SLEEPJ, 2020, 1–11

doi: 10.1093/sleep/zsz246
Advance Access Publication Date: 16 October 2019
Original Article

ORIGINAL ARTICLE

Concordance between self-reported and actigraphy-assessed sleep duration among African-American adults: findings from the Jackson Heart Sleep Study

Chandra L. Jackson[1,2,*], Julia B. Ward[3,4], Dayna A. Johnson[5], Mario Sims[6], James Wilson[7] and Susan Redline[8,9]

[1]Epidemiology Branch, National Institute of Environmental Health Sciences, National Institutes of Health, Department of Health and Human Services, Research Triangle Park, NC, [2]Intramural Program, National Institute on Minority Health and Health Disparities, National Institutes of Health, Department of Health and Human Services, Bethesda, MD, [3]Social & Scientific Systems, Durham, NC, [4]Department of Epidemiology, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, NC, [5]Department of Epidemiology, Rollins School of Public Health, Emory University, Atlanta, GA, [6]Department of Medicine, University of Mississippi Medical Center, Jackson, MS, [7]Department of Physiology and Biophysics, University of Mississippi Medical Center, Jackson, MS, [8]Department of Medicine, Beth Israel Deaconess Medical Center, Boston, MA and [9]Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, MA

*Corresponding author. Chandra L. Jackson, 111 TW Alexander Drive, Research Triangle Park, NC 27709. Email: Chandra.Jackson@nih.gov.

Abstract

Study Objectives: Most epidemiological studies assess sleep duration using questionnaires. Interpreting this information requires understanding the extent to which self-reported habitual sleep reflects objectively assessed sleep duration, particularly among African Americans, who disproportionately experience poor sleep health.

Methods: Among African-American participants of the Jackson Heart Sleep Study, we investigated differences in questionnaire-based self-assessed average sleep duration and self-assessed wake-bed time differences compared to actigraphy-based assessments of total sleep time (TST) and average time in bed (TIB). Linear regression models provided estimates of concordance between actigraphy-based and self-reported sleep duration.

Results: Among 821 adults, self-assessed average sleep duration was lower than self-assessed wake-bed time differences (6.4 ± 1.4 vs. 7.5 ± 1.7 h, $p < 0.0001$). Mean actigraphy-based TST was 6.6 ± 1.2 h, and actigraphy-based average TIB was 7.6 ± 1.2 h. Self-assessed average sleep duration and actigraphy-based TST were moderately correlated ($r = 0.28$, $p < 0.0001$). Self-assessed average sleep duration underestimated actigraphy-based TST by −30.7 min (95% confidence intervals [CI]: −36.5 to −24.9). In contrast, self-assessed wake-bed time differences overestimated actigraphy-based TST by 45.1 min (95% CI: 38.6–51.5). In subgroup analyses, self-assessed average sleep duration underestimated actigraphy-based measures most strongly among participants with insomnia symptoms.

Conclusions: Among African Americans, self-assessed average sleep duration underestimated objectively measured sleep while self-assessed wake-bed time differences overestimated objectively measured sleep. Sleep measurement property differences should be considered when investigating disparities in sleep and evaluating their associations with health outcomes.

Statement of Significance

Few large-scale epidemiological studies investigate the extent to which self-reported habitual sleep reflects average objectively measured sleep duration. Among 821 African-American participants of the Jackson Heart Sleep Study, self-assessed average sleep duration underestimated actigraphy-based total sleep time (TST) by −30.7 min (95% confidence intervals [CI]: −36.5 to −24.9), but self-assessed wake-bed time differences overestimated actigraphy-based TST by 45.1 min (95% CI: 38.6–51.5). Furthermore, self-assessed average sleep duration underestimated actigraphy-based measures particularly among participants with insomnia symptoms. Sleep measurement property differences should be considered when investigating sleep disparities and evaluating their associations with health outcomes.

Key words: actigraphy; epidemiology; insomnia; OSA; sleep; sleep duration; objective; subjective; African Americans

Submitted: 15 March, 2019; **Revised:** 4 August, 2019

Introduction

Insufficient sleep, defined as less than an average of 6 hours of sleep per night, is associated with an increased risk of obesity, type 2 diabetes, hypertension, cardiovascular disease (CVD), and mortality [1–3]. Most epidemiologic studies rely on self-reported habitual sleep duration. Few studies have investigated the extent to which self-reported habitual sleep reflects average objectively measured sleep duration as well as how questions to measure sleep duration and their responses differ [4–9]. Although African Americans have been found to have more sleep disturbances including sleep apnea syndrome, short sleep duration, poor sleep quality, and daytime sleepiness compared to non-Hispanic white, Hispanic, and Asian individuals [10], most prior studies have been conducted among predominately white populations [7, 9, 11].

The level of agreement or concordance between self-reported and objective measures has also been shown to vary by race in the few studies with sufficient racial/ethnic diversity [6, 12]. Among 1910 adult participants (mean age: 68.3 ± 9.1 years) of the Multi-Ethnic Study of Atherosclerosis (MESA), Jackson et al. found that self-assessed sleep duration overestimated both wrist actigraphy and single-night in-home polysomnography (PSG) across racial/ethnic groups, although whites were more likely than blacks to overestimate their sleep duration [12]. This study also found that self-assessed sleep duration moderately correlated with multi-day actigraphy-measured assessments (ρ = 0.38 overall), but this correlation was significantly lower among blacks (ρ = 0.28) compared to whites (ρ = 0.45), and was even less correlated for PSG. Another study among the Coronary Artery Risk Development in Young Adults (CARDIA) participants (mean age: 42.9 ± 3.6 years and 44% black) found a mean difference of 0.8 h between actigraphy-measured and self-reported sleep duration and moderate correlations for blacks and whites [6]. Lastly, a recent study investigated agreement between two nights of in-home PSG, nine nights of wrist actigraphy, and sleep diaries among 223 middle-to-older aged black, white, and Asian participants (mean age: 59.9 ± 7.2 years). All measures significantly differed in their estimation of sleep duration, and PSG was less concordant with prospective diary estimates among blacks [13]. To advance research on the sleep of African Americans, it is important to replicate previous findings and then to improve the measurement of sleep constructs by assessing the validity and reliability of self-reported sleep measures, which are more widely available and cost effective compared to objective measures.

Furthermore, in addition to race/ethnicity, the magnitude of agreement between objective and subjective measures of sleep duration may be modified by other sociodemographic (e.g. age, sex, education, income, primary language spoken), health (e.g. depression, obesity, self-rated health), and sleep (e.g. insomnia, sleep apnea, sleepiness, sleep efficiency, sleep variability) characteristics. In MESA, non-English primary language was associated with an overestimation of sleep time [12]. In CARDIA, mean difference varied by age, socioeconomic status, obesity, sleep apnea risk, and level of sleepiness [6]. Matthews et al. found that depressive symptoms and poor health perceptions affected the magnitude of agreement between actigraphic-assessed sleep duration and questionnaire and diary measures [13]. Insomnia symptoms have also been identified as a factor that may influence perceived sleep duration [14]. While these previous studies have identified potential modifiers of the association between objective and subjective measures of sleep duration, these modifiers have not rigorously assessed among a large sample of African-American adults.

Therefore, we addressed the aforementioned literature gaps by examining the concordance of alternative approaches for eliciting self-reported sleep duration compared to an objective actigraphy-based measure of sleep among a large sample of African-American or black participants in the Jackson Heart Sleep Study (JHSS). We also evaluated the influences of insomnia symptoms, depressive symptoms, sleep apnea, low sleep efficiency, and socioeconomic status (i.e. education) on measurement differences in subjective and objective sleep duration.

