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Stress, positive affect, and sleep in older African American adults: a test of the stress buffering hypothesis

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Abstract

Background: Although sleep disparities contribute to racial health disparities, little is known about factors affecting sleep among African Americans. One such factor may be positive affect, which could impact sleep directly (direct effect hypothesis) or indirectly by buffering the effects of stress (stress buffering hypothesis).

Purpose: We tested the direct effect and stress buffering effects of positive affect on sleep at three levels (day, week, trait) in a sample of 210 older African American adults, ranging in age from 50 to 89 years old.

Method: Daily positive affect, perceived stress, sleep quality, and sleep duration were collected for five consecutive days. Multilevel modeling was used to test the direct and stress buffering hypotheses both within-person (day level) and between-persons (week level). Trait positive affect, past five-year stress severity, and global sleep quality were assessed cross-sectionally. Regression was used to test the direct and stress buffering hypotheses at the trait level.

Results: In line with the direct effect hypothesis, higher week-level positive affect predicted better sleep quality and sleep duration. Day-level positive affect was not significantly associated with daily sleep quality or daily sleep duration. Higher trait positive affect predicted better global sleep quality. However, neither day-level perceived stress nor past five-year stress severity significantly interacted with positive affect measures for any sleep outcome; no interaction effect was observed on week-level sleep duration. Positive affect and perceived stress interacted at the week level to predict sleep quality, but not in the hypothesized direction.

Conclusions: We found support for the direct effect hypothesis at the week- and trait-levels, but not at the day level. In contrast, we found no support for the stress buffering hypothesis.

Key words: sleep quality; sleep duration; perceived stress; multilevel modeling; racial health disparities.

Sufficient, high-quality sleep is vital for maintaining health.[1–4] The National Sleep Foundation recommends seven-to-eight hours of sleep per night for older adults.[5] Deviating from this range—whether sleeping more or less—has been associated with increased risk for several major adverse health outcomes, including cardiometabolic disease.[6–8] However, achieving adequate sleep is not equally accessible to everyone.

Due to a variety of psychosocial, interpersonal, societal, and community factors, African Americans tend to experience poorer sleep compared to White Americans.[9,10] Increased exposure to stress, including psychosocial stressors (eg, racism-related vigilance), interpersonal stressors (eg, experiences of discrimination), and environmental stressors (eg, neighborhood-level poverty, noise exposure), likely contribute to poor sleep among African Americans.[11,12] These sleep health disparities may in turn contribute to broader racial health disparities, particularly concerning cardiometabolic health outcomes.[12–14] Positive affect could improve sleep outcomes, either directly or by buffering against the negative effects of stress.[15,16] A more nuanced understanding of the factors that promote good sleep among older African American adults could inform the development of targeted interventions to reduce racial health disparities, and lead to substantial public health benefit.[14,17] To date, however, little research has examined psychosocial factors in relation to sleep within older African American adults. To address this gap, we examined the effects of positive affect and stress on sleep in older African American adults.

Positive affect encompasses pleasant subjective feelings (eg, happiness, excitement).[18] Research suggests that higher positive affect is associated with better sleep,[19] as well as reduced risk of morbidity and mortality.[20,21] Such associations are independent of negative affect and depressive symptoms, suggesting that positive affect may elicit unique and protective physiological and behavioral responses.[22,23] Interestingly, despite being afflicted by both sleep[17,24] and cardiometabolic health disparities,[25] African Americans tend to report significantly higher positive affect than Whites.[26] Research to elucidate the effects of positive affect on sleep and health among African Americans is therefore warranted.

Pressman and Cohen (2005) proposed two primary pathways by which positive affect may influence health outcomes: direct effect(s) and/or stress buffering.[20] In the direct effect pathway, positive affect is hypothesized to directly influence health and health behaviors, such as sleep. High levels of positive affect have been associated with reduced cortisol output over one day, lower ambulatory heart rate, and a reduced plasma fibrinogen response to a laboratory stressor.[15,16] Importantly, these results were independent of stress levels, suggesting a direct effect of positive affect on physiological processes.[15,16] Research has also found that high positive affect is associated with fewer self-reported sleep problems, such as difficulty falling asleep and difficulty staying asleep, while the opposite has been found for low positive affect.[19,23,27] In the stress buffering pathway, positive affect attenuates the negative impact of stress on sleep. During stressful periods, positive affect may facilitate adaptive coping, enabling individuals to process stressors before they disrupt sleep.[28] Evidence supporting the stress buffering hypothesis has been found in older adult caregivers.[28] However, little research has examined whether positive affect buffers the effect of stress on sleep in older adults more broadly.

Positive affect can occur briefly as state positive affect, or persistently as trait positive affect.[20] State positive affect fluctuates within individuals over time, while trait positive affect reflects stable between-person differences in overall affect. Both higher state and trait positive affect have been linked to enhanced sleep quality.[20,27] Although initial evidence suggests that trait positive affect may be a better predictor of actigraphy-measured and self-reported sleep measures of sleep quantity and quality compared to state positive affect,[19,27] more research is warranted to disentangle their respective effects. To this point, prior studies have found that average sleep quality and quantity across time and variability in sleep quality and quantity on a day-to-day basis can both affect health objective and subjective sleep outcomes.[7,29,30] Therefore, research aimed at delineating how psychosocial factors impact sleep across varying timescales is needed.

