



5-2013

## What is the Best Measure of Daytime Sleepiness in Adults With Heart Failure?

Barbara Riegel

*University of Pennsylvania*, [briegel@nursing.upenn.edu](mailto:briegel@nursing.upenn.edu)

Alexandra L. Hanlon

Xuemei Zhang

Desiree Fleck

Steven L. Sayers

*See next page for additional authors*

Follow this and additional works at: <https://repository.upenn.edu/nrs>

 Part of the [Cardiology Commons](#), and the [Cardiovascular Diseases Commons](#)

---

### Recommended Citation

Riegel, B., Hanlon, A. L., Zhang, X., Fleck, D., Sayers, S. L., Goldberg, L. R., & Weintraub, W. S. (2013). What is the Best Measure of Daytime Sleepiness in Adults With Heart Failure?. *Journal of the American Association of Nurse Practitioners*, 25 (5), 272-279. <http://dx.doi.org/10.1111/j.1745-7599.2012.00784.x>

This paper is posted at ScholarlyCommons. <https://repository.upenn.edu/nrs/30>  
For more information, please contact [repository@pobox.upenn.edu](mailto:repository@pobox.upenn.edu).

---

# What is the Best Measure of Daytime Sleepiness in Adults With Heart Failure?

## Abstract

### Purpose

To identify the best screening measure of daytime sleepiness in adults with heart failure (HF).

### Data sources

A total of 280 adults with HF completed the Epworth Sleepiness Scale, the Stanford Sleepiness Scale, and a single Likert item measuring daytime sleepiness. The sensitivity and specificity of these self-report measures were assessed in relation to a measure of daytime dysfunction from poor sleep quality.

### Conclusions

Only 16% of the sample reported significant daytime dysfunction because of poor sleep quality. Those reporting daytime dysfunction were likely to be younger ( $p < .001$ ), to be unmarried ( $p = .002$ ), to have New York Heart Association (NYHA) functional class IV HF ( $p = .015$ ), and to report low income ( $p = .006$ ) and fewer hours of sleep ( $p = .015$ ). The measure of daytime sleepiness that was most sensitive to daytime dysfunction was a single Likert item measured on a 10-point (1–10) scale. Patients with a score  $\geq 4$  were 2.4 times more likely to have daytime dysfunction than those with a score  $< 4$ .

### Implications for practice

Complaints of daytime dysfunction because of poor sleep are not common in adults with HF. Routine use of a single question about daytime sleepiness can help nurse practitioners to identify those HF patients with significant sleep issues that may require further screening.

### Keywords

heart failure, screening, sleep disorders, outcomes

### Disciplines

Cardiology | Cardiovascular Diseases

### Author(s)

Barbara Riegel, Alexandra L. Hanlon, Xuemei Zhang, Desiree Fleck, Steven L. Sayers, Lee R. Goldberg, and William S. Weintraub

Published in final edited form as:

*J Am Assoc Nurse Pract.* 2013 May ; 25(5): 272–279. doi:10.1111/j.1745-7599.2012.00784.x.

## What is the Best Measure of Daytime Sleepiness in Adults with Heart Failure?

**Barbara Riegel, DNSc, RN, FAAN, FAHA,**

Professor, University of Pennsylvania School of Nursing

**Alexandra L. Hanlon, PhD,**

Research Associate Professor, University of Pennsylvania School of Nursing

**Xuemei Zhang, MS,**

Senior Biostatistician, CHOP-Westat BDMC

**Desiree Fleck, PhD, RN,**

Advanced Practice Nurse, Children's Hospital of Pennsylvania

**Steven L. Sayers, PhD,**

Associate Professor, University of Pennsylvania School of Medicine and Philadelphia Veterans Affairs Medical Center

**Lee R. Goldberg, MD, MPH, and**

Associate Professor, University of Pennsylvania School of Medicine

**William S. Weintraub, MD**

Chief of Cardiology, Director of Christiana Care Center for Outcomes Research Christiana Care Health System, Newark, DE

### Abstract

**Purpose**—To identify the best screening measure of daytime sleepiness in adults with heart failure (HF).

**Data sources**—280 adults with HF completed the Epworth Sleepiness Scale, the Stanford Sleepiness Scale, and a single Likert item measuring daytime sleepiness. The sensitivity and specificity of these self-report measures were assessed in relation to a measure of daytime dysfunction from poor sleep quality.