We hypothesized that there would be poorer agreement between objectively assessed sleep duration and self-reported total sleep duration as compared to sleep duration calculated as the difference between bed and wake times because of the challenges in accurately estimating average sleep duration compared to recalling actual times when going to bed and waking up. We further hypothesized that educational attainment, sleep apnea, insomnia symptoms, low sleep efficiency, and depressive symptoms would reduce concordance across measurements. An improved understanding of agreement across sleep duration measures will help guide future research aimed at characterizing risks associated with sleep disturbances.

Methods

Jackson Heart Sleep Study

To test our hypotheses, we utilized data from an ancillary study to the Jackson Heart Study (JHS), the JHSS. The design of the overall JHS has been reported elsewhere [15]. Briefly, the JHS is a large community-based, prospective cohort study designed to examine the etiology of CVD in African Americans. The 5306 participants in the overall study were aged 35–84 years and resided in the Jackson, Mississippi metropolitan statistical area between September 2000 and March 2004. To date, JHS has conducted three waves of data collection. Exam 1 occurred from September 2000 to March 2004; Exam 2 occurred from October 2005 to December 2008; and Exam 3 occurred from February 2009 to January 2013. Institutional Review Board approval was obtained from University of Mississippi Medical Center, Jackson State University, and Tougaloo College, Partners Health, and all participants gave written informed consent.

Our analysis utilizes data from the JHSS, which was conducted from 2012 to 2016 and enrolled 913 JHS participants [16]. JHS participants were eligible for the JHSS if they participated in the third JHS follow-up exam (n = 3609) or other follow-up ancillary studies. Participants were contacted by phone and/or mail (n = 3015) with an invitation to participate. Individuals reporting regular use of continuous positive airway pressure (n=70) or who were first-degree relatives of a consenting participant (n=10) were not eligible for the study. The JHSS included a clinic visit and in-home sleep apnea testing, 7-day wrist actigraphy, fasting venipuncture, anthropometry, blood pressure and other vascular assessments, and interviewer-administered sleep and health questionnaires. Our analysis excluded participants missing self-reported sleep or actigraphy data (n = 81). We further excluded participants with objective or subjective sleep measurements at least 2 h or more than 23 h (n = 11), resulting in a final study sample of 821 participants.

Measurements

All variables, with the exception of educational attainment, household income, marital status, and physical activity status, were collected during the JHSS. Educational data were collected during JHS Exam 1; and household income, marital status, and physical activity status were collected during JHS Exam 3.

Sleep duration measures

Sleep questionnaire. Participants in the JHSS completed a self-report questionnaire regarding their sleep duration on weekdays or workdays and on weekends using questions also used in the Sleep Heart Health Study and Hispanic Community Health Study/Study of Latinos. Participants were asked: (1) How many hours of sleep do you usually get per night (a) on weekdays or workdays and (b) on weekends?, (2) Not including naps, what time do you usually go to bed (a) on weekdays or workdays and (b) on weekends?, and (3) Not including naps, what time do you usually wake up (a) on weekdays or workdays and (b) on weekends? Two self-report sleep measures were derived for weekday and weekend sleep: (1) self-assessed average sleep duration and (2) self-assessed wake-bed time differences.

Wrist actigraphy. Objective sleep duration was obtained from 7-day wrist actigraphy. For 7 consecutive days, JHSS participants wore a GT3X+ Activity Monitor on the nondominant wrist and completed a sleep diary [17]. Actigraphic data were scored in 60-s epochs as sleep or wake using ActiLife version 6.13 analysis software (ActiGraph Corp, Pensicola, FL) using a validated algorithm (Cole-Kripke) [18]. Using activity counts and light (i.e. lux) data from the actigraphs and sleep diary entries, scorers blinded to all other data, annotated the start and end of the main sleep period. From valid nocturnal actigraphy data, we computed the average values for total sleep time (TST) and average time in bed (TIB) (or sleep interval) for weekdays. Sunday through Thursday nights were considered weekday nights. TST was calculated as the time when asleep between sleep onset and end of the sleep period. TIB (or sleep interval) was calculated as the total time between "lights off" and "lights on" (including sleep and wake episodes during the sleep period). Separate analyses, focusing on weekend data, were also conducted and shown in the supplemental materials.

Potential moderators of concordance and calibration

Age group and sex. We investigated potential differences in concordance between participants aged less than 65 and at least 65 years and between men and women.

Insomnia symptoms and sleep apnea. Insomnia symptoms were based on self-report using the Women's Health Initiative Insomnia Rating Scale (WHIIRS) score of at least 9 (range: 0–20) [19]. Based on our study protocol, all participants enrolled in the JHSS agreed to a sleep study and attempted in-home sleep apnea testing, and any apparent missing data ($N = 43$) was due to device failures or poor data quality. We conducted a level 3 in-home sleep apnea test (Embletta-Gold device; Embla, Broomfield, CO), recording nasal pressure (measuring airflow), thoracic and abdominal inductance plethysmography, finger pulse oximetry, body position, and ECG [16]. The Respiratory Event Index (REI) was derived as the sum of all apneas and hypopneas associated with at least 4% oxygen desaturations per hour of estimated sleep [16]. Obstructive sleep apnea (OSA) was defined using the cutoff for "moderate or severe" OSA of REI at least 15 events per hour [20].

Sleep efficiency. Sleep efficiency was obtained from JHSS 7-day wrist actigraphy and was defined as the ratio of TST to total TIB during the main sleep period (nocturnal sleep period). For our analyses, we dichotomized sleep efficiency at 85% [21].

Educational attainment. Measured at Exam 1 (2000–2003), participants were categorized into one of three educational groups: less than high school; high school graduate/GED; or vocational school, trade school, or college. For our analyses, we dichotomized education into ≤high school education and >high school education [12].

Depressive symptoms. Depressive symptoms were measured by scores on the Center for Epidemiological Studies–Depression Scale (CES-D) [22]. The CES-D is a 20-item, 4-point Likert-type scale assessing the extent to which individuals experienced depressive symptoms during the prior week [22]. While not designed for clinical diagnoses, the CES-D is based on clinical depression symptoms and correlates well with other depression scales [22]. The total score ranges from 0 to 60, with higher scores indicating more depressive symptoms. CES-D scores were dichotomized using a standard cutoff of at least 16 to classify individuals with high depressive symptoms [22].

Assessment of other covariates

Marital status was defined as married, divorced/separated/widowed, or never married. Annual household income was classified as <$25,000, $25,000–<$75,000, or ≥$75,000. Work schedule was categorized as not in the labor force, day shift or standard hours, or night shift. Smoking status was classified as never, former, or current, and alcohol consumption was classified as never, moderate, or heavy. Measured weight and height were used to calculate body mass index (BMI), and categorized as follows: <18.5 kg/m^2 (underweight), 18.5–<25 kg/m^2 (normal), 25–<30 kg/m^2 (overweight), and ≥30 kg/m^2 (obese) [23]. Self-rated health was dichotomized as fair/poor and excellent/good. Physical activity was measured using the physical activity cohort instrument (PAC) at the home visit before the JHS clinical examination. Based on the American Heart Association guidelines, physical activity was categorized as poor (0 min of moderate and vigorous activity), intermediate (>0 min but <150 min of moderate activity, >0 min but <75 min of vigorous activity, or >0 min but <150 min of combined moderate and vigorous activity), or ideal (≥150 min of moderate activity, ≥75 min of vigorous activity, or ≥150 min of combined moderate and vigorous activity) [24]. Hypertension was defined as a systolic blood pressure at least 130 mmHg or a diastolic blood pressure at least 80 mmHg, use of antihypertensive medications (based on self-report and actual use) within 2 weeks prior to data collection, or self-reported history of hypertension [25]. Diabetes was defined as fasting glucose at least 126 mg/dL, and was confirmed by either an self-reported diabetes diagnosis or medication inventory or self-reported use of antidiabetic medications [26].