To address these gaps in the literature, we examined the influence that positive affect has on sleep at multiple levels in a population affected by sleep health disparities: older urban African American adults. Based on extant research, we hypothesized that: (a) higher levels of positive affect would be associated with better sleep both within-persons (day-level) and between-persons (week-level; direct effect hypotheses); (b) higher levels of positive affect would attenuate the negative effect of perceived stress on sleep, at both the day and week level (stress buffering hypothesis); and (c) similar patterns of results would emerge in trait-level analyses, supporting the direct effect and stress buffering hypotheses using cross-sectional measures of positive affect, perceived stress, and sleep quality (trait hypotheses).

Method

Participants and procedure

Data from the present study come from the Health among Older Adults Living in Detroit (HOLD) project, a study on healthy aging among older, community-dwelling African American adults living in the Detroit area. Participants were primarily recruited through the Institute of Gerontology's Healthy Black Elders Center Participant Research Pool.[31] Snowball sampling and advertisements placed in the local community were also used. Eligible participants self-identified as African American, lived in metro Detroit area, and were at least 50 years old.

Data collection occurred between November 2017 and March 2020, and consisted of two home visits, separated by a five day at-home daily diary period plus two days on which participants independently completed additional questionnaires. At the first home visit, participants provided written informed consent, completed a series of questionnaires (including demographic measures, stress, and health behaviors), and received detailed instructions regarding at-home measures. During the at-home period, participants completed questions related to daily mood, activities, and experiences once per day for five days. The trait affect questionnaire was also completed independently during the at-home period. Blood was collected at the second home visit, along with anthropometric and health measures. Participants were compensated for their participation. All study procedures were approved by the Wayne State University Institutional Review Board.

A total of 211 older African American adults enrolled in HOLD; one participant withdrew, leaving an overall sample of 210. Sample size was determined based on prior similar studies[32,33] and available research funds. Although the project aimed to recruit a larger number of participants, further recruitment was halted due to the COVID-19 pandemic. Participants ($n = 10$) were excluded from the multilevel analyses if they had no data for daily sleep duration and daily sleep quality on all five days, leaving an analytic sample of 200 (age = 67.64 ± 8.30 years; 74% female). For the trait analyses, participants ($n = 7$) were excluded if they had no data for global sleep quality, leaving an analytic sample of 203. Detailed participant characteristics can be found in Table 1.

Table 1. Participant characteristics

Continuous variable	Mean ± SD
Age	67.64 ± 8.30
Daily sleep duration	7.03 ± 1.44
Daily sleep quality	4.70 ± 1.25
Daily perceived stress	0.84 ± 0.60
Daily positive affect	2.51 ± 0.76
Global sleep quality	6.52 ± 3.84
Stress severity (past 5 years)	8.14 ± 8.77
Trait positive affect	3.51 ± 0.8
Self-rated health	3.15 ± 0.98
Categorical variable	**%**
Sex (Female)	74
Education	
High school diploma or less	18
Some college to 2-year degree	49
4- or 5-year degree or more	33
Income	
<$5,000–$19,999	45
$20,000–$59,999	45
≥$60,000	10

Measures

Positive affect

Day-level positive affect was assessed as part of the daily diary using the positive items from a modified version of the Trait Adjective Questionnaire (TAQ),[34,35] adapted to reflect same-day affect. The original TAQ contains 61 items.[34] To reduce participant burden and aid full completion of daily diaries, we used a version of the TAQ previously adopted by Cohen and colleagues that contains nine items across three subcategories of positive affect (vigor, well-being, and calm).[35] To further reduce participant burden in the daily diary while still capturing the multidimensional nature of positive affect, two items were retained from each subcategory.

Participants were asked to report how often they felt each of six positive emotions (eg, "happy," "calm") throughout the day on a scale from 1 (*none of the time*) to 5 (*all of the time*) on each day of the daily diary period. The average of the six items was used to assess day-level positive affect, with higher scores reflecting more positive affect. These scores were then person-mean centered. Positive values indicate that positive affect on that day surpassed the individual's weekly average, while negative values indicated positive affect below their weekly average. Additionally, positive affect was averaged across days into a composite representing positive affect at the week level; these scores were then grand-mean centered. Positive values therefore indicate that a participant has higher positive affect on average across the week compared to other participants, while negative values represent participants with lower-than-average positive affect. The intraclass correlation coefficient (ICC) for daily positive affect across the daily diary period was .69.

Trait-level positive affect was measured cross-sectionally during the at-home assessment period using a modified version of the TAQ.[35] Participants were asked to indicate how accurately each of nine positive emotions (eg, "happy," "calm") describes them as they generally or typically are. Response options ranged from 1 (*not at all accurate*) to 5 (*extremely accurate*). The average of the nine items was used to assess trait-level positive affect; scores were grand-mean centered. Higher scores indicate greater trait level positive affect. Cronbach's alpha for the trait-level positive affect items in the present study was .90.

Perceived stress

Day-level perceived stress was assessed using a version of the Perceived Stress Scale 4 (Cohen, 1983) modified to ask about perceptions of stress on each day. Each day of the daily diary period, participants were asked to respond to four items describing their level of perceived stress (eg, "Thinking about today, how often did you feel that you were unable to control the important things of the day?") on a scale from 1 (*never*) to 5 (*very often*). Positively worded items were reverse coded. The average of the four items was used to assess day-level perceived stress; daily scores were person-mean centered. Higher scores reflect more perceived stress. Week level scores were created by averaging across days, then grand-mean centering. The ICC for daily perceived stress across the daily diary period was .56.

