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Blood Pressure Dipping and Urban Stressors in Young Adult African Americans

Thomas A. Mellman, M.D.^{1,2}, Tyish S. Hall Brown, Ph.D., M.H.S.¹, Ihori Kobayashi, Ph.D.¹, Soleman H. Abu-Bader, M.S.W., Ph.D.³, Joseph Lavela, B.S.¹, Duaa Altaee, B.A.¹, Latesha McLaughlin, B.S.¹, and Otelio S. Randall, M.D.⁴

¹Howard University College of Medicine, Department of Psychiatry and Behavioral Sciences

²Center for Clinical and Translational Sciences

³Howard University School of Social Work

⁴Department of Medicine, Division of Cardiology

Abstract

Background—Blunted nocturnal blood pressure (BP) dipping is an early marker of cardiovascular risk that is prevalent among African Americans.

Purpose—We evaluated relationships of BP dipping to neighborhood and posttraumatic stress and sleep in urban residing young adult African Americans.

Methods—One hundred thirty six Black, predominately African American, men and women with a mean age of 22.9 (SD = 4.6) filled out surveys, were interviewed and had two, 24-hour ambulatory BP recordings.

Results—Thirty eight percent had BP dipping ratios < .10. Wake after sleep onset (WASO), neighborhood disorder and neighborhood poverty rates but not posttraumatic stress symptoms, and other sleep measures, correlated significantly with dipping ratios. Models with the neighborhood measures that also included WASO increased the explained variance.

Conclusions—Studies elucidating mechanisms underlying effects of neighborhoods on BP dipping and the role of disrupted sleep, and how they can be mitigated are important directions for future research.

Keywords

blood pressure dipping; African American; neighborhood disorder; posttraumatic stress; sleep

INTRODUCTION

African Americans have worse outcomes for numerous chronic health conditions. Cardiovascular diseases are particularly common, with greater rates of hypertension, and rates of deaths from coronary heart disease and strokes that are one third to two times higher

than the rates for other racial/ethnic groups in the United States (1). Determinants of these disparities are complex and include environmental and behavioral factors (1). Identification of specific contributors is critical for developing effective prevention. Given evidence that the pathogenesis of cardiovascular disease begins at an early age (2), markers of early risk are needed.

Blood pressure (BP) normally diminishes to its lowest levels at night during sleep. Blunting of this nocturnal reduction or non-dipping is associated with increased risk for end-organ diseases (3). Non-dipping is more common among African Americans than comparison groups (reviewed in 4) and this disparity has been documented in adolescents (5).

Stressful neighborhood environments, posttraumatic stress, and compromised sleep are environmental/behavioral factors that have been implicated in nocturnal BP regulation and cardiovascular disparities more broadly. Distressed poor urban neighborhoods have been linked to a range of negative health outcomes. This effect has been hypothesized to be a consequence of the stress of ongoing threat engendered by high unemployment rates, crime, and physical decay, as well as limited opportunities for physical activity and purchasing healthy food (6). In a recent study of 133 adults of whom 53 were Black, a measure of neighborhood problems accounted for 6% of the variance in nocturnal dipping of mean arterial blood pressure (MAP) independent of social status, age, gender, race, body mass index (BMI), smoking, exercise, depression and discrimination (7). Violence exposure has been linked to BP non-dipping in adolescents (5) and to posttraumatic stress disorder (PTSD) (8) and PTSD has been prospectively linked to cardiovascular disease (9). Short sleep and insomnia have also been linked to cardiovascular disease (10, 11) and poor sleep quality has been associated with BP non-dipping (12).

Distressed neighborhoods, PTSD, and compromised sleep are inter-related and are particularly salient to urban residing minorities. African Americans are more likely to live in the largest cities and have higher poverty rates than any other racial ethnic groups (<http://www.census.gov/hhes/www/poverty.html>). Exposure to interpersonal violence is common in high density, lower income urban environments (13). In a National survey, Blacks and Hispanics had higher rates of exposure to violence, and 9 percent of Blacks were found to have the highest rates of PTSD (14). Population data indicate that sleep durations of less than 6 hours were more common among African Americans and that this association was partially explained by the African Americans more often living in inner cities (15).