Statistical analysis

Sociodemographic, health, and sleep characteristics were first summarized with descriptive and graphical analyses for the

study population. We next employed linear regression models to assess the associations of the two self-assessed sleep measures (average sleep duration and wake-bed time differences) with the two actigraphy-based measures (TST and TIB), centered at 7 h, overall and separately for the various age categories, sex, educational attainment, insomnia symptoms, OSA, and depressive symptoms. The intercepts, slopes, and corresponding 95% confidence intervals (CI) were reported for each model.

Linear regression models were employed to regress subjective self-assessed sleep duration onto the objective actigraphy-measured sleep. Each model's intercept represented concordance. Concordance captured the degree to which, on average, participants overestimated (intercept > 0) or underestimated (intercept < 0) sleep. Where there is no disagreement or complete concordance, the intercept would be 0. The regression slope represented calibration, which is the change in the subjective measure (self-reported sleep duration) relative to change in the objective measure (actigraphy-measured sleep duration). A slope of 1 indicated perfect synchrony between the two sleep measures. Self-report and actigraphy could also be perfectly calibrated with a slope other than 1, e.g. 0.50: in this case, 1 min in self-reported sleep would equal a half-minute in actigraphy-measured sleep. Poorly calibrated models have large CIs around the slope. The CIs around the slope are larger when there is more uncertainty in the calibration (more variability in the relationship between subjective and objective sleep).

We were additionally interested in whether concordance and calibration differed across categories of age, sex, educational attainment, insomnia symptoms, OSA, sleep efficiency, and depressive symptoms. We, therefore, employed Wald tests to examine an interaction term for actigraphy-measured sleep and each potential modifier. When the interaction term was significant at the $p < 0.05$ level, we considered the concordance and calibration to differ between the two groups.

We also examined intercepts and slopes stratified by the potential modifier (e.g. sex), and tested whether the intercepts differed at the $p < 0.05$ level using the "suest" command for seemingly unrelated estimation in Stata 15.0. We calculated Spearman correlation coefficients (rho: ρ) between self-reported and actigraphy-measured sleep, overall and by age, sex, education, insomnia symptoms, OSA, sleep efficiency, and depressive symptom groups. We then tested the between-group differences in Spearman correlations using bootstrap estimation. For a given pair of Spearman correlations (e.g. ρ [self-report vs. actigraphy] for males vs. females), we sampled with replacement from the male dataset and female dataset 1000 times, each time calculating the difference in ρ values for males vs. females, to obtain the standard error of this difference, and then the probability of the corresponding z value based on bootstrap difference and standard error.

We next calculated weighted and unweighted Kappa statistics to assess agreement between categories of subjective and objective measures of sleep duration. To do this, we created categorical sleep variables for each of the sleep measures (short sleep: <7 h; recommended sleep: 7–9 h; and long sleep: >9 h). We considered a less than chance agreement ≤ 0, slight agreement = 0.01–0.20, fair agreement = 0.21–0.40, moderate agreement = 0.41–0.60, substantial agreement = 0.61–0.80, and almost perfect agreement = 0.81–0.99.

Bland–Altman plots were employed to further analyze the agreement between the subjective and objective measurements. The mean difference represented the estimated concordance, and the standard deviation (SD) of the differences measured the random fluctuations around the mean. All analyses were conducted for weekday sleep measurements, separately. SAS version 9.4 (SAS Institute, Cary, NC) and STATA 15.0 (Stata Corporation, College Station, TX) were used to carry out the analyses.

Results

Study population characteristics

Table 1 displays sociodemographic, health behavior, and clinical characteristics among the 821 eligible JHSS participants. Study participants' mean age was 63.4 ± 10.7 years, and 66.1% identified as females. More than half of the population was married. Nearly three-quarters of participants had greater than a high school education, and 27.3% had an annual household income less than $25,000. Most participants were not in the labor force (53.7%), and those with employment were predominantly day-shift workers. No JHSS participants identified as retired. Compared to men, women were slightly older, less likely to be married, more likely to have a high school education or less, to not be in the labor force, and to have an annual household income less than $25,000.

Regarding health behaviors and clinical characteristics, most participants reported never smoking (64.5%) and did not currently drink alcohol (66.4%). The majority (54.8%) were classified as obese, 17.2% had high depressive symptoms, and 22.0% had fair/poor self-rated health. Less than a third of participants (30.5%) had an ideal level of physical activity and 80.1% had hypertension while 26.8% were classified as having diabetes. Compared to men, women were less likely to smoke, consume alcohol, or report fair/poor health. Women were more likely than men to be obese and to have high depressive symptoms, poor physical activity levels, hypertension, or diabetes.

Sleep characteristics

Table 1 displays the average sleep measures, focused on weekdays. Self-assessed average sleep duration and wake-bed time differences were 6.4 ± 1.4 and 7.5 ± 1.7 h, respectively. Average actigraphy-based TST and TIB (sleep interval) were 6.6 ± 1.2 and 7.6 ± 1.2 h, respectively. Furthermore, 27.2% of participants had insomnia symptoms (WHIIRS ≥ 9), 23.1% had moderate or severe OSA, and 29.2% had low sleep efficiency (<85%). Insomnia symptoms prevalence was higher among women, while women had a lower prevalence of OSA than men.

Figure 1, illustrating the overall distribution of the two self-reported and two actigraphy-based sleep measures for weekdays, demonstrates that self-assessed average sleep duration overlapped to a large extent with actigraphy-based TST but underestimated actigraphy-based TIB (sleep interval). In contrast, self-assessed wake-bed time differences largely overlapped with actigraphy-based TIB (sleep interval) but overestimated actigraphy-based TST. Figure 1 also demonstrates that both self-reported sleep measures had more variability than the actigraphy-based measures.

Figure 2 illustrates Bland–Altman plots of the systematic difference between self-reported and actigraphy-measured sleep duration. These plots show that agreement appeared to mostly decrease with increasing average sleep duration.

Table 1. Sociodemographic, health behavior, and clinical characteristics among 821* participants of the Jackson Heart Sleep Study, 2012–2016

		Sex	
	Total	Female *n* = 543 (66.1)	Male *n* = 278 (33.9)
Age (years), mean ± SD	63.4 ± 10.7	63.8 ± 10.7	62.5 ± 10.8
Marital status[†]			
Married	461 (56.2)	245 (45.1)	216 (77.7)
Divorced/separated/widowed	279 (34.0)	231 (42.5)	48 (17.3)
Never married	81 (9.9)	67 (12.3)	14 (5.0)
Educational attainment[‡]			
≤High school	210 (25.6)	150 (27.6)	60 (21.6)
>High school	611 (74.4)	393 (72.4)	218 (78.4)
Annual household income[†]			
<$25,000	193 (27.3)	146 (31.4)	47 (19.5)
$25,000–74,999	343 (48.6)	234 (50.3)	109 (45.2)
≥$75,000	170 (24.1)	85 (18.3)	85 (35.3)
Weekday sleep duration (hours), mean ± SD			
Self-assessed average sleep duration (subjective)[§]	6.4 ± 1.4	6.4 ± 1.4	6.3 ± 1.4
Self-assessed wake-bed time difference (subjective)[‖]	7.5 ± 1.7	7.6 ± 1.6	7.3 ± 1.7
Actigraphy total sleep time (objective)[¶]	6.6 ± 1.2	6.7 ± 1.2	6.5 ± 1.2
Actigraphy average time in bed (objective)[¶]	7.6 ± 1.2	7.7 ± 1.2	7.4 ± 1.2
Work schedule			
Not in the labor force	438 (53.7)	309 (57.0)	129 (47.1)
Day shift or standard hours[&]	290 (35.5)	189 (34.9)	101 (36.9)
Night shift	88 (10.8)	44 (8.1)	44 (16.1)
Health behaviors			
Smoking status			
Never	492 (64.5)	350 (69.0)	142 (55.5)
Former	205 (26.9)	120 (23.7)	85 (33.2)
Current	66 (8.7)	37 (7.3)	29 (11.3)
Current alcohol use (yes)	273 (33.6)	157 (29.2)	116 (42.2)
BMI categories			
Underweight (<18.5 kg/m^2)	4 (0.5)	2 (0.4)	2 (0.7)
Normal (18.5–<25 kg/m^2)	102 (12.5)	64 (11.9)	38 (13.8)
Overweight (25–<30 kg/m^2)	263 (32.2)	159 (29.4)	104 (37.7)
Obese (≥30 kg/m^2)	447 (54.8)	315 (58.3)	132 (47.8)
Clinical characteristics			
Obstructive sleep apnea (yes)[#]	180 (23.1)	98 (19.1)	82 (31.1)
Insomnia symptoms (yes)[**]	223 (27.2)	168 (31.0)	55 (19.8)
Low sleep efficiency (yes)[††]	240 (29.2)	160 (29.5)	80 (28.8)
High depressive symptoms (yes)[‡‡]	139 (17.2)	107 (19.9)	32 (11.7)
Self-rated health: fair/poor (vs. excellent/good)	175 (22.0)	114 (21.6)	61 (22.9)
Physical activity[†, §§]			
Poor	314 (39.1)	212 (39.9)	102 (37.6)
Intermediate	244 (30.4)	169 (31.8)	75 (27.7)
Ideal	245 (30.5)	151 (28.4)	94 (34.7)
Hypertension	646 (80.1)	443 (83.3)	203 (73.8)
Diabetes[‖‖]	216 (26.8)	148 (27.9)	68 (24.7)