Stressor exposure severity

Past five-year stressor severity, an index of stressor perception across a broader timescale, was assessed using the Stress and Adversity Inventory for Adults (STRAIN),[36] which was administered during the first home visit. The STRAIN is a NIMH/RDoC-recommended measure for comprehensively assessing the count and severity of stressors occurring across the life course (see https://www.strainsetup.com). A total of 55 unique stressors are assessed; for each stressor that a participant endorses, follow-up questions probe the severity, frequency, exposure timing, and duration of the stressor. In HOLD, the STRAIN was administered in an interview style by a trained research assistant. Past five-year stressor severity was indexed as the sum of the stressor severity ratings for stressors experienced in the five years preceding the assessment. Scores were grand-mean centered, and higher scores reflect more perceived stress. The STRAIN has high test-test reliability (ICC for lifetime stressor count and severity = 0.936 and 0.953, respectively); concurrent, discriminant, and incremental validity; and predictive utility in relation to numerous outcomes, including sleep.[37–40]

Daily subjective sleep quality and sleep duration

Daily subjective sleep quality was assessed using a single item in the daily diary every day for five days. Participants were asked to respond to the question, "Overall, how did you sleep last night?" Response options ranged from 1 (*terrible*) to 8 (*great*). Higher scores reflect better subjective sleep quality. Single items of sleep quality are commonly used in repeated measures designs to reduce participant burden, and past research has supported the validity and reliability of such items.[41,42] The ICC for daily sleep quality across the daily diary period was .60.

Daily sleep duration was assessed using the difference, in hours, between the time that the participant reported falling asleep the night before and the time the participant reported waking up in the morning on the day of the daily diary entry. The ICC for daily sleep duration across the daily diary period was .38.

Global sleep quality

Global sleep quality was assessed as the global score from the Pittsburgh Sleep Quality Index (PSQI),[43] which was administered during the first home visit. The PSQI is a widely used 19-item sleep quality inventory assessing aspects of sleep across the past month. Established scoring guidelines were followed. Briefly, seven sleep component scores were derived, representing sleep duration, sleep disturbance, sleep latency, daytime dysfunction due to sleepiness, sleep efficiency, overall sleep quality, and sleep medication use. Components were then coded on a three-point scale ranging from 0 (*no dysfunction*) to 3 (*greatest dysfunction*). Component scores were summed into a total score, which can range from 0 to 21. Higher PSQI scores represent poorer global sleep quality. The PSQI has demonstrated moderate to good test-retest reliability in prior studies (ICCs between .70 and .86).[44] In the present study, Cronbach's alpha for the seven PSQI components was .72.

Covariates

Demographic covariates were assessed the first home visit and included sex (1 = male, 2 = female), age, and socioeconomic status (SES; a composite of income and education). Income was assessed as self-reported household pre-tax income, on a scale from 1 (<\$5,000) to 13 (≥\$150,000). Education was assessed as self-reported highest level of education, on a scale from 1 (*No school/some grade school*) to 12 (*Ph.D. or other professional degree*). To create the SES composite score, income and education were both Z-score standardized; the mean of these standardized variables was then taken. Higher scores represent higher SES. Self-rated health was also included as a covariate due to overlap between the constructs of positive affect and health.[45] Self-rated health was assessed using a single item ("In general, would you say your health is":) on a scale from 1 (*excellent*) to 5 (*poor*); this item was reverse coded so that higher scores represent better self-rated health. Age and self-rated health were grand-mean centered to improve the interpretability of the results.

Data analysis

Overview

All analyses were conducted in R.[46] Multilevel modeling was used to examine day level (within-person) and week level (between-person) associations between self-reported measures of daily positive affect, daily perceived stress, and daily sleep across a five-day period. The lme4 package[47] was used to estimate all multilevel models. Person-mean centering and grand-mean centering were used to disaggregate within- and between-person variability in daily positive affect and daily perceived stress. Additionally, grand-mean centering was used on all other continuous variables to improve the interpretability of the results. Linear regression was used to examine trait-level associations between measures of positive affect, perceived stress, and sleep quality taken cross-sectionally at one time point.

Multilevel imputation

For the multilevel analyses, data were missing at the day level. All variables were missing <9% of observations, except sleep duration, which had 189 (18.9%) missing observations. These rates of missingness are not uncommon in repeated measures designs. To properly account for missingness within a multilevel data structure, multilevel multiple imputation was used; multiple imputation produces less biased estimates and is less error prone than listwise and pairwise deletion.[48] The packages pan[49] and mitml[50] were used for multilevel multiple imputation, following guidelines for multiple imputation of random intercepts models.[49] In line with these guidelines, 100000 burn-in iterations were generated; after this, 100 imputations were generated, spaced 20 000 iterations apart. To examine whether the use of multiple imputation impacted the results, supplementary sensitivity analyses were conducted in which each model was run using non-imputed data.

After imputation, day-level and continuous variables were person-mean and grand-mean centered in each imputed data set as needed. Items in the daily diaries asked about positive affect and stress on that day, and about sleep quality the night before. Day-level positive affect and day-level perceived stress were therefore lagged by one day in all imputed data sets, so the previous days' positive affect and stress could be used to predict sleep quantity and sleep quality the subsequent night. The terms "daily positive affect" and "daily perceived stress" from here refer to the lagged variables. Multilevel models were applied across all imputed data sets; pooled parameter estimates and inferences were calculated following Rubin's Rules.[51] The emmeans package[52] and ggplot2[53] were used to probe and plot significant interactions.