Confirming the relationships between distressed neighborhoods, PTSD, and compromised sleep with BP dipping and evaluating their inter-relationships, which do not appear to have been addressed in previous studies, would inform development of preventive strategies. Neighborhood threat and PTSD could both engender heightened arousal into the sleep period and both are associated with compromised sleep. We hypothesized that both would have independent inverse relationships with BP dipping that would be partially mediated by reduced sleep duration and greater sleep disruption.

METHODS

Participants

Participants were recruited between 2008 – 2012 from the Washington, DC metropolitan area primarily by flyers and referrals from previous study participants. The study setting was the clinical research unit of the medical center for Howard University (HU), a Historically Black institution in urban DC. The protocol was approved by the HU Institutional Review Board and all participants received detailed description of the study and reviewed and signed the informed consent document. Initial advertisement included the University campus, however, in order to balance study recruitment flyers were only posted in community settings that represented the study target demographics (e.g. near the University and Southeast D.C.) for the latter 2/3rds of the recruitment period.

During initial screening, potential participants were ineligible if they reported height and weight with a calculated body mass index ≥ 40 , excessive use of caffeine (> 5 cups of coffee per day or its equivalent of other caffeinated drinks), heavy smoking (> 20 cigarettes per day) and drinking (> 14 drinks/week in men, > 7 drinks/week in women), chronic medical conditions or severe psychiatric illnesses (i.e. schizophrenia, bipolar, chronic depression, psychotic disorders) that required consistent use of medications, or had regular night shift work.

Participants for the laboratory phase were selected from those who filled out questionnaires based on availability and interest, and to balance the sample by increased selection of men, participants who screened positively for PTSD, and participants from the community. Additional exclusion criteria for the final study group were a current psychiatric disorder other than PTSD, phobic disorders, or depression that was secondary in onset and severity to PTSD, current alcohol or drug abuse/dependence elicited through the structured clinical interview, positive urine toxicology for illicit drugs, sleep apnea defined as an apnea/hypopnea index of ≥ 10 on a screening sleep recording, and non-adherence to the protocol.

Self-report Measures

These included a demographic questionnaire that obtained information on age, gender, race, highest educational level, and home address. Neighborhood stress was assessed by the City Stress Index (CSI), an 18-item self-report measure that queries for indicators of stressful urban environments such as abandoned houses, the sound of gunshots and dilapidated buildings. It has a 4-point response format ranging from never to often or none to most (16). The scale generates a composite score of neighborhood stress with subscales measuring neighborhood disorder and exposure to violence (in distinction from PTSD assessment, violence toward family members or friends). In our sample the inter-correlation of these subscales was $r = .66$ and they had distinct patterns of correlation with study dependent variables and are therefore both represented in analyses. Cronbach's alpha for the sample was .85 for neighborhood disorder and .87 for exposure to violence. Neighborhood disorder was significantly correlated with the rate of violent crime for the census tract, $r = .38$, property crime, $r = .31$, and poverty rates, $r = .26$, all p 's $< .01$. Exposure to violence was only correlated with violent crime, $r = .28$, $p < .01$.

Subjective sleep assessments included the Insomnia Severity Index which measures the amount of difficulty falling asleep, staying asleep, and waking early, satisfaction with sleep, impact of insomnia on daily functioning, degree to which others notice, and the amount of distress caused by lack of sleep for the past two weeks using five-point Likert-ratings. A cutoff score of 10 represents clinically significant insomnia in community populations (17). Cronbach's alpha for our sample was .89. A sleep survey, developed by the investigative team and modeled after standard sleep diaries, asked participants to report their typical bed and wake times (for weekdays and weekends), number and duration of awakenings, and length of time it took to fall asleep, over the past month. This information was used to calculate estimates of total sleep duration and wake after sleep onset (WASO) with weighted averages calculated from reports of weekday and weekend patterns. WASO was calculated as the number of awakenings times the estimated duration of awakenings (minutes) between the initial onset of sleep and the terminal awakening.

Census Tract Indicators

Census tracts were identified using the U.S. Census Bureau's online geographic locator (www.factfinder.census.gov) from the home address filled out on the demographic form. Rates for violent and property crime and poverty for each tract were obtained from www.neighborhoodinfodc.org or <http://factfinder2.census.gov>. Addresses were unavailable for 13 of the completing study participants.

Interviews

The Clinician Administered PTSD Scale (CAPS) is a structured clinical interview designed to determine DSM-IV diagnostic criteria and symptom severity (18). Cronbach's alpha for current PTSD severity for this sample was .94. The Structured Clinical Interview for the DSM-IV was used to determine lifetime and current mood disorders, psychotic disorders, other anxiety disorders, substance abuse/dependence and eating disorders (19). All structured interviews were conducted by trained staff and were reviewed by the first author (TAM) who is a licensed psychiatrist.

Laboratory Procedures

Two overnight polysomnography recordings were obtained 1–2 weeks prior to, and continuous electrocardiogram recordings were obtained concurrently with BP monitoring. Other than apnea screening, data from these procedures are reported elsewhere. Two, 24-hour ambulatory BP (ABP) recordings were conducted 1-week apart. Monitoring utilized an oscillometric method (Spacelabs 90207) and was initiated during the morning hours at Howard University Hospital's clinical research unit. The ABP monitors were programmed to record blood pressure every hour. Participants left the research unit and assumed normal daytime activities and returned the following morning. Mean daytime and nighttime systolic and diastolic BP measures are reported, however, their weighted average, mean arterial pressure (MAP), calculated from the two, 24-hour recordings were used for analyses. Nocturnal BP variables were derived by averaging MAP from time in bed (nocturnal) and time out of bed (wake) following the terminal awakening as noted in a brief sleep diary form. The nocturnal BP dipping ratio was calculated as (mean wake MAP – mean nocturnal MAP)/wake MAP. For descriptive purposes non-dippers were categorized based on a value

< .10. Participants also wore actigraphs (MicroMini-Motionlogger, AMI, Ardsley, NY) during the BP monitoring and data were used to confirm diary reported sleep times and to analyze potential relationships between BP dipping and concurrent objective sleep measures.

Data Analysis

All data analyses were conducted with SPSS version 20 (IBM). Data were checked for normality and log transformations were performed for CAPS scores and WASO. Pearson correlations were calculated for BP dipping ratios with age, BMI, PTSD and the sleep measures, the CSI subscales, and neighborhood rates for violent and property crime and poverty. The contribution of the prior variables significantly associated with BP dipping to significantly related neighborhood variables were then tested in regression models.

RESULTS

One hundred eighty participants were invited to participate in the interview and laboratory phase of the study. Of these, 12 were excluded due to positive urine toxicology findings and 6 due to apnea/hypopnea indices > 10. An additional 5 participants were identified as having other exclusion criteria or did not follow through with assessments. Of the remaining 157 participants, BP recordings were not completed or usable in 21, leaving 136 participants whose data were analyzed for this report. This subsample was similar to the 180 invited for the laboratory phase procedures with respect to the distribution of men and women and trauma and PTSD categories. Their mean age was 23.1 (SD = 4.7) and 54.4% (n = 74) were female. Eighty one percent (n = 110) identified as African American, 8.8% African, 7.4% Caribbean, .7% Black-Hispanic, and 2.2% as biracial. Most participants (97%) were single and 84.6% had no children. Fifty eight percent indicated being a student (of various institutions) and 37.5% (n = 51) were living on the Howard University campus.

Eighty three percent (n = 113) had a lifetime trauma meeting DSM-IV criterion A for PTSD; 16.2 % of the total met full current PTSD criteria, and 14.7% had current sub-threshold symptoms (at least 2 but not 3 of the symptom cluster criteria) (i.e. 30.9%, n = 42, with current significant PTSD symptoms); an additional 20.6% (n = 28) met criteria for PTSD during their lifetime and had recovered, and 66 (44.5% of the study group), 23 of whom were trauma exposed, never developed PTSD. Seven (5.1%) met current criteria for major depression (all comorbid and secondary in onset to PTSD) and an additional 26 (19.1%) had prior major depression during their lifetime. Forty three percent (n = 59) endorsed symptoms consistent with current clinically significant insomnia. Fifteen percent (n = 20) had BMIs over 30 (i.e. were obese) and an additional 37.5% (n = 51) were overweight. Twelve participants (8.8%) reported smoking cigarettes (< 20/day). Smoking was not associated with BP dipping (p = .98). Fifty two of 136 (38.2%) had mean nocturnal dipping ratios below the common literature cutoff of .10. Average BPs were in the normal range and are presented in the Table along with dipping ratios for systolic, diastolic BPs and MAP.