N (%), unless otherwise noted. Variables with 3% and greater missing: annual household income (13.9%), smoking (7.1%), OSA (5.2%), and self-rated health (3.4%).
SD, standard deviation; BMI, body mass index.

*Includes those with all actigraphy and self-reported sleep measures and with sleep measures ≥2 h and ≤23 h.

[†]Collected at Jackson Heart Study Exam 3.

[‡]Collected at Jackson Heart Study Exam 1

[§]Self-reported sleep duration (in hours) using the question "How many hours of sleep do you usually get per night?"

[‖]Self-reported sleep duration (in hours) calculated using questions regarding bed and wake times.

[¶]Measured using wrist actigraphy.

[&]Standard hours = "regular 9:00 am to 5:00 pm job."

[#]Obstructive sleep apnea (OSA) was measured using the Respiratory Event Index (REI) ≥ 4% (i.e. the number of all apneas and hypopneas with ≥4% oxygen desaturations per hour of sleep); OSA was defined as an apnea-hypopnea index (AHI) ≥ 15 events per hour.

**Insomnia symptoms was based on self-report using a Women's Health Initiative Insomnia Rating Scale score of ≥9 (range: 0–20).

[††]Participants defined as having low sleep efficiency when <85% of total time spent in bed was spent asleep.

[‡‡]High depressive symptoms defined as a Center for Epidemiological Studies–Depression Scale (CES-D) score ≥16.

[§§]Based on the American Heart Association Physical Activity categorization.

[‖‖]Diabetes includes type 1 and type 2 diabetes mellitus.

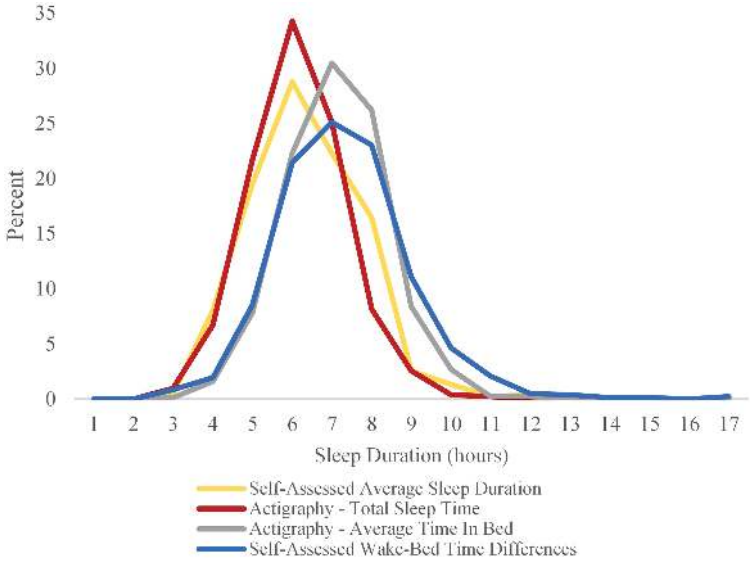

Figure 1. Overall distributions of weekday sleep duration from self-assessed average sleep duration, self-assessed wake-bed time differences, wrist actigraphy for total sleep time, and wrist actigraphy for average time in bed.

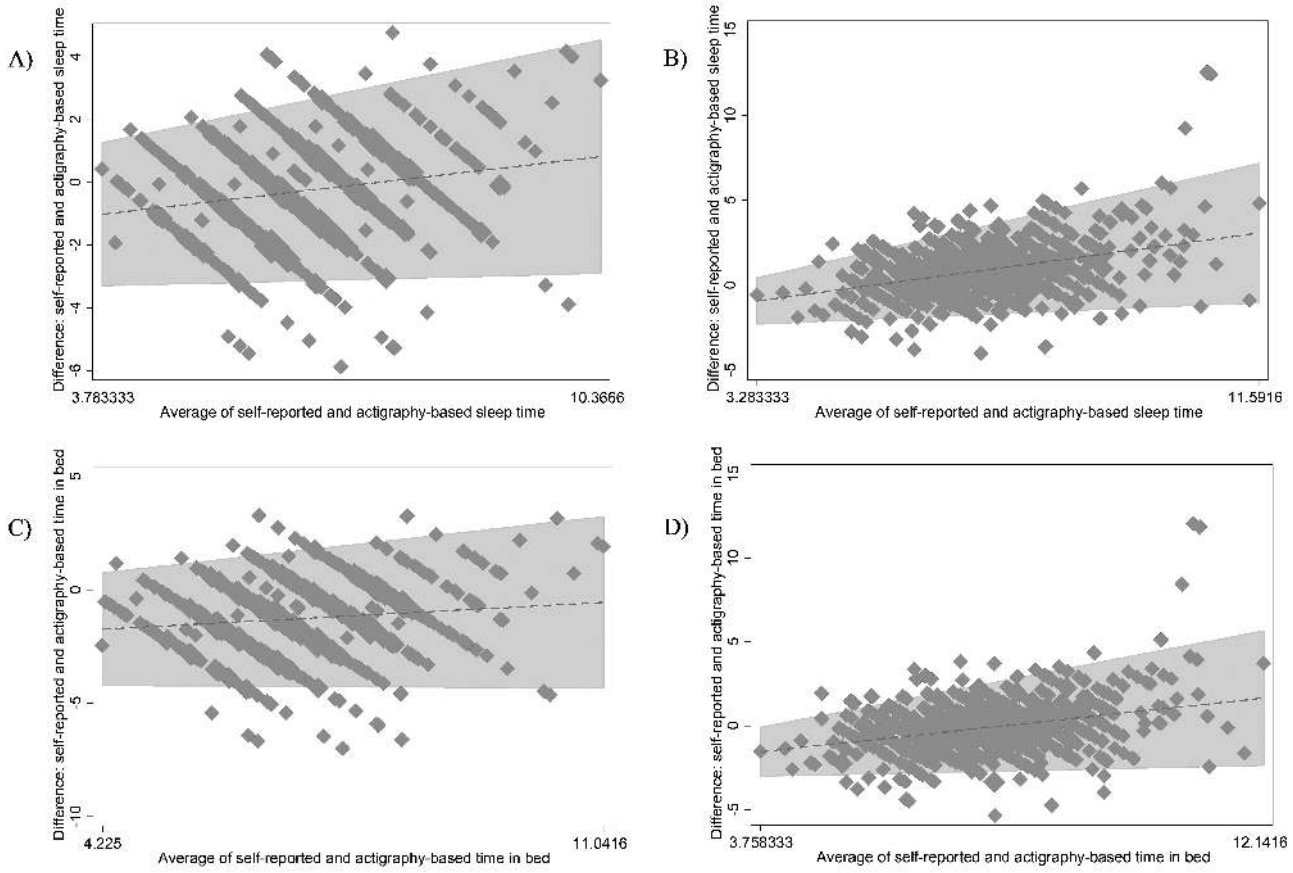

Figure 2. Bland–Altman plots of the difference versus the average of weekday self-reported and actigraphy-based sleep duration, using (A) self-assessed average sleep duration vs. actigraphy-based total sleep time (TST); (B) self-assessed wake-bed time differences vs. actigraphy-based TST; (C) self-assessed average sleep duration vs. actigraphy-based average time in bed (TIB); (D) self-assessed wake-bed time differences vs. actigraphy-based TIB.