**Conclusions**—Only 16% of the sample reported significant daytime dysfunction due to poor sleep quality. Those reporting daytime dysfunction were likely to be younger ( $p < 0.001$ ), to be unmarried ( $p = 0.002$ ), to have New York Heart Association (NYHA) functional class IV HF ( $p = 0.015$ ), and to report low income ( $p = 0.006$ ) and fewer hours of sleep ( $p = 0.015$ ). The measure of daytime sleepiness that was most sensitive to daytime dysfunction was a single Likert item measured on a 10-point (1–10) scale. Patients with a score  $\geq 4$  were 2.4 times more likely to have daytime dysfunction than those with a score  $< 4$ .

**Implications for practice**—Complaints of daytime dysfunction due to poor sleep are not common in adults with HF. Routine use of a single question about daytime sleepiness can help nurse practitioners to identify those HF patients with significant sleep issues that may require further screening.

---

Sleep disordered breathing (SDB) is extremely common in adults with heart failure (HF). In a recent prevalence study, 61% of HF patients had central or obstructive sleep apnea (MacDonald, Fang, Pittman, White, & Malhotra, 2008). Yet, referral for polysomnography is not routine, even in specialty HF settings (Riegel, Moser, Powell, Rector, & Havranek, 2006). Identification and treatment of SDB is imperative because an untreated sleep disorder amplifies the strain on the heart with increased respiratory effort, hypoxia, and sympathetic stimulation (Valdivia-Arenas, Powers, & Khayat, 2009). Persons with SDB are at increased risk for myocardial infarction, stroke, arrhythmia, and probably early mortality (Selim, Won, & Yaggi, 2010). Treatment of SDB may improve ejection fraction and outcomes for patients with systolic HF and decrease pulmonary artery pressures for those with preserved ejection fraction (Oldenburg et al., 2009).

In the general population, people with SDB are typically sleepy during the day and a complaint of excessive daytime sleepiness is the symptom that stimulates a referral for testing. Yet, daytime sleepiness is rarely pronounced in HF patients with SDB (Javaheri, et al, 1998; Kaneko et al., 2003; Sin et al., 1999). Therefore, a sensitive, accurate, and easy-to-administer screening method is needed to identify patients who may have SDB in order to more quickly and efficiently address this dangerous comorbidity. The purpose of this study was to test the sensitivity and specificity of three simple screening measures of daytime sleepiness in adults with HF.

Daytime sleepiness is defined as difficulty maintaining a desired level of wakefulness (Young, 2004). Individuals with excessive daytime sleepiness experience a feeling of being drowsy with a tendency to actually fall asleep or nap, known as sleep propensity (Laffont et al., 2002). There is general agreement that sleep propensity reflects the interaction of homeostatic mechanisms and circadian rhythm (Achermann, 2004; Achermann & Borbely, 1994). The homeostatic mechanisms regulate sleep intensity, while the circadian clock regulates the timing of sleep. Others have proposed that sleep propensity depends on the relative strength of the sleep and wake drives (Edgar, Dement, & Fuller, 1993). The sleep drive is the mechanism that tells us of the need for sleep while the wake drive reflects chronobiological and environmental factors such as physical activity, which stimulate arousal (Cluydts, De Valck, Verstraeten, & Theys, 2002). In adults with SDB, sleep intensity and continuity are interrupted by repeated episodes when breathing stops or is markedly reduced, which cause nighttime arousals and daytime sleep propensity (Banno & Kryger, 2007).

## Measures of Sleepiness

A variety of measures are available for the assessment of excessive daytime sleepiness. Cluydts et al (2002) divided these measures into behavioral measures, subjective rating scales, and electrophysiological measures. Behavioral measures include performance tests

such as the psychomotor vigilance task (PVT). The PVT is a sensitive measure of lapses in attention in response to daytime sleepiness (Dinges et al., 1997). Subjective rating scales reflect acute or global sleepiness. Two examples of subjective rating scales are the Stanford Sleepiness Scale (SSS) and the Epworth Sleepiness Scale (ESS) (Hoddes, Zarcone, Smythe, Phillips, & Dement, 1973). The SSS measures sleepiness at a particular moment while the ESS measures global or typical sleepiness (Johns, 1992). Electrophysiological measures include tests such as polysomnography, pupillometry, and the Multiple Sleep Latency Test. When sensitivity and specificity of the Multiple Sleep Latency Test, the maintenance of wakefulness test, and the ESS were compared, the ESS was the most discriminating test (Johns, 2000). These measures vary greatly in cost, equipment, and training requirements.