The participants' residences represented a range of neighborhoods of the District of Columbia. Thirty seven percent lived in Ward 1, in Northwest DC where Howard University is located, and an additional 10% lived in adjacent wards. Seventeen percent lived in Northeast D.C. and 11% lived in Southeast DC Wards east of the Anacostia River. Twenty

five percent lived in nearby counties in Maryland or Virginia and most of those not residing in DC (20% of the total) living in Prince George's County Maryland. Overall these are predominately African American neighborhoods ranging from poor to middle class. Data from census tract information indicated mean rates of violent crime of 11.1/1,000 individuals (SD = 8.5) and mean rates for property crime of 40.2/1,000 (SD = 16.6). The mean rate for violent crime in the U.S. for 2012 was 3.87/1,000 people and 28.6/1,000 for property crime (www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2012). The mean poverty rate for participants' neighborhoods was 18.9% (SD = 10.8) with the national rate being 15.9% (www.census.gov/prod/2013pubs). In order to exclude effects of BP measurement disrupting sleep, correlations were calculated for BP dipping ratios with concurrent actigraphic WASO and sleep duration measures from the same 24 hour period were calculated and none were significant (all p 's > .10).

Correlations with BP dipping ratios for age, BMI, PTSD and the sleep measures are presented in Table 1. The only significant correlation was with 1 month subjective WASO ($r = -.18$, $p = .050$). Neighborhood measures including the neighborhood disorder subscale of the CSI ($r = -.21$, $p = .02$) and poverty rates ($r = -.20$, $p = .03$) were significantly correlated with BP dipping ratios. Hierarchical regression models were calculated to evaluate the inter-relationships of neighborhood disorder and poverty levels with WASO in predicting BP dipping ratios and are presented in Table 2. The strength of the relationships with these 2 neighborhood variables were minimally affected by adding WASO to the model, however the addition of WASO increased the variance explained by 3.0 and 2.8 percent, respectively. These relationships were not affected by adding age, BMI and sex to the respective models, none of which had significant or trend level relationships with BP dipping.

DISCUSSION

While our evaluation included measurements of PTSD and multiple sleep indices, only self-reported and a census derived indicators of distressed neighborhoods, and a self-reported measure of habitually disrupted sleep were significantly correlated with nocturnal BP dipping in our sample of urban residing young adult African Americans. Not finding the expected relationship with PTSD may have been related to the younger age of our sample as health risks of PTSD likely interact with aging. Our sample was also non-clinical with less severe symptoms than what has been represented in prior PTSD cardiovascular risk studies. It is also possible that in populations affected by stressful neighborhood environments the effects of PTSD are less salient.

Our analyses do not indicate relationships of BP dipping with sex, age or BMI. BP dipping was specifically related to the neighborhood disorder subscale which queries exposure to crimes, police activity, drug-related, and other threatening neighborhood activity (16). These items overlap the scale utilized by Euteneuer et al. (7) that has items referencing crime, vandalism, litter and noise. Our study provides validation of these relationships in demonstrating a similar strength relationship of BP dipping with poverty rates. The absence of significant or trend level relationships with self-reported "Exposure to Violence" and violent crime rates suggest a greater effect of persisting environmental exposure than past violent episodes.

The only sleep index that showed significant relationships to BP dipping and a contribution to the effect of neighborhood environments was the measure of WASO derived from the estimates of the typical number and duration of awakenings from the past month. Objectively measured WASO from the nights of BP monitoring was over two times greater than the estimates for the past month and did not correlate with the BP dipping ratios (see Table 1). It is possible that WASO was increased by the hourly BP measurements during sleep, however, WASO in the home environment has been found to be underestimated absent blood pressure measurement (20). The absence of significant associations with concurrently recorded actigraphic sleep measures argues against blunted nocturnal BP dipping simply being an artifact of awakening. Population studies that have linked adverse health consequences with compromised sleep typically utilized self-report estimates of sleep duration and not WASO. It is possible that sleep disruption has greater contribution toward health risk than sleep duration in young urban minority populations.