Sleep duration based on questionnaire vs. wrist actigraphy

Actigraphy-based TST was underestimated (–30.7 min [95% CI: –36.5 to –24.9]) when using self-assessed average sleep duration and overestimated (45.1 min [95% CI: 38.6–51.5]) when using self-assessed wake-bed time differences (Table 2). Self-reporting disagreement for actigraphy-based TIB (sleep interval) was –50.6 min (95% CI: –56.7 to –44.5) when using average sleep

Table 2. Unadjusted average concordance and calibration (95% CI) between self-reported and measured sleep duration (minutes) using wrist actigraphy for both total sleep time and average time in bed on weekdays, centered at 7 hours of sleep*

	Weekday wrist actigraphy							
	Total sleep time (TST)				Average time in bed (TIB)			
	Self-assessed average sleep duration		Self-assessed wake-bed time differences		Self-assessed average sleep duration		Self-assessed wake-bed time differences	
	Intercept (concordance)	Slope (calibration)	Intercept (concordance)	Slope (calibration)	Intercept (concordance)	Slope (calibration)	Intercept (concordance)	Slope (calibration)
All	−30.7 (−36.5, −24.9)	0.35 (0.27, 0.43)	45.1 (38.6, 51.5)	0.63 (0.54, 0.71)	−50.6 (−56.7, −44.5)	0.33 (0.25, 0.40)	7.8 (1.1, 14.5)	0.63 (0.55, 0.71)
Age (years)								
<65	−28.4 (−36.6, −20.2)	0.38 (0.27, 0.49)	**36.9 (26.9, 47.0)**	0.56 (0.42, 0.69)	−50.3 (−57.8, −42.9)	0.34 (0.24, 0.44)	3.4 (−5.6, 12.3)	0.56 (0.44, 0.68)
≥65	−32.1 (−40.7, −23.5)	0.32 (0.20, 0.44)	**51.9 (43.4, 60.4)**	0.65 (0.54, 0.77)	−50.7 (−61.1, −40.2)	0.32 (0.20, 0.43)	13.4 (3.3, 23.5)	0.66 (0.55, 0.77)
Sex								
Women	−29.2 (−36.3, −22.1)	0.34 (0.25, 0.44)	**50.1 (42.6, 57.7)**	0.66 (0.55, 0.76)	−48.9 (−56.7, −41.0)	0.31 (0.22, 0.41)	10.2 (2.1, 18.3)	0.66 (0.56, 0.75)
Men	−33.7 (−43.7, −23.7)	0.35 (0.22, 0.48)	**33.8 (21.7, 45.9)**	0.54 (0.39, 0.70)	−53.3 (−63.0, −43.7)	0.34 (0.22, 0.47)	2.8 (−8.8, 14.4)	0.55 (0.40, 0.70)
Education								
≤HS	−36.4 (−48.2, −24.7)	0.33 (0.18, 0.48)	52.2 (39.3, 65.0)	0.69 (0.53, 0.85)	−55.2 (−68.2, −42.3)	0.30 (0.16, 0.44)	8.7 (−4.8, 22.3)	0.73 (0.58, 0.87)
>HS	−28.6 (−35.2, −21.9)	0.36 (0.26, 0.45)	42.2 (34.7, 49.7)	0.59 (0.49, 0.70)	−49.1 (−55.9, −42.2)	0.34 (0.25, 0.43)	7.6 (−0.0, 15.3)	0.58 (0.49, 0.68)
Insomnia †								
Yes	**−71.3 (−82.8, −59.8)**	**0.23 (0.08, 0.37)**	39.3 (27.4, 51.2)	0.58 (0.43, 0.73)	**−84.7 (−97.0, −72.4)**	**0.20 (0.07, 0.34)**	1.5 (−10.9, 13.8)	0.60 (0.46, 0.74)
No	**−15.1 (−21.3, −8.8)**	**0.41 (0.32, 0.49)**	47.2 (39.5, 54.9)	0.65 (0.54, 0.75)	**−38.3 (−44.8, −31.8)**	**0.40 (0.32, 0.48)**	10.0 (2.1, 17.9)	0.64 (0.54, 0.74)
Sleep apnea ‡								
Yes	−28.2 (−40.6, −15.9)	**0.20 (0.04, 0.37)**	42.6 (30.5, 54.6)	0.56 (0.41, 0.72)	−40.7 (−53.9, −27.5)	**0.19 (0.04, 0.35)**	6.1 (−6.3, 18.5)	0.59 (0.45, 0.73)
No	−29.4 (−36.0, −22.7)	**0.40 (0.31, 0.50)**	47.6 (39.9, 55.4)	0.65 (0.54, 0.76)	−51.9 (−59.0, −44.8)	**0.38 (0.29, 0.46)**	10.3 (2.1, 18.4)	0.64 (0.54, 0.74)
Efficiency §								
Low	−28.0 (−42.3, −13.6)	0.25 (0.08, 0.43)	**75.4 (61.1, 89.7)**	0.75 (0.58, 0.92)	−48.0 (−59.5, −36.5)	**0.20 (0.05, 0.35)**	14.0 (2.6, 25.3)	0.66 (0.52, 0.81)
High	−33.4 (−39.8, −26.9)	0.41 (0.32, 0.50)	**35.9 (28.5, 43.3)**	0.68 (0.57, 0.78)	−51.9 (−59.1, −44.7)	**0.37 (0.29, 0.46)**	5.2 (−3.0, 13.4)	0.62 (0.52, 0.72)
High depressive symptoms ‖								
Yes	−30.1 (−44.8, −15.3)	0.40 (0.22, 0.58)	53.9 (38.7, 69.0)	0.68 (0.50, 0.87)	−52.3 (−67.7, −36.8)	0.39 (0.22, 0.56)	14.4 (−1.0, 29.8)	0.71 (0.54, 0.88)
No	−30.7 (−37.1, −24.4)	0.33 (0.24, 0.42)	43.5 (36.3, 50.7)	0.61 (0.51, 0.71)	−50.0 (−56.7, −43.2)	0.31 (0.23, 0.39)	6.8 (−0.7, 14.3)	0.61 (0.52, 0.70)

Concordance captures the degree to which, on average, subjects over (if intercept >0) or underestimate (if <0) sleep. Where there is complete concordance, the intercept would be 0. The regression slope represents calibration, which is the relationship between the two scales, or the change in the subjective (self-reported sleep duration) relative to change in the objective measure (wrist actigraphy measured sleep duration). *Sleep Duration Concordance and Calibration by Potential Moderators*: Table shows unadjusted average concordance and calibration between self-reported and measured sleep duration (in minutes) using multi-day (Sunday through Thursday night) wrist actigraphy for both total sleep time and average time in bed by a priori sociodemographic (e.g. age, sex, education) and health-related (e.g. insomnia symptoms, sleep apnea, low sleep efficiency, depressive symptom) characteristics.