As the goal of this study was to identify a measure of daytime sleepiness that is sensitive to daytime dysfunction in adults with HF, self-report measures that can be used to screen patients in an office setting were preferentially tested. We assessed the ability of three such measures of daytime sleepiness to identify sufficiently poor sleep quality to cause complaints of daytime dysfunction in adults with HF. The measure tested in addition to the ESS and the SSS was a simple Likert item assessing sleepiness. Poor sleep quality was measured with the daytime dysfunction subscale of the Pittsburgh Sleep Quality Index (Buysse, 1989). A measure of daytime dysfunction due to poor sleep was chosen because others have shown that SDB can cause daytime dysfunction even in those individuals who do not perceive being sleepy (Verstraeten & Cluydts, 2004).

## Methods

A sample of 280 adults with HF was enrolled from 3 sites in Philadelphia Pennsylvania and Newark Delaware as part of a larger study of the impact of sleepiness on HF self-care. Institutional review board approval was obtained from each institution and every subject provided informed consent. Data for the current descriptive study were collected by research assistants at enrollment, which took place during home visits. Further details of this study have been published previously (Riegel et al., in press).

## Study Population

All participants had chronic (systolic or diastolic) symptomatic HF confirmed based on echocardiographic and clinical evidence and were: 1) able to perform tests (e.g., sufficient visual and hearing acuity, able to speak and read English); and 2) living in a community (noninstitutional) setting. We excluded those with major depression to avoid issues of sleepiness caused by depression. Anyone noted in the medical record to have a major depressive illness were excluded. We also screened potential participants with the 9-item Patient Health Questionnaire (PHQ-9) (Kroenke, Spitzer, & Williams, 2001); anyone reporting 5 or more of the 9 symptoms more than half the days in the past 2 weeks (1 of the symptoms had to be depressed mood or anhedonia) was excluded. Anyone with a positive response to the item asking about suicidal ideation or with evidence of major depression was strongly encouraged to seek care and the provider was notified. We also excluded individuals with significant cognitive impairment by history or on testing with the Telephone Interview for Cognition Screening (TICS); anyone with a score < 24 (significant

cognitive impairment) was excluded (Brandt & Folstein, 2003). Individuals with an imminently terminal illness, plans to move out of the area, a history of drug or alcohol abuse within the prior year, night shift workers, and those on renal dialysis were excluded. In total, 333 eligible individuals were identified and 280 were enrolled.

## Measurement

Sleep dysfunction was assessed with the daytime dysfunction subscale of the Pittsburgh Sleep Quality Index (PSQI), a subjective rating scale (Buysse, 1989). The subscale items ask about staying awake and maintaining enough enthusiasm to get things done during the day. The two items are scored 0 (not in the past month) to 3 (three or more times a week), summed and then compressed into a subscale score ranging from 0–3; a higher score indicates more daytime dysfunction. When the full PSQI score is used, a score > 5 has a sensitivity of 89.6% and a specificity of 86.5% in distinguishing good and poor sleepers. In this study, the score on PSQI daytime dysfunction subscale was dichotomized at a cut-point of 2 (0/1 versus 2/3).

**Epworth Sleepiness Scale (ESS)**—Respondents rated the likelihood of falling asleep in 8 soporific situations using a 4-point scale ranging from never dozing (0) to high chance of dozing (3) (Johns, 1993). Test-retest reliability ( $r = 0.82$ ) and internal consistency ( $\alpha = 0.88$ ) have been established in addition to its single factor structure (Johns, 2000). Scores are summed, with higher scores indicating greater sleepiness, or categorized as sleepy ( $\geq 11$ ) or not sleepy ( $< 11$ ). At this cut-point of 11, the ESS had a sensitivity of 93.5% and a specificity of 100% for distinguishing pathological from normal sleepiness in a sample drawn from sleep disorder centers (Maislin et al., 1995). This cut-point on the ESS, however, may not adequately detect excessive daytime sleepiness in adults with HF (Javaheri, et al., 1998; Kaneko, et al., 2003; Sin, et al., 1999). So, in addition to a cut-point of 11 (sleepy  $\geq 11$  or not sleepy  $< 11$ ), we tested a cut-point of 6 (sleepy  $\geq 6$  or not sleepy  $< 6$ ) on the advice of the instrument author (Murray Johns, personal communication, 2006). This lower cut-point allowed us to have a higher index of suspicion for HF patients who are known to have less sleepiness than other patