

SCIENTIFIC INVESTIGATIONS

Relationship between Physical Function and Sleep Quality in African Americans

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Study Objectives: There is a growing body of research examining the relationship between sleep and functional outcomes. However, little is known about sleep and physical functioning in older African Americans.

Methods: Data for this project included 450 community-dwelling older African Americans (71.4 ± 9.2 years of age) who participated in the Baltimore Study of Black Aging. Overall sleep pattern and quality was measured by the Pittsburgh Sleep Quality Index (PSQI). Physical functioning was measured by the number of activities of daily living that each participant reported difficulty (ADL; e.g. eating, dressing, and bathing). Negative binomial regression models were conducted to estimate the association between sleep quality and physical functioning.

Results: Seventy-two percent of the participants reported poor sleep quality. African Americans who reported poor sleep quality had a greater likelihood of an increase in the number of difficulties in ADLs that they reported even after accounting for demographic characteristics and health conditions. The relationship between sleep quality and physical functioning did not vary by gender.

Conclusions: Sleep may be an important factor to consider when seeking to improve physical functioning among community-dwelling older African Americans.

Keywords: sleep quality, physical function, activities of daily living (ADL), African Americans, gender

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INTRODUCTION

Despite all of the medical and technological advances in the United States, community-dwelling older African Americans continue to exhibit worse physical functioning putting them at risk for adverse health outcomes.^{1–6} Several factors such as socioeconomic status (SES), psychological factors, biomedical factors, and specific chronic conditions have been examined to better understand why African Americans have worse functional status.^{7–12} Yet, modest progress has been achieved. This is largely because there are other factors such as sleep that might contribute to the functioning status of community dwelling older African Americans. Identifying and understanding specific factors that may be related to physical functioning is a key step in maintaining the independence and well-being of community-dwelling older African Americans.

Sleep is a basic human need and an important indicator of health and well-being. However, little attention has focused on how physical functioning is impacted by sleep, particularly among African Americans. There are a growing number of studies that consistently demonstrate disproportionately higher rates of sleep disorders (e.g., sleep apnea) and poor sleep quality/disturbance among African Americans.^{13–19} Specifically, African Americans are more likely to report poorer sleep quality, a larger disparity in overall sleep duration, and greater night-to-night variability compared to whites.^{14–16,18–21} Such sleep disturbances have been shown to be associated with

BRIEF SUMMARY

Current Knowledge/Study Rationale: There is a burgeoning body of research examining the relationship between sleep and functional outcomes particularly among older adults. However, there is a paucity of work focusing on sleep and physical functioning in older African Americans.

Study Impact: Sleep quality is an important correlate of difficulties of ADL among older African Americans regardless of gender. Understanding this relationship in this understudied population is important given that the number of older African Americans is expected to continue to grow over the next three decades in the United States.

a poorer quality of life.^{22–24} Poor sleep is associated with many adverse health conditions (i.e., hypertension, diabetes, and cardiovascular disease) that are commonly observed in African Americans.^{15,25–28} African Americans are at greater risk for morbidity and premature mortality than whites.²⁹ Sleep disturbances are also associated with poor cognitive functioning in African Americans, particularly worse performance on tasks of memory and global cognition.^{30–32} Cognitive dysfunction is associated with shorter sleep duration,^{30,31,33,34} long sleep duration,^{30,31,34} changes in sleep duration,³⁵ and poor sleep quality.³⁶ While there is a growing body of work on sleep quality and health outcomes, little is known about how sleep impact physical functioning among older African Americans. Further it is unclear if this relationship varies by gender.

There is limited research that has explored gender differences in sleep disturbances among African Americans. Prior research, which has explored gender differences, has observed significant differences between African males and females depending upon the sleep parameter investigated. For example, African American males tend report shorter sleep duration²⁰ and are more risk for sleep apnea¹⁴ than African American females. In contrast, African American females are more at risk for insomnia than African American males.¹⁴ However, previous studies have also observed no significant gender differences among African Americans in trouble falling asleep^{14,32} and/or sleep efficiency.¹⁴ These results highlight the importance of further exploring gender differences in sleep disturbances among African Americans and how potential gender differences in sleep may assist in understanding gender differences in health outcomes.

To our knowledge, no study has investigated whether sleep quality in older African Americans are associated with physical functioning. Here, we focus on understanding the relationship between sleep and physical functioning among older African Americans in an effort to understand the heterogeneity that may exist among African Americans with regard to sleep quality and physical functioning.³⁷ Further focusing solely on African Americans is a key initial step to advancing our understanding on how to reduce or eliminate race-related disparities in sleep quality and physical functioning.^{38,39} Information gained from understanding whether sleep quality impacts physical functioning among older African Americans will help us prepare for the needs of the growing segment of the United States population. Thus, the overall goal of this study is to examine whether sleep quality is associated with physical functioning in a large sample of urban community-dwelling older African Americans. The first aim is to evaluate the relationship between physical functioning and sleep quality after adjusting for demographic and health indices. It is anticipated that those with poor sleep quality will be associated with worse physical functioning. The second aim is to investigate whether the association between physical function and sleep quality varies between men and women. It is hypothesized that the relationship between physical function and sleep quality are worse among men than women.

METHODS

Participants

The study sample included urban and independently living African American older adults from the Baltimore Study of Black Aging: Patterns of Cognitive Aging (BSBA: PCA). The main objective of BSBA: PCA was to explore the patterns and individual factors that influence individual differences in cognitive functioning among older African Americans. Participants aged 50 years and older were recruited from 29 senior housing facilities that consisted primarily (> 75%) of African Americans living in the West Baltimore area. Data for BSBA was collected across two different waves: 2006–2008 (wave 1) and 2009–2011 (wave 2). Each testing session took approximately 2.5 hours and was conducted in a vacant, public room of the

participant's apartment building or in a private room at a senior citizen facility. During each testing session, a trained research assistant assessed the participant using a battery of questions that included sociodemographic, physical health, and mental health measures. Each participant was compensated \$30 at the first wave and \$75 at the second wave. Additional details of the BSBA study design are described elsewhere.^{40,41}

The BSBA: PCA wave 1 data collection included 602 participants (449 females and 153 males) with a mean age of 69.1 (SD = 9.8, range 48–95). Participants' average monthly income at wave 1 data collection was \$1,000 (SD \$600; range = < \$100 to > \$2,300), and the average educational level was 11.6 ± 3.0 years (range = 3–20). The BSBA: PCA wave 2 data collection included 450 of the 602 participants from wave 1. Sleep indices were only administered at wave 2; therefore, this paper will include only participants from wave 2. The mean age of the sample age was 68 years (SD 9.2) and mean level of education was 11 years (SD 2.9). All participants signed a written informed consent agreement approved by the institutional review board at Duke University.

Physical Function

The outcome variable, physical functioning, was based upon the participant's report of difficulty in performing basic activities of daily living (ADLs). This included eating, dressing, grooming, walking, bathing, using the toilet, and transferring in and out of bed.⁴² The 4 possible response categories included: (1) never need help; (2) have difficulty but can do without help; (3) have difficulty and need help; (4) never do the activity. A binary variable was created for each ADL representing those who reported any difficulty for that particular ADL. We summed across the binary variables to create the number of difficulties with ADLs that each participant reported.

Sleep Indices

The Pittsburgh Sleep Quality Index (PSQI)⁴³ was used to assess participants' typical sleep habits and patterns within the last month. Questions were designed to assess 7 components, including sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. The PSQI has been shown to be strongly reliable ($\alpha = 0.83$). In addition, it has been shown to have relatively high sensitivity (89.6%) and specificity (86.5%) in differentiating good and bad sleep habits and high correlation with the common sleep disorders to include insufficient sleep syndrome, primary insomnia, circadian rhythm disorders, restless legs syndrome, and sleep apnea. Global sleep quality scores can range from 0 (good sleeper) to 21 (poor sleeper). A global quality score ≤ 5 indicates the perception of "good sleep quality," a global score > 5 indicates a perception of "poor sleep quality." A binary variable was created to identify those who reported global sleep quality scores > 5 compared to those who reported ≤ 5 .

Covariates

Covariates included demographic and health conditions. Demographic variables included age, gender, years of education, and family income. Age and years of education were measured

Table 1—Distribution of sample characteristics of total sample and by gender among 450 older African Americans.

	Total (n = 450)	Men (n = 102)	Women (n = 348)	p value
Age (years), mean ± SD	71.4 ± 9.2	69.2 ± 9.0	72.0 ± 9.1	0.006
Education (years completed), mean ± SD	11.5 ± 2.8	11.1 ± 3.0	11.6 ± 2.7	0.144
Family Income (categories), mean ± SD	11.1 ± 5.6	11.5 ± 6.3	10.9 ± 5.4	0.374
Number of Medical Conditions, mean ± SD	2.6 ± 1.3	2.2 ± 1.3	2.7 ± 1.3	0.002
Depressive Symptoms (score), mean ± SD	13.4 ± 4.4	12.7 ± 3.9	13.6 ± 4.6	0.063
Number of ADLs reported with difficulty, mean ± SD	0.3 ± 0.8	0.2 ± 0.7	0.3 ± 0.8	0.225
Poor Sleep Quality, %	72.4	67.6	73.8	0.218

Self-reported family income was based on participants' selection of 1 of 23 categories ranging from less than \$100 to \$2,300 or more per month in \$100 increments. Number of medical conditions include angina, asthma, arthritis, cancer diabetes, stroke, heart attack, and high blood pressure. Depressive symptoms are based on the 20-item Center for Epidemiological Studies Depression Scale. ADLs included eating, dressing, grooming, walking, bathing, using the toilet, and transferring in and out of bed. Poor Sleep Quality represents a Pittsburgh Sleep Quality Index (PSQI) Global Score > 5. SD, standard deviations.

as continuous variables. Gender was coded as a binary variable with 1 indicating those who were female. Family income was based on participants' selection of one of twenty-three categories ranging from under \$100 to \$2,300 or more per month in \$100 dollar categories.

Health conditions included depressive symptoms and chronic conditions. Depressive symptoms were assessed using the 20-item Center for Epidemiological Studies Depression (CES-D) Scale.^{44,45} The CES-D is commonly used in detecting depressive symptoms in older adults across diverse populations.⁴⁶ Chronic conditions were based on participants' report of physician diagnoses of the following: angina, asthma, arthritis, cancer, diabetes, stroke, heart attack, or high blood pressure.^{7,47,48} Each of the chronic conditions was coded as a binary variable (1 = present; 0 = absent). A variable representing the number of chronic conditions each participant reported was created by summing across each of the chronic condition binary variables.

Analyses

Student's t-tests for continuous variables were used to evaluate the mean and chi squares were used to examine proportional differences by gender for the demographic variables, number of chronic conditions, depressive symptoms, number of difficulties with ADLs, and sleep quality. Negative binomial regression models were specified to examine the association between sleep quality and number of difficulties with ADLs. The negative binomial regression model, rather than the Poisson regression model, was selected to account for the overdispersion of the outcome variable.^{49–52} Incident rate ratios and corresponding 95% confidence intervals were used to present findings from the four progressively more complex negative binomial models. The first model tested association between sleep quality and number of difficulties with ADLs. The second model tested whether that relationship remained after accounting for demographic variables. The third model tested whether the relationship between sleep quality and number of difficulties with ADLs remained after adjusting for demographic and health measures. The fourth model tested whether the relationship between sleep quality and number of difficulties with ADLs differed by gender after accounting for demographic

and health measures. More specifically, an interaction term of sleep quality and gender will be entered into model 4. If the interaction term is significant ($p < 0.05$), additional stratified analyses will be performed to examine the relationship between sleep quality and number of difficulties with ADLs for men and women separately. A p value < 0.05 was considered statistically significant and all tests were two-tailed. Analyses were conducted using Stata, Version 13 (College Station, TX).

RESULTS

The distribution of the sample characteristics for the total sample and by gender is displayed in **Table 1**. Of the 450 African Americans, the majority of the sample was female, and the average age was 71.4 ± 9.2 years. With respect to socioeconomic status, the average number of years of education completed was 11.5 ± 2.8 years, and the average monthly income was between \$1,100 and \$1,200. On average, participants reported 2.6 ± 1.3 chronic conditions and reported a CES-D score of 13.5 ± 4.5 . The average number of difficulties with ADLs was 0.4 ± 0.8 . Seventy-two percent of the participants reported poor sleep quality. Examining the sample characteristics by gender revealed that women were older (72.0 vs. 69.2 years) and reported more chronic conditions (2.7 vs. 2.2 years) compared to men. There were no significant differences between men and women with respect to education, income, depressive symptoms, number of difficulties with ADLs, or poor sleep quality.

Association between Sleep Quality and Number of ADLs Reported Difficulty

Table 2 displays the association between sleep quality and the number of difficulties with ADLs. Poor sleep quality was associated with the number of difficulties with ADLs for older African Americans across models 1–3. Specifically, in the unadjusted model, African Americans who reported poor sleep quality had a higher likelihood of increasing the number of difficulties with ADLs than those who reported good sleep quality. After adjusting for demographics variables in model 2, African Americans who reported poor sleep quality had a greater likelihood of increasing the number of difficulties with

Table 2—Incidence rate ratios (95% confidence intervals) for the association between physical functioning and sleep quality in 450 older African Americans.

Characteristic	Model 1	Model 2	Model 3	Model 4
Poor Sleep Quality (PSQI > 5)	2.19 (1.25,3.85)	2.25 (1.26,4.01)	1.87 (1.04,3.35)	1.86 (0.47,7.42)
Age (years)		1.02 (0.99,1.04)	1.02 (0.99,1.04)	1.02 (0.99,1.05)
Gender (women)		1.57 (0.84,2.92)	1.13 (0.61,2.08)	1.13 (0.30,4.55)
Education (years completed)		1.01 (0.91,1.12)	1.01 (0.92,1.11)	1.01 (0.92,1.11)
Income (categories)		0.98 (0.92,1.02)	0.99 (0.94,1.04)	0.99 (0.94,1.04)
Number of medical conditions			1.50 (1.27,1.77)	1.50 (1.27,1.77)
Depressive symptoms (score)			1.00 (0.96,1.05)	1.00 (0.96,1.05)
Poor sleep quality * Gender				1.00 (0.22,4.60)

Poor sleep quality represents a Pittsburgh Sleep Quality Index (PSQI) Global Score > 5. PSQI ≤ 5 is the reference group. Men are the reference group for the gender variable. Depressive symptoms score is based on the 20-item Center for Epidemiological Studies Depression Scale. Number of medical conditions include angina, asthma, arthritis, cancer diabetes, stroke, heart attack, and high blood pressure. Poor sleep quality * Gender is the interaction term between poor sleep quality and gender.

ADLs (incidence rate ratio (IRR) = 2.25, 95% confidence interval (CI) 1.26, 4.01). The relationship remained even after adjusting including health-related factors in model 3 (IRR = 1.87, 95% CI 1.05, 3.35). In model 4 an interaction term of sleep quality and gender was added to model 3 to determine if the relationship between sleep quality and number of difficulties with ADLs was different for men and women. The relationship between sleep quality and the number of difficulties with ADLs did not differ by gender (IRR = 1.00, 95% CI 0.22, 4.60; $p = 0.992$).

Additional analyses were conducted by examining the components of the PQSI. Of the seven components, 3 components were associated with number of difficulties with ADLs. Those who reported difficulty in sleep quality had a greater likelihood of increasing the number of difficulties with ADLs (IRR = 1.95, 95% CI 1.19, 3.19) compared to those who reported no difficulty in sleep quality. Those who reported difficulty in use of sleep medications had a greater likelihood of increasing the number of difficulties with ADLs (IRR = 2.15, 95% CI 1.23, 3.75) compared to those who reported no difficulty in use of sleep medications.

Those who reported difficulty in use of sleep medications had a greater likelihood of increasing the number of difficulties with ADLs (IRR = 2.15, 95% CI 1.23, 3.75) compared to those who reported no difficulty in use of sleep medications. Those who reported difficulty in daytime dysfunction due to sleep habits had a greater likelihood of increasing the number of difficulties with ADLs (IRR = 2.54, 95% CI 1.61, 3.98) compared to those who reported no difficulty in daytime dysfunction. No differences were observed between sleep latency, sleep duration, habitual sleep efficiency, or sleep disturbances and the number of difficulties with ADL reported.

DISCUSSION

We sought to understand the relationship between sleep quality and physical functioning in older African Americans and whether this relationship varies by gender. After accounting

for demographic and health measures, poor sleep quality was associated with a greater likelihood of an increase in the number of difficulties with ADLs. The relationship between sleep quality and number of difficulties with ADLs that a participant reported did not vary by gender. Findings indicate that sleep quality is an important correlate of difficulties of ADL among older African Americans irrespective of gender. Understanding this relationship in this understudied population is important given that the number of older African Americans is expected to continue to grow over the next three decades in the United States.

We observed that reported poor sleep quality was associated with increasing difficulty in a number of ADLs. This finding is not only consistent with previous work in older adults, but extends previous research to older African Americans. In particular, a relationship between insomnia variables and impairment in ADLs has been previously reported in three community-based samples in the United States.⁴⁶ Significant associations between insomnia symptoms and subjective reports of limitations in specific household activities (e.g., doing laundry, doing shopping, being social engaged), which may be important for independent living have also been demonstrated in older adults.⁵³ One potential and interesting explanation for the relationship between sleep quality and physical functioning (i.e., ADLs) is that poor sleep quality can lead to mental fatigue during the day that can contribute to physical dysfunction.⁵⁴ Recently, authors reported that older adults with difficulty staying asleep are at a greater risk for persistent severe fatigue.⁵⁵ Thus, perhaps, poor sleep may negatively impact the capacity for performance.^{56,57} As such, the ability to perform tasks that require additional effort may be impaired when an individual is suffering from poor quality sleep. Future studies seeking to understand the mechanism by which sleep quality impacts functional status is needed within an older African American cohort.

In this study we demonstrated that the association between sleep quality and physical function did not vary by gender. This finding is inconsistent with the hypothesis. However this finding was in agreement with previous work.^{58,59} While there

are some data suggesting that African American women are more likely to report poorer sleep quality than African American men,²⁸ other studies have observed no significant gender differences among African Americans for sleep quality and/or sleep duration.^{58,59} In the current study, African American women were significantly older and reported more chronic conditions than African American men. Thus, age-related factors such as the increase in the number of chronic health conditions may explain the lack of observed gender difference in the relationship between sleep quality and number of difficulties with ADLS reported.

It is well documented that African Americans report the least amount of sleep of all racial/ethnic groups surveyed.^{14,17–20,60} While data in the literature may be limited and at times, inconsistent for African Americans, data does suggest that young to middle aged African Americans sleep worse than white Americans.¹⁴ Specifically, African Americans take longer to fall asleep, report poorer sleep quality, tend to have more light while less deep sleep, and nap more often and longer than white Americans.¹⁴ Additionally, African Americans have a higher prevalence of sleep-disordered breathing such as sleep apnea and demonstrate more risk factors for poor sleep.¹⁴ These findings may suggest that the attitude and perspective regarding sleep as an important aspect of overall health and well-being may also differ across various sociocultural and ethnic groups.¹⁴

Several limitations of this study warrant comment. First, this study only included older African Americans who live in Baltimore, Maryland. Therefore, the external validity of this study may be limited to older African Americans who reside in urban areas similar to Baltimore, Maryland. Second, the findings of this study were based on self-reported data. The accuracy of self-report disability^{61,62} and chronic conditions^{2,63} in older adults has been previously documented. While our results point to differences in physical function in African Americans with poor quality sleep, it is unclear whether these findings are a consequence of chronic sleep disturbance present in patients with disrupted sleep from health conditions (e.g., obesity), health behaviors (e.g., nicotine use and exercise) and/or an undiagnosed and untreated sleep disorder (restless legs syndrome, obstructive sleep apnea, chronic sleep deprivation) or sociodemographic factors (e.g., financial strain, food insecurity, noisy and/or unsafe environment) that may routinely be experienced by African Americans. The results presented here support the need for a more robust emphasis on the evaluation of sleep in the African American population in effort to improve physical function. Finally, because this is cross sectional data, the opportunity to draw inferences regarding directionality is limited. Specifically, with these data, it cannot be determined that an individual who report difficulty in a greater number of ADLs is more inclined to be less active in the day and/or stressed, anxious about being restricted in his/her activities, which impact their sleep that night. A longitudinal study with a sufficient number of older African Americans that seeks to understand how sleep quality impacts the course of ADL disability is needed.

Despite the limitations, this study has several strengths. First, to our knowledge, this is the first study to investigate

the association between sleep quality and physical functioning in older African American adults. Second, this study includes a large number of community-dwelling older African Americans. Third, this study accounts for health and demographic variables that have previously been observed to be associated with sleep quality and/or physical functioning particularly within older African Americans.

As the older African American population is expected to increase over the next 30 years,⁶⁴ older African Americans (compared to their other older ethnic cohorts) are more likely to be resource-limited both economically and medically.⁶⁴ Subsequently, this particular group may be increasingly vulnerable to an ongoing state of suboptimal health conditions, restricted access to health care, and, subsequently, high rates of chronic health conditions (i.e., hypertension, diabetes, renal disease).^{64,65} As result, the high healthcare expenses associated with these health disparities^{66–68} is likely to increase without increased efforts to reduce and/or eliminate these issues. Studies building on the foundation established with this study should investigate the impact of modifiable health, cultural and environmental variables related to sleep disturbances to develop customized and targeted campaigns to improve sleep and physical function in older African Americans.

ABBREVIATIONS

ADL, Activities of Daily Living
 BSBA, Baltimore Study of Black Aging
 BSBA:PCA, Baltimore Study of Black Aging: Patterns of Cognitive Aging
 CES-D, Center for Epidemiological Studies Depression Scale
 PSQI, Pittsburgh Sleep Quality Index
 SES, Socioeconomic Status

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