CI, confidence interval; ≤HS, high school education or less; >HS, more than high school education; Inter., intercept; TIB, time in bed; TST, total sleep time.

*Bold coefficients are significantly different within strata ($p < 0.05$).

†Insomnia symptoms was based on self-report using a Women's Health Initiative Insomnia Rating Scale score of ≥9 (range: 0–20).

‡Obstructive sleep apnea (OSA) was measured using the Respiratory Event Index (REI) ≥ 4% (i.e. the number of all apneas and hypopneas with ≥4% oxygen desaturations per hour of sleep); OSA was defined as an REI ≥ 15 events per hour.

§Participants defined as having low sleep efficiency when <85% of total time spent in bed was spent asleep.

‖High depressive symptoms defined as Center for Epidemiological Studies–Depression Scale (CES-D) score ≥16.

duration and 7.8 min (95% CI: 1.1–14.5) when using wake-bed time differences. Calibration between self-assessed average sleep duration and actigraphy-based TST (0.35 [0.27–0.43]) indicated that a change of 1 h in average sleep duration was equivalent to 21 min (0.35 × 60 min) of actigraphy-based TST (Table 2). Calibration with self-assessed wake-bed time differences (0.63 [0.54–0.71]) indicated that 1 h in wake-bed time differences equaled 38 min (0.63 × 60 min) of actigraphy TST (Table 2).

The overall Spearman correlation between self-assessed average sleep duration and actigraphy-based TST was ρ = 0.28, and the overall Spearman correlation between self-assessed wake-bed time differences and actigraphy-based TST was ρ = 0.48 (Supplementary Table S1). These findings indicated that actigraphy-based TST explained 8% of the variation in self-assessed average sleep duration but 23% of the variation in self-assessed wake-bed time differences. As shown in Table 3, the weighted kappa statistics for categories of weekday self-reported sleep measures and weekday actigraphy-based TST suggested slight agreement with average sleep duration (k_w = 0.1848) and fair agreement with wake-bed time differences (k_w = 0.2372). Table 3 also demonstrates fair agreement between the two self-assessed sleep measures (k_w = 0.2874).

Potential moderators of concordance and calibration for sleep measures

Examination of concordance and calibration for actigraphy-based TST across potential moderators indicated that for self-reported average sleep duration there were no significant differences in concordance nor calibration across categories defined by age, sex, education, high depressive symptoms, low sleep efficiency, or OSA (Table 2). Those with insomnia symptoms underestimated sleep duration to a greater extent than those without insomnia symptoms (−71.3 min [−82.8 to −59.8] vs. −15.1 min [−21.3 to −8.8]). Those with insomnia symptoms also had less accurate calibration than those without insomnia symptoms (0.23 [0.08–0.37] vs. 0.41 [0.32–0.49]). For the relationship between self-assessed wake-bed time differences and actigraphy-based TST, there were no significant disagreements in concordance or calibration for education, insomnia symptoms, OSA, or high depressive symptoms. However, concordance did vary by age, sex, and low sleep efficiency, whereby those aged at least 65 years had greater overestimation of sleep and lower concordance than those aged less than 65 years (51.9 min [43.4–60.4] vs.

Table 3. Agreement between self-assessed and actigraphy-based sleep measures on weekdays

	Short sleep	Recommended sleep	Long sleep	Total
Self-assessed average sleep duration	Wrist actigraphy (total sleep time)			
Short sleep	336 (72.1)	121 (26.0)	9 (1.9)	466
Recommended sleep	183 (54.0)	141 (41.6)	15 (4.4)	339
Long sleep	3 (18.8)	12 (75.0)	1 (6.3)	16
Total	522 (63.6)	274 (33.4)	25 (3.1)	821
Agreement: 58.2%	Expected agreement: 49.9%		Kappa: 0.1656	$p < 0.0001$
(w)Agreement: 78.4%	(w)Expected agreement: 73.5%		(w)Kappa: 0.1848	(w)$p < 0.0001$
Self-assessed wake-bed time differences	Wrist actigraphy (total sleep time)			
Short sleep	228 (84.8)	40 (14.9)	1 (0.4)	269
Recommended sleep	266 (58.5)	178 (39.1)	11 (2.4)	455
Long sleep	28 (28.9)	56 (57.7)	13 (13.4)	97
Total	522 (63.6)	274 (33.4)	25 (3.1)	821
Agreement: 58.8%	Expected agreement: 39.7%		Kappa: 0.1881	$p < 0.0001$
(w)Agreement: 78.6%	(w)Expected agreement: 65.6%		(w)Kappa: 0.2372	(w)$p < 0.0001$
Self-assessed average sleep duration	Wrist actigraphy (average time in bed)			
Short sleep	187 (40.1)	245 (52.6)	34 (7.3)	466
Recommended sleep	73 (21.5)	216 (63.7)	50 (14.8)	339
Long sleep	1 (6.3)	8 (50.0)	7 (43.8)	16
Total	261 (31.8)	469 (57.1)	91 (11.1)	821
Agreement: 49.9%	Expected agreement: 41.9%		Kappa: 0.1391	$p < 0.0001$
(w)Agreement: 72.8%	(w)Expected agreement: 67.5%		(w)Kappa: 0.1651	(w)$p < 0.0001$
Self-assessed wake-bed time differences	Wrist actigraphy (average time in bed)			
Short sleep	150 (55.8)	113 (42.0)	6 (2.2)	269
Recommended sleep	103 (22.6)	300 (65.9)	52 (11.4)	455
Long sleep	8 (8.3)	56 (57.7)	33 (34.0)	97
Total	261 (31.8)	469 (57.1)	91 (11.1)	821
Agreement: 58.8%	Expected agreement: 43.4%		Kappa: 0.2728	$p < 0.0001$
(w)Agreement: 78.6%	(w)Expected agreement: 68.0%		(w)Kappa: 0.3301	(w)$p < 0.0001$
Self-assessed average sleep duration	Self-assessed wake-bed time differences			
Short sleep	220 (47.2)	209 (44.9)	37 (7.9)	466
Recommended sleep	49 (14.5)	242 (71.4)	48 (14.2)	339
Long sleep	0 (0.0)	4 (25.0)	12 (75.0)	16
Total	269 (32.8)	455 (55.4)	97 (11.8)	821
Agreement: 57.7%	Expected agreement: 41.7%		Kappa: 0.2749	$p < 0.0001$
(w)Agreement: 76.6%	(w)Expected agreement: 67.2%		(w)Kappa: 0.2874	(w)$p < 0.0001$

Data presented as *N* (row %). Short sleep: <7 h; recommended sleep: 7–9 h; long sleep: >9 h. Kappa statistic interpretation: less than chance agreement ≤ 0; slight agreement = 0.01–0.20; fair agreement = 0.21–0.40; moderate agreement = 0.41–0.60; substantial agreement = 0.61–0.80; almost perfect agreement = 0.81–0.99.

36.9 min [26.9–47.0]), women had lower concordance than men (50.1 min [42.6–57.7] vs. 33.8 min [21.7–45.9]), and those with low sleep efficiency had lower concordance than those with high sleep efficiency (75.4 min [61.1–89.7] vs. 35.9 min [28.5–43.3]).

For actigraphy-based TST, the Spearman correlations did not significantly differ across potential modifiers, with the exception of across categories of sleep efficiency for self-assessed average sleep duration and across age groups among men for self-assessed wake-bed time differences (Supplementary Table S1). The correlation was significantly lower among those with low sleep efficiency than among those with high sleep efficiency ($\rho = 0.14$ vs. $\rho = 0.34$). Additionally, the correlation was significantly lower among men aged less than 65 years than among men aged at least 65 years ($\rho = 0.32$ vs. $\rho = 0.57$). An opposite age pattern emerged among men for self-assessed average sleep duration; however, these differences did not reach statistical significance.