Multilevel modeling: direct effect hypothesis

Separate two-level multilevel models were used to test the direct effect hypotheses that positive affect will predict sleep quality and sleep duration, respectively. At the day level (Level 1), person-mean centered daily positive affect was included as the primary predictor of daily sleep duration and subjective sleep quality, respectively. This enabled us to examine within-person associations between positive affect and sleep by testing whether participants slept better and longer on days when their positive affect was higher than their own personal average. At the week level (Level 2), grand-mean centered average positive affect was included as a predictor. This enabled us to examine between-person associations between positive affect and sleep, by testing whether people with higher average positive affect sleep better on average compared to those with lower average positive affect. Sex, grand-mean centered age, SES, and grand-mean centered self-rated health were included as covariates at Level 2.

Random intercepts were included in all models. The need for random slopes was tested using likelihood ratio tests comparing the intercept-only direct effect models for sleep quality and sleep duration to the respective model with random slopes included (first for positive affect and then for perceived stress). For most models, results suggested that including random slopes did not improve model fit (Ps = 0.06 to 0.76). The only exception was for the model estimating sleep quality with a random slope for perceived stress; this model reached singularity, precluding the use of random slopes. Therefore, random slopes were not included in any models.

Multilevel modeling: stress buffering hypothesis

The stress buffering hypotheses was tested in two steps. In Step 1, separate two-level multilevel models were used to test the direct effect of daily stress on sleep quality and sleep duration, analogous to the models examining the direct effect of positive affect. These models included person-mean centered daily perceived stress and person-mean centered daily positive affect at the day level, with grand-mean centered daily perceived stress, grand-mean centered daily positive affect, sex, age, SES, and self-rated health at the week level. In Step 2, to test the hypotheses that positive affect moderates the association between stress and sleep duration and sleep quality, interaction terms were added to each Step 1 model. In these models, an interaction term was added for person-mean centered daily positive affect and person-mean centered daily perceived stress at the day level, enabling us to examine whether the negative effect of experiencing perceived stress on sleep that night is attenuated on days when positive affect is higher than a person's own mean. At the week level, an interaction between grand-mean centered average positive affect and grand-mean centered average perceived stress was added, enabling us to test whether the negative effect of stress on sleep was attenuated for people with higher positive affect on average.

Regression analyses: direct effect and stress buffering at the trait level

Regression analyses were conducted using a person-level data set of cross-sectional measures. After excluding participants with no data for global sleep quality, no data were missing for sex, SES, self-rated health, or age. However, 10 (4.9%) participants had no data for past five-year stressor severity,

Table 2. Results of multilevel models testing the direct effect hypothesis.

Fixed effects	Sleep duration		Sleep quality	
	B [95% CI]	*P*	B [95% CI]	*P*
Intercept	7.05 [6.65, 7.45]	**<.01**	4.92 [4.60. 5.25]	**<.01**
Sex	0.05 [−0.42, 0.52]	.84	−0.22 [−0.60, 0.16]	.25
Age	−0.01 [−0.04, 0.01]	.41	0.00 [−0.02, 0.03]	.70
SES	−0.40 [−0.65, −0.14]	**<.01**	−0.04 [−0.24, 0.16]	.68
Self-rated health	−0.06 [−0.31, 0.18]	.62	0.15 [−0.04, 0.34]	.12
Positive affect (day)	−0.22 [−0.48, 0.05]	.11	−0.02 [−0.16, 0.13]	.83
Positive affect (week)	0.43 [0.14, 0.72]	**<.01**	0.70 [0.48, 0.93]	**<.01**

SES, socioeconomic status; Positive affect at the day-level was person-mean centered; positive affect at the week level and all continuous covariates were grand-mean centered.

and 18 (9.1%) were missing trait positive affect data. Missing data were handled using multiple imputation with chained equations (mice), using the mice package.[54] A total of 50 imputations were generated, with 35 iterations between each imputation. Models were applied across all imputed data sets, and results were pooled using Rubin's Rules.[51]

Linear regression was used to test the direct effect and stress buffering hypotheses at the trait level. For the direct effect hypothesis, a model was constructed with trait level positive affect predicting global sleep quality, adjusting for the effects of sex, grand-mean centered age, SES, and grand-mean centered self-rated health. The stress buffering hypothesis was examined in two steps. In Step 1, a model was constructed to examine the direct effect of grand-mean centered past five-year stressor severity on global sleep quality, with trait-level positive affect, sex, grand-mean centered age, SES, and grand-mean centered self-rated health included as covariates. In Step 2, an interaction between trait-level positive affect and gran-mean centered past five-year stressor severity was added to the Step 1 model.

Results

Participant characteristics

On average, participants reported sleeping 7.03 ± 1.44 hours per night; daily sleep quality was 4.70 ± 1.25, on average, falling between the "bad" (3) and "good" (6) anchor points. Global PSQI scores were 6.52 ± 3.84, on average, slightly over the cutoff of 5 that is commonly used to distinguish good versus poor sleepers. With higher PSQI scores representing poorer global sleep quality, this suggests that participants in HOLD typically sleep somewhat poorly across longer timescales (Table 1).

Multilevel modeling results: direct effect hypothesis

Examining the unconditional means model revealed that 38% of the variance in daily sleep duration was attributable to within-person (day level) factors, with the remaining 62% of variance stemming from between-person factors. In multilevel analysis, positive affect at the week level significantly predicted daily sleep duration as hypothesized, $B = 0.43$, 95% CI [0.14, 0.72], $P < .01$, such that participants with higher average positive affect across the week reported significantly longer sleep on average. Among the covariates, only SES significantly predicted sleep duration, $B = -0.40$, 95% CI [−0.65, −0.14], $P < .01$, such that higher SES was associated with shorter sleep duration. Contrary to our hypothesis, positive affect did not significantly predict sleep duration at the day level (Table 2).

Examining the unconditional means model revealed that 59% of the variance in daily sleep quality was attributable to within-person factors. Week-level positive affect significantly predicted sleep quality as hypothesized, $B = 0.70$, 95% CI [0.48, 0.93], $P < .01$, such that individuals with higher average positive affect across the week had better daily sleep quality on average. No other significant effects on sleep quality were observed (Table 2).

Multilevel modeling results: stress buffering hypothesis

The Step 1 model found no effect of daily perceived stress on daily sleep duration at the day level ($P = .35$) or the week level ($P = .51$). Among the covariates, SES, $B = -0.39$, 95% CI [−0.65, −0.14], $P < .01$, and positive affect at the week level, $B = 0.49$, 95% CI [0.15, 0.84], $P < .01$, significantly predicted sleep duration. In Step 2, the hypothesis that positive affect would moderate the effect of perceived stress on sleep was not supported at the day level (*P* for interaction = .32) or the week level ($P = .79$). Higher SES remained a significant predictor of shorter sleep duration, $B = -0.39$, 95% CI [−0.65, −0.14], $P < .01$. No other significant associations were observed. Effects of covariates, random effects, and variance explained were similar in Step 1 and Step 2 models; Step 2 results are presented in Table 3.

In Step 1, no effect of daily perceived stress on sleep quality was observed for at the day level ($P = .78$) or the week level ($P = .79$); among the covariates, only positive affect at the week level was a significant predictor of sleep quality, $B = 0.68$, 95% CI [0.46, 1.01], $P < .01$. In Step 2, the interaction between positive affect and perceived stress did not significantly predict daily sleep quality at the day level ($P = .87$), contrary to our hypothesis. No covariates were significantly associated with sleep quality.

At the week level, the interaction between positive affect and perceived stress was significant in predicting sleep quality, $B = -0.47$, 95% CI [−0.80, −0.16], $P < .01$ (see Table 3), although the association was not in the hypothesized direction. Simple slopes analyses revealed that at one standard deviation above the grand mean for positive affect, the association between perceived stress and sleep quality was significant, $B = -0.47$, 95% CI [−0.92, −0.02], $P = .04$

Table 3. Results of multilevel models testing the stress buffering hypothesis.

	Sleep duration		Sleep quality	
Fixed effects	B [95% CI]	*P*	B [95% CI]	*P*
Intercept	7.05 [6.62, 7.48]	**<.01**	4.75 [4.41, 5.09]	**<.01**
Sex	0.05 [−0.43, 0.52]	.85	−0.17 [−0.55, 0.21]	.38
Age	−0.01 [−0.04, 0.02]	.51	0.00 [−0.02, 0.02]	.76
SES	−0.39 [−0.65, −0.14]	**<.01**	−0.05 [−0.24, 0.15]	.65
Self-rated health	−0.05 [−0.30, 0.20]	.67	0.14 [−0.05, 0.33]	.14
Positive affect (day)	−0.19 [−0.45, 0.08]	.16	−0.02 [−0.17, 0.13]	.77
Positive affect (week)	0.49 [0.14, 0.84]	**<.01**	0.73 [0.46, 1.01]	**<.01**
Perceived stress (day)	0.13 [−0.15, 0.40]	.37	−0.02 [−0.18, 0.14]	.77
Perceived stress (week)	0.15 [−0.29, 0.61]	.50	−0.11 [−0.46, 0.25]	.55
Interaction (day)	−0.31 [−0.92, 0.30]	.32	0.03 [−0.33, 0.38]	.87
Interaction (week)	0.05 [−0.35, 0.46]	.79	−0.47 [−0.80, −0.16]	**<.01**

SES, socioeconomic status; Positive affect at the day-level was person-mean centered; positive affect at the week level, as well as all continuous covariates, were grand-mean centered; Interaction (day) refers to the interaction between day-level perceived stress and day-level positive affect; Interaction (week) refers to the interaction between week-level perceived stress and week-level positive affect.

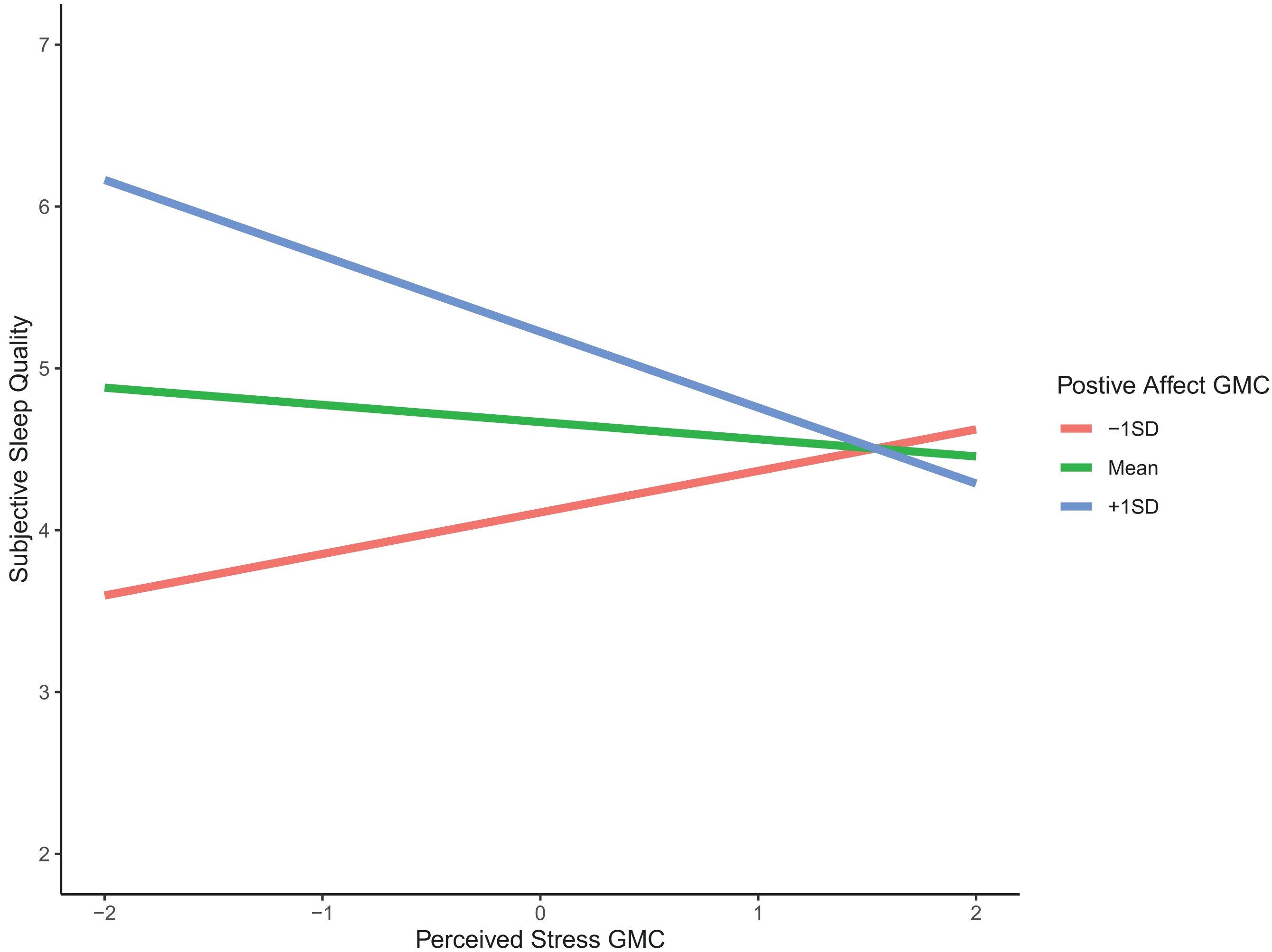

Figure 1. Simple slopes for the interaction effect of week-level stress and positive affect on sleep quality. Note: Marginal effects plot depicting the effect of week-level perceived stress on subjective sleep quality at three levels of week-level positive affect: 1 SD below the sample mean, at the sample mean, and 1 SD above the sample mean. Slopes derived from pooled results across imputed data sets. Analysis of simple slopes suggests that, for participants 1 SD above the mean on positive affect at the week-level, higher week-level perceived stress was associated with significantly worse subjective sleep quality. For participants at or below the mean for positive affect, perceived stress did not significantly affect sleep quality. GMC, grand-mean centered

(see Figure 1). However, the slopes were not significantly different from 0 for both mean positive affect, $B = -0.11$, 95% CI [−0.46, 0.25], $P = .55$, and one standard deviation below mean positive affect, $B = 0.26$, 95% CI [−0.15, 0.66], $P = .21$. This pattern of results suggests that among participants with high average positive affect, greater perceived stress at the week level was associated with worse average sleep quality. However, for those at or below the mean for week-level positive affect, perceived stress at the week level did not impact sleep quality. Effects of covariates, random effects, and variance explained at Level 1 (day-level) were similar in Step 1 and Step 2 models. Variance explained at Level 2 (week-level) increased from 18% to 22% when the interaction between perceived stress and positive affect was added. Step 2 results are presented in Table 3.

Regression results: direct effect and stress buffering hypotheses at the trait level

In the direct effect regression model, as hypothesized, higher trait positive affect was associated with better global sleep quality (ie, lower global PSQI scores), $B = -0.88$, 95% CI [−1.56, −0.20], $P < .01$. Among the covariates, only self-rated health was a significant predictor of global sleep quality, $B = -1.14$, 95% CI [−1.73, −0.56], $P < .01$, such that those reporting better self-rated health also reported better global sleep quality (Table 4). In Step 1 of the stress buffering analysis, past five-year stress severity was not directly associated with global sleep quality ($P = .35$). After the addition of past five-year stress severity, the effects of self-rated health, $B = -1.10$, 95% CI [−1.69, −0.50], $P < .01$, and trait-level positive affect, $B = -0.86$, 95% CI [−1.55, −0.17], $P = .01$, remained significant predictors of global sleep quality. In Step 2, the interaction between past five-year stress severity and trait positive affect was not a significant predictor of global sleep quality ($P = .92$), contrary to hypotheses. All other associations remained similar to Step 1 results; Step 2 results are presented in Table 4.

Results of sensitivity analyses

Sensitivity analyses revealed that results using non-imputed data were for the most part consistent with those using imputed data. However, there were three effects that were significant in sensitivity analyses but not in the primary analyses: the direct effect of positive affect at the day level on sleep duration, $B = -0.26$, 95% CI [−0.53, −0.004], $P = .048$, and the effect of sex on global sleep quality in both the direct effect model, $B = 1.50$, 95% CI [0.24, 2.76], $P = .02$, and the stress buffering model, $B = 1.78$, 95% CI [0.45, 3.12], $P = .01$. Results of sensitivity analyses using listwise deletion in non-imputed data are presented in Tables S1–S3.

For the effects that were inconsistent between the analyses using multiple imputation and non-imputed data, additional sensitivity analyses were conducted using mean imputation; these results are presented in Tables S4–S5. For the direct effect of positive affect at the day level on sleep duration, both person-level mean (across days) imputation and sample-level mean imputation were used. In these analyses, the effect of day-level affect was not significant using person-level mean imputation, $B = -0.21$, 95% CI [−0.43, 0.02], $P = .07$, or sample-level mean imputation, $B = -0.22$, 95% CI [−0.45, 0.01], $P = .06$. For the effect of sex in both trait-level models (direct effects and stress buffering models) predicting global sleep quality, sample-level mean imputation was used. These analyses revealed that the effect of sex on global sleep quality was not significant in either the direct effects, $B = 1.07$, 95% CI [−0.11, 2.26], $P = .08$, or stress buffering models, $B = 1.07$, 95% CI [−0.13, 2.26], $P = .08$. Results of a Welch's two-sample t-test also suggested that global sleep quality did not significantly differ by sex, $t(\mathrm{df}) = -1.01$ (105.91), $P = .32$. The pattern of results across all models suggests that daily positive affect likely did not affect daily sleep duration in this sample, and that no sex differences in global sleep quality were present.

Discussion

Sleep disparities are hypothesized to underlie racial health disparities,[13] but little is known about predictors of sleep among African Americans. Positive affect may impact sleep directly, or indirectly by buffering against the negative effect of stress on sleep.[20] However, associations among positive affect, stress, and sleep within African Americans remain underexplored. To address these gaps, we tested the direct and stress-buffering effects of positive affect on sleep in a large sample of older African American adults.

Results indicated that higher positive affect was associated with higher week-level average sleep quality and duration, and with better global sleep quality, supporting the direct effect hypothesis on these two levels. However, no day-level, within-person associations between positive affect and sleep

Table 4. Results of trait-level regression analyses.

	Direct effect		Stress buffering	
	B [95% CI]	*P*	B [95% CI]	*P*
Intercept	4.52 [2.40, 6.64]	**<.01**	4.57 [2.44, 6.71]	**<.01**
Sex	1.14 [−0.04, 2.33]	.06	1.22 [−0.08, 2.32]	.07
Age	−0.02 [−0.08, 0.05]	.55	−0.01 [−0.08, 0.06]	.80
SES	−0.07 [−0.70, 0.56]	.83	−0.08 [−0.71, 0.55]	.81
Self-rated health	−1.14 [−1.73, −0.56]	**<.01**	−1.10 [−1.69, −0.50]	**<.01**
Positive affect (trait)	−0.88 [−1.56, −0.20]	**.01**	−0.86 [−1.55, −0.17]	**.01**
Stress severity (past 5 years)	--	--	0.03 [−0.03, 0.10]	.35
Interaction	--	--	0.00 [−0.07, 0.08]	.92

SES, socioeconomic status; Positive affect at the trait level, stress severity across the past five years, and all continuous covariates were grand-mean centered; Interaction refers to the interaction between past five-year stress severity and trait-level positive affect.

measures were observed. No support for the stress buffering hypothesis was found. Although week-level average positive affect moderated the effect of week-level average perceived stress on sleep quality, the effect was not in the direction predicted by the stress buffering hypothesis. Instead, higher week-level perceived stress was associated with poorer sleep quality only among individuals who endorsed high levels of positive affect across the week on average. Among those endorsing low-to-medium levels of positive affect, perceived stress was not significantly related to sleep, suggesting that perhaps other factors influence sleep health in these individuals. Therefore, rather than high positive affect protecting against the negative impact of stress on sleep, the detrimental effect of stress on sleep was only observed for those individuals endorsing high levels of positive affect.

These findings provide some support for the direct effect hypothesis,[20] indicating that higher levels of positive affect are linked to longer sleep duration and better sleep quality over the course of a week, as well as better global sleep quality as a trait. The direct effect hypothesis might also suggest that days on which positive affect is higher than a person's normative level would be followed by nights with better sleep. However, this was not seen in the present results. Day-to-day positive affect was not significantly related to day-level sleep quality or sleep duration, suggesting that participants' fluctuation around their own weekly positive affect average did not influence their day-to-day sleep. This finding contrasts with some prior research, which has shown that days with higher positive affect are often followed by nights of better sleep quality and reduced sleep problems.[23,55,56] However, the literature on this topic is mixed. Other studies have reported no direct link between day-level positive affect and subsequent sleep quality, or even a negative impact of higher daily positive affect on sleep duration.[57–59] Additional research examining facets of positive affect (eg, high arousal vs. low arousal) could help clarify these mixed findings.

We did not find evidence for the stress buffering hypothesis. It is worth noting, however, that we did not observe a direct effect of stress on sleep here, despite prior research indicating that perceived stress[60] and measures of stressor exposure from the STRAIN[36] have been related to sleep outcomes. Because stress did not directly affect sleep in the present study, the ability for positive affect to act as a protective buffer may have been limited. Still, we found one notable and unexpected interaction between positive affect and stress. At the week level, average daily perceived stress was not significantly related to sleep quality for those with low and mean levels of positive affect. However, week-level perceived stress was associated with significantly worse sleep quality at high week-level positive affect.

The present finding that high stress only negatively impacted sleep among those with high positive affect could suggest that individuals with higher average positive affect are more susceptible to the negative impact of stress on sleep quality, rather than being shielded from it. It is also possible that the combination of high positive affect and high perceived stress could reflect participants with generally higher levels of cognitive or emotional arousal; high levels of cognitive and emotional arousal have previously been shown to negatively impact sleep.[61,62] Positive affect itself is a broad construct with both high-arousal and low-arousal components, each of which could exert unique effects on sleep.[61] Despite these gaps in understanding, positive affect is potentially modifiable via intervention,[63] and positive affect-inducing interventions have successfully been used to improve other health behaviors, such as physical activity.[64] Positive affect inducing interventions may thus have promise for improving sleep health as well. However, additional research aimed at disentangling the effects of stress, arousal, and positive affect on sleep is needed before positive affect can effectively be leveraged as an avenue for alleviating health disparities by improving sleep among African Americans. Longitudinal studies aimed at examining the temporal dynamics of relations between stress, positive affect, and sleep would be particularly insightful.

