 2005. Participants were recruited via advertising at two local medical centers for a study on trauma and health, and all participants gave informed consent on the basis of a protocol that was in compliance with local institutional review boards. The Clinician Administered PTSD Scale (CAPS) was used to determine PTSD diagnostic status (24), and the Structured Clinical Interview for DSM-IV (SCID) (25) was used to diagnose other Axis I disorders. Any potential participants meeting criteria for current alcohol or other substance dependence/abuse ($n = 7$) or psychotic disorders (including schizophrenia and bipolar with active manic symptoms; $n = 4$) were excluded. Two additional participants were excluded during the screening process due to medication usage (amytriptyline and methadone). Participants recruited for the comparison group were excluded if they met criteria for lifetime PTSD ($n = 27$) or if they met criteria for current or lifetime major depressive disorder ($n = 18$). Finally, two participants were excluded from these analyses due to missing log data as described in further detail in the following text. On the basis of the structured clinical interviews, the remaining 117 study participants were classified into the following two groups: PTSD ($n = 67$) and non-PTSD comparison ($n = 50$). Eight diagnostic raters were used, and interrater reliability for diagnoses on the basis of videotapes of patient interviews was $\kappa = .94$. Participants were compensated $250 ($50 for screening interview and $200 at study completion).

This sample reported a wide range of index trauma exposures. For participants not diagnosed with PTSD, 40 (80%) reported a criterion A trauma in their history. The following were endorsed as the index trauma: childhood physical or sexual assault (12% in non-PTSD; 22% in PTSD); adult physical or sexual assault (5% in non-PTSD; 17% in PTSD); domestic violence (8% in non-PTSD; 20% in PTSD); witnessing violence as an adult (3% in non-PTSD; 4% in PTSD); witnessing violence as a child (10% in non-PTSD; 4% in PTSD); death of someone close to them (32% in non-PTSD; 21% in PTSD); accident (3% in non-PTSD; 3% in PTSD); natural disaster (5% in non-PTSD; 0% in PTSD); and other traumatic event (22% in non-PTSD; 9% in PTSD).

Medications were recorded, and anyone taking a medication with cardiovascular effects (e.g., beta-blocker, diuretic) was classified as taking a cardiac affecting medication. This included psychiatric medications that could affect cardiac function (e.g., beta blockers, α adrenergic blockade medication, and anticholinergic) were also counted as a cardiac affecting medication. Statistical comparisons for demographic and diagnostic characteristics and cardiac medication use between PTSD and comparison group are reported in Table 1.

### Measures

A series of self-report measures were also administered. These questionnaires included the short form of the Cook-Medley Hostility Scale (26), the Buss-Durkee Hostility Inventory (27), the Spielberger Anger Expression Scale (28), and the Rotter Interpersonal Trust Scale (29).

### Procedure

Participants were screened for eligibility with the CAPS and the SCID (and a urine sample was used to corroborate alcohol/drug use reports on the SCID). Eligible participants returned for a second visit (arriving at the laboratory between 8:00 and 9:00 AM) during which time they were instructed in the use of their ambulatory blood pressure/heart rate monitor. Monitors and a log of readings and activity level were returned during a third and final study visit.

### Ambulatory Monitoring

Participants were fitted with an ambulatory recorder: the Accutracker II (Suntech Medical Instruments, Raleigh, North Carolina) or the Spacelabs 90207. Reliability and validity of these recorders have been demonstrated previously (30,31). There was some difficulty in obtaining valid readings with the Accutracker, particularly in women with greater arm circumference. Thus, once invalid measurements were obtained for participants with the Accutracker II, a Spacelabs 90207 ambulatory monitor was purchased and instead used for these participants (14%). Participants were instructed to carry on with their usual daily activities, to keep their nondominant arm (where the cuff was attached) at their side whenever the recorder operated, and to wear the monitor for 24 hours.

The recorder was programmed to operate every 30 ± 5 min during waking hours on the basis of self-reported sleep/wake times. On each measurement occasion, single readings were obtained of AHR and ambulatory systolic (ASBP) and diastolic (ADBP) blood pressure. Both monitors were programmed to