Examination of concordance and calibration for actigraphy-based TIB (sleep interval) across potential moderators indicated that, for self-assessed average sleep duration, there were no significant disagreements in concordance nor calibration across age, sex, education, sleep efficiency, or high depressive symptom categories. Those with insomnia symptoms had significantly underestimated sleep duration compared to those without insomnia symptoms (–84.7 min [–97.0 to –72.4] vs. –38.3 min [–44.8 to –31.8]). Those with insomnia symptoms also had less accurate calibration than those without insomnia symptoms (0.20 [0.07–0.34] vs. 0.40 [0.32–0.48]). OSA and sleep efficiency demonstrated a similar pattern with regard to calibration. For self-assessed wake-bed time differences, there were no significant disagreements in concordance or calibration across potential moderators.

For actigraphy-based TIB (sleep interval), the Spearman correlations did not significantly differ across potential moderators, with the exception of insomnia status and sleep efficiency for self-assessed average sleep duration (Supplementary Table S1). The correlation was significantly lower among those with insomnia symptoms compared to those without insomnia symptoms ($\rho = 0.19$ vs. $\rho = 0.35$) and lower among those with low sleep efficiency than among those with high sleep efficiency ($\rho = 0.12$ vs. $\rho = 0.34$). A similar pattern was observed across OSA; however, these differences were not statistically significant.

Weekend sleep duration

Similar analyses were conducted for weekend sleep duration (see Supplement). Overall, all sleep duration measurements were longer on weekends than weekdays and while patterns were similar for weekday measurements, overall concordance and calibration were poorer for weekday measurements.

Discussion

Among 821 African-American participants of the JHSS, we found low-to-modest agreement among self-reported and actigraphy-based sleep duration measurements, but identified that concordance differed according to the specific questions used to assess sleep duration. The two common approaches for assessing self-reported sleep duration—i.e. one requiring the participant to estimate average sleep duration and the other estimating sleep duration based on average bed and wake times—resulted in different and directionally opposite levels of disagreement when compared to actigraphy-estimated sleep duration. Notably, self-reported average sleep duration provided a significant underestimate of sleep duration while self-reported wake-bed differences overestimated sleep duration. Wake-bed differences agreed well with TIB (sleep interval) but overestimated TST. Concordance appeared to generally decrease with increasing mean sleep duration, which suggests that individuals with more time awake during the night may have more trouble reporting or that individuals with shorter sleep have greater sleep misperception. Similarly, self-reported sleep duration resulted in greater underestimation of actigraphy-estimated TST among individuals with insomnia symptoms based on a comparison of self-reported sleep duration and actigraphy TST. Overall, these findings underscore that sleep duration may be systematically over or underestimated according to measurements used, and that this is particularly large among participants with insomnia symptoms, potentially due to sleep misperception that often accompanies insomnia [27].

There is great variation in how sleep duration can be assessed in epidemiological studies as there is no standard, agreed upon way to ask participants about their habitual sleep duration. Our study finding that the directionality of the level of agreement differed depending on which question was asked highlights the understudied challenge of using different self-reported measurements across epidemiological studies investigating sleep disparities across various populations. If participants underestimate or overestimate their sleep duration depending on the survey question, then population differences in the true association of health outcomes could be either overestimated or underestimated.

All questions of sleep duration are limited by problems in their ability to accurately determine actual sleep latency even though people generally know the time they went to bed. Using bedtimes (which can be more easily estimated than asking for sleep onset times) to anchor sleep onset will result in an overestimation of sleep duration, as shown in this and prior studies [12, 28]. Underestimation of wake after sleep onset also will contribute to overestimation of sleep duration using bed-wake times. Additionally, we showed that sleep duration is underestimated when individuals are asked to estimate their average sleep duration. This likely reflects sleep misperception, overestimation of sleep latency (which is also difficult to estimate from actigraphy), and/or overestimation of time awake after sleep onset. In addition, simple questions asking for usual sleep time can be limited by participant rounding that reduces precision and may introduce reporting biases, such as those resulting from participants seeking to report what they understand may be desirable durations.

As previously mentioned, several previous studies found moderate correlations between actigraphy and self-report ranging from 0.31 to 0.47 [7, 9, 11]. In CARDIA (mean age of 42.9 ± 3.6 years), there was a correlation of 0.45 ($\rho = 0.26$ for blacks; $\rho = 0.54$ for whites); and in MESA (mean age of 68.3 ± 9.1 years), there was a correlation of 0.38 ($\rho = 0.28$ for blacks; $\rho = 0.45$ for whites). Correlation among black adults in our JHS study was also moderate ($\rho = 0.28$). In CARDIA, self-reported sleep duration overestimated 3-day actigraphy-based measures of sleep duration by 48 min when based on the subjective measure of: "How many hours of sleep do you usually get at night (or when you usually sleep)?" [6]. These results could be in the opposite direction of our findings of −30.7 min due to, for instance, varying population characteristics and methodologies (e.g. 3 vs. 5 days of actigraphy measurements) between the studies. Another study that used PSG and diaries among 96 black adults (mean age of 59.9 ± 7.2 years) found that sleep duration from PSG was less concordant with prospective diary estimates among blacks [13].

Regarding potential moderators, there were no significant differences in concordance nor calibration for TST across categories defined by age, sex, education, high depressive symptoms, low sleep efficiency, or OSA in our study. For wake-bed time differences, those aged at least 65 years had greater disagreement than those aged less than 65 years, and women had greater disagreement than men. This finding could reflect the general poor sleep quality and lower sleep efficiency in older individuals. In CARDIA and MESA, high sleep efficiency (≥85%) also was associated with less disagreement. In CARDIA, Lauderdale et al. also found that mean difference was closer to 0 for participants who were black, obese, had high depression scores, high risk for sleep apnea (which made the greatest difference in concordance), high sleepiness, and among participants with high sleep efficiency [6]. According to MESA data, Jackson et al. found no significant differences in agreement for insomnia symptoms, depression, or educational attainment for each racial/ethnic group [12]. Chinese participants speaking Chinese vs. English as the primary language overestimated their sleep time, indicating a potential influence of culture or language on sleep-reported sleep duration. Additionally, depressive symptoms, poor health perceptions, and hostility affected the magnitude of agreement in a separate study [13]. Moreover, our study found that agreement for average sleep was less among individuals with insomnia symptoms. Misperception that often accompanies insomnia may have contributed to the particularly large measurement error observed among individuals with insomnia symptoms [27]. Understanding potential explanations for mixed findings is an important next step.

It is also important to acknowledge that, although actigraphy is our "gold standard," these methods may still introduce errors due to difficulties in distinguishing waking rest and sleep difficulty. Actigraphs have different hardware and software and use different scoring algorithms [29]; thus, results and sources of error may vary across devices. Hand annotation of actigraphy records also varies across laboratories and studies, and there are no standardized guidelines on how to annotate to sleep onset

and offset or nap periods. Such standardization is needed to improve comparability of data across studies.

This study has several potential limitations and strengths. Due to geographic, socioeconomic, and cultural differences, the sample from Jackson, Mississippi is not representative of African Americans across the United States. Also, our findings may not be generalizable to populations with lower education levels. Despite these limitations, investigating concordance of subjective and objective sleep among African Americans, an understudied population, is a major strength of the study. This is one of the first and largest studies to administer both commonly used sleep duration questions and objective measures of sleep duration through several days of actigraphy among African Americans. Furthermore, our findings have important implications for the health disparities literature as it is important to distinguish true differences from apparent differences that are due to measurement error in all subgroups of the population. Additionally, we had a relatively large sample size for which we were able to stratify by various potential modifiers (e.g. sleep apnea; insomnia symptoms) that are rarely formally investigated as modifiers of reporting differences.