With the exception of week-level positive affect, we found null effects of stress and positive affect on sleep duration, treated as a continuous variable. Evidence suggests that 7–8 hours is typically an optimal amount of sleep, with both more and less sleep being associated with adverse outcomes.[6–8] Nevertheless, in the present study, we chose a linear model with sleep as a continuous outcome for two reasons. First, evidence suggests that African Americans sleep fewer hours per night compared to White Americans, with short sleep among African Americans partially underlying racial cardiovascular health disparities.[12,65] Second, past studies examining the effects of positive affect on sleep duration have also typically treated sleep as a continuous outcome.[57,58] That said, it is possible that the effects of positive affect on sleep may be non-linear, and that the use of linear modeling may obscure an association between positive affect and sleep duration.[19]

It is worth noting that income was low in the present sample, with 45% of participants earning less than $20,000 annually. Low-income individuals are subjected to more adverse neighborhood conditions, such as high noise levels and neighborhood poverty, compared to those with higher incomes.[66,67] These adverse neighborhood conditions, in turn, can also negatively affect sleep health and have been hypothesized to be a mechanisms driving racial disparities in sleep health.[68,69] Future research aimed at parsing the effects of individual-level socioeconomic factors and neighborhood-level socioeconomic factors on sleep health is needed, particularly among older racially-minoritized adults.

Strengths and limitations

Several strengths of this study should be noted. First, associations among positive affect, stress, and sleep were examined at three levels: day level (within person), week level (between person), and trait level (between person). Positive affect, stress, and sleep all vary both between persons and within the same person across time. Parsing within- and between-person effects is thus necessary to fully understand relationships among these variables. Second, this study focuses on psychosocial factors predicting sleep in a minoritized and underserved population, namely older African American adults. This study provides an important contribution in demonstrating that positive affect directly impacts measures of sleep within African Americans, potentially pointing to novel avenues for the development of effective health policies and interventions. Such research is crucial among adults over age 50, who tend to experience substantial age-related declines in sleep health, including shortened sleep duration and increased difficulty initiating and maintaining sleep.[70] However, because emotion regulation skills theoretically improve with increasing age,[71,72] positive affect and stress may have stronger effects on the sleep health of younger individuals. Research is needed to examine the effects of emotional and psychosocial factors on sleep among younger African Americans, who are disproportionately affected by poor sleep.[73]

Several limitations should also be noted. First, all measures of stress, affect, and sleep were self-reported. Additionally, two measures of sleep (daily sleep quality and sleep duration) were based on single-item measures. Although single-item assessment of sleep quality has been validated,[41] studies including more objective measures would complement subjective studies. Given the known limitations of the daily sleep measures used, the present study also included the PSQI, a well-validated and widely used scale, as a measure of sleep quality in the trait-level analyses. Similar results were found in both the trait level and multilevel analyses, strengthening the current study. Still, research using more objective and comprehensive measures is needed. There are also additional factors that may confound the associations among stress, positive affect, and sleep. For example, evidence suggests that daily substance use, such as consumption of alcohol, could play a role in these associations.[74] Additionally, bed sharing among couples has been found to influence sleep health in complex ways, with both positive and negative effects.[75] Unfortunately, we do not have access to data on participants' sleep hygiene or bed sharing behaviors. Future research investigating the effects of psychosocial factors on sleep should consider examining the roles of such behavioral and interpersonal factors.

Conclusion

In conclusion, sleep is critically important for maintaining human health, yet most Americans do not get adequate, high-quality sleep. African Americans in particular are afflicted by sleep health disparities, which likely contribute to racial health disparities more broadly[13,14,24] Consequently, modifiable targets for interventions aimed at improving sleep are needed; positive affect may be a viable candidate. The present results generally support a direct effect of positive affect on sleep, particularly at the week and trait levels. In contrast, we did not find support for the stress buffering hypothesis, suggesting that reducing the negative impact of stress is not necessarily the mechanism by which higher positive affect improves sleep, at least in the present sample. Our results suggest that higher positive affect may be linked to better sleep among older African American results, potentially informing the development of more effective interventions and policies aimed at reducing health disparities by improving sleep among African Americans.

Supplementary Material

Supplementary material is available at *Annals of Behavioral Medicine* online.

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Author Contributions

Davis (Formal analysis, Visualization, Writing—original draft, Writing—review & editing), Shields (Data curation, Writing—review & editing), Slavich (Data curation, Writing—review & editing), Zilioli (Conceptualization, Funding acquisition, Writing—review & editing)

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Conflict of Interest

None declared.

Data Availability

(1) *Study registration*: This study was pre-registered at Open Science Framework (https://osf.io/p9hgx/). (2) *Analytic plan registration*: The analytic plan for this study was pre-registered at Open Science Framework (https://osf.io/p9hgx/) after data collection was complete. (3) *Availability of data*: De-identified data from this study are not available in a public archive but will be made available (as allowable according to institutional IRB standards) by emailing the corresponding author. (4) *Availability of analytic code*: Analytic code is not available in a public archive but may be available by emailing the corresponding author. (5) *Availability of materials*: Materials used to conduct the study are not publicly available.

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