Limitations of this study include that it was cross-sectional, from a single-site, and recruitment was not achieved through systematic sampling. The participants did, however, represent a range of socio-economic strata including residence in relatively distressed urban neighborhoods. Generalizability may be affected by the representation of students enrolled in college (57%). According to a recent document of the American Council on Education (21) 35.3% of African Americans age 18 to 24 were estimated to be enrolled in college in 2009. Less than half of our sample attending college, however, lived on a college campus, and those who lived at Howard University are exposed to urban stress. Other limitations include that BP measures of 1 hour would not capture all fluctuations and ecological data other than for sleep that could explain some of the BP variations was not captured. Exclusion criteria needed to avoid confounding relationships to BP (e.g. morbid obesity, shift work) limit generalizability of the sample.

Although the amount of variance explained in our study was limited, the associations indicate a relationship of neighborhood environment to an important early indicator of cardiovascular risk and a contribution of disrupted sleep. A societal goal of reducing the threatening characteristics of neighborhoods could therefore confer benefits to public health and diminish health disparities. In addition, confirming and determining pathways underlying the effect of neighborhood environments and sleep disruption on healthy nocturnal cardiovascular relaxation and how they can be mitigated by behavioral and/or pharmacological interventions are important directions for future research.

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Biography

Thomas Mellman received a consulting fee from Tonix Pharmaceuticals during the past 2 years. Drs. Hall Brown, Kobayashi, Abu-Bader, and Randall, and Mr. Lavela, and Ms. Altaee and McLaughlin have no potential conflicts of interest. All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

Table 1

Blood pressure (BP) measures with relationship of mean arterial pressure (MAP) dipping to age, body mass index (BMI), posttraumatic stress disorder (PTSD) and sleep

	mean (SD); Range	
Daytime systolic BP	123.4 (10.6); 91 – 155	
Nighttime systolic BP	116.3 (11.8); 93 – 153	
Systolic dipping ratio	.06 (.07); –.16 – .18	
Daytime diastolic BP	72.8 (7.4); 55 – 98	
Nighttime diastolic BP	64.7 (7.8); 47 – 89	
Diastolic dipping ratio	.11 (.12); –.31 – .36	
Daytime MAP	0.3 (6.6); 75 – 114	
Nighttime MAP	80.3 (7.7); 68 – 114	
MAP dipping ratio	.11 (.05); –.095 – .25	
		Correlation with MAP dipping ratio
Age	22.9 (4.6); 18 – 35	.08
Body Mass Index	25.3 (4.5); 17 – 40	–.05
PTSD severity (CAPS^I score)	21.6 (20.5); 0 – 80	–.03
Insomnia Severity	9.8 (6.5); 0 – 25	–.13
1 month subjective TST^I	380.7 (103.0); 142.1 – 684.1	.05
1 month subjective WASO^I	28.2 (37.5); 0 – 240.0	–.18*
2 night Actigraph TST^I	345.4 (90.4); 157.5 – 541.0	.12
2 night Actigraph WASO^I	70.2 (53.1); .5 – 274	–.14

*
p .05

^ICAPS – Clinician Assessed PTSD Scale, TST – total sleep time (minutes), WASO – wake after sleep onset (minutes)

Table 2

Hierarchical Regressions predicting Nocturnal Blood Pressure Dipping

	Nocturnal Dipping ratio				Nocturnal Dipping ratio		
	β	p	R ²		β	p	R ²
Model 1:				Model 1:			
Neighborhood Disorder	-.16	.08		Poverty rate	-.16	.09	
			.026				.027
Model 2:				Model 2:			
Neighborhood Disorder	-.15	.09		Poverty rate	-.16	.09	
WASO ¹	-.17	.06		WASO	-.17	.08	
			.056				.055

¹ WASO – wake after sleep onset (minutes)