In conclusion, the findings from this study underscore the need to cautiously extrapolate findings across studies using alternative measurement instruments. We often compare results across studies with varying sleep duration questions when investigating sleep-related disparities, but if participants underestimate or overestimate their sleep duration depending on the survey question, racial differences in the true association of health outcomes could be either underestimated or overestimated due to sleep duration misclassification among race/ethnic minorities. Future research should evaluate the psychometric properties of various widely used sleep instruments—whether questionnaire-based or across devices for objective sleep measures—across racial/ethnic groups. More methodological assessments are needed to identify the preferred way to ask questions regarding sleep duration in the general population and especially across diverse populations. Until then, self-reporting differences across measurement instruments and demographic groups appear to limit our ability to appropriately compare findings across epidemiological studies. Moreover, our findings underscore a need to identify low cost and low burden objective tools for measuring sleep duration in large populations. Although various commercial wearable devices are growing in popularity, there is a need for rigorous research to understand their limitations and utility across population groups.

Supplementary Material

Supplementary material is available at *SLEEP* online.

Funding

The research reported in this publication was supported by the National Heart, Lung, and Blood Institute (NHLBI) (R01HL110068). This work was funded, in part, by the Intramural Program at the NIH, National Institute of Environmental Health Sciences (Z1AES103325-01). Dr. Redline was supported in part by 5R35HL135818, and Dr. Johnson was supported in part by K01HL138211. The Jackson Heart Study (JHS) is supported and conducted in collaboration with Jackson State University (HHSN268201800013I), Tougaloo College (HHSN268201800014I), the Mississippi State Department of Health (HHSN268201800015I/HHSN26800001), and the University of Mississippi Medical Center (HHSN268201800010I, HHSN268201800011I and HHSN268201800012I) contracts from the National Heart, Lung, and Blood Institute (NHLBI) and the National Institute for Minority Health and Health Disparities (NIMHD). The authors also wish to thank the staffs and participants of the JHS. Dr. Wilson is supported by U54GM115428 from the National Institute of General Medical Sciences. The views expressed in this manuscript are those of the authors and do not necessarily represent the views of the National Heart, Lung, and Blood Institute; the National Institutes of Health; or the U.S. Department of Health and Human Services.

Conflict of interest statement. None declared.

References

1. Gottlieb DJ, *et al*. Association of sleep time with diabetes mellitus and impaired glucose tolerance. *Arch Intern Med*. 2005;**165**(8):863–867.
2. Ayas NT, *et al*. A prospective study of self-reported sleep duration and incident diabetes in women. *Diabetes Care*. 2003;**26**(2):380–384.
3. Ayas NT, *et al*. A prospective study of sleep duration and coronary heart disease in women. *Arch Intern Med*. 2003;**163**(2):205–209.
4. Grandner MA, *et al*. Who gets the best sleep? Ethnic and socioeconomic factors related to sleep complaints. *Sleep Med*. 2010;**11**(5):470–478.
5. Lauderdale DS, *et al*. Cross-sectional and longitudinal associations between objectively measured sleep duration and body mass index: the CARDIA Sleep Study. *Am J Epidemiol*. 2009;**170**(7):805–813.
6. Lauderdale DS, *et al*. Self-reported and measured sleep duration: how similar are they? *Epidemiology*. 2008;**19**(6):838–845.
7. Silva GE, *et al*. Relationship between reported and measured sleep times: the Sleep Heart Health Study (SHHS). *J Clin Sleep Med*. 2007;**3**(6):622–630.
8. Unruh ML, *et al*. Subjective and objective sleep quality and aging in the Sleep Heart Health Study. *J Am Geriatr Soc*. 2008;**56**(7):1218–1227.
9. Van Den Berg JF, *et al*. Disagreement between subjective and actigraphic measures of sleep duration in a population-based study of elderly persons. *J Sleep Res*. 2008;**17**(3):295–302.
10. Chen X, *et al*. Racial/ethnic differences in sleep disturbances: the Multi-Ethnic Study of Atherosclerosis (MESA). *Sleep*. 2015;**38**(6):877–888.
11. Girschik J, *et al*. Validation of self-reported sleep against actigraphy. *J Epidemiol*. 2012;**22**(5):462–468.
12. Jackson CL, Patel SR, Jackson WB II, Lutsey PL, Redline S. Agreement between self-reported and objectively measured sleep duration among white, black, Hispanic, and Chinese adults in the United States: Multi-Ethnic Study of Atherosclerosis. *Sleep*. 2018;**41**(6). doi:10.1093/sleep/zsy057
13. Matthews KA, *et al*. Similarities and differences in estimates of sleep duration by polysomnography, actigraphy, diary, and self-reported habitual sleep in a community sample. *Sleep Health*. 2018;**4**(1):96–103.
14. Vgontzas AN, *et al*. Insomnia with objective short sleep duration: the most biologically severe phenotype of the disorder. *Sleep Med Rev*. 2013;**17**(4):241–254.

15. Taylor HA Jr, *et al*. Toward resolution of cardiovascular health disparities in African Americans: design and methods of the Jackson Heart Study. *Ethn Dis*. 2005;**15** (4 Suppl 6):S6-4–S6-17.
16. Johnson DA, Guo N, Rueschman M, Wang R, Wilson JG, Redline S. Prevalence and correlates of obstructive sleep apnea among African Americans: the Jackson Heart Sleep Study. *Sleep*. 2018;**41**(10). doi:10.1093/sleep/zsy154
17. Morgenthaler T, *et al*.; Standards of Practice Committee; American Academy of Sleep Medicine. Practice parameters for the use of actigraphy in the assessment of sleep and sleep disorders: an update for 2007. *Sleep*. 2007;**30**(4):519–529.
18. Cole RJ, *et al*. Automatic sleep/wake identification from wrist activity. *Sleep*. 1992;**15**(5):461–469.
19. Levine DW, *et al*. Reliability and validity of the Women's Health Initiative Insomnia Rating Scale. *Psychol Assess*. 2003;**15**(2):137–148.
20. Myers KA, *et al*. Does this patient have obstructive sleep apnea? The Rational Clinical Examination systematic review. *JAMA*. 2013;**310**(7):731–741.
21. Johnson DA, Thomas SJ, Abdalla M, *et al*. Association between sleep apnea and blood pressure control among blacks: Jackson Heart Sleep Study. *Circulation*. 2019;**139**(10):1275–1284.
22. Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas*. 1977;**1**(3):385–401.
23. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report. National Institutes of Health. *Obes Res*. 1998;**6** (Suppl 2):51S-209S.
24. Folsom AR, *et al*.; ARIC Study Investigators. Community prevalence of ideal cardiovascular health, by the American Heart Association definition, and relationship with cardiovascular disease incidence. *J Am Coll Cardiol*. 2011;**57**(16):1690–1696.
25. Muntner P, *et al*. Potential US Population Impact of the 2017 ACC/AHA High Blood Pressure Guideline. *Circulation*. 2018;**137**(2):109–118.
26. American Diabetes A. Screening for type 2 diabetes. *Diabetes Care*. 2004;**27** (Suppl 1):S11–S14.
27. Bastien CH, *et al*. Insomnia and sleep misperception. *Pathol Biol (Paris)*. 2014;**62**(5):241–251.
28. Cespedes EM, *et al*. Comparison of self-reported sleep duration with actigraphy: results from the Hispanic Community Health Study/Study of Latinos Sueño Ancillary Study. *Am J Epidemiol*. 2016;**183**(6):561–573.
29. Quante M, *et al*. Practical considerations in using accelerometers to assess physical activity, sedentary behavior, and sleep. *Sleep Health*. 2015;**1**(4):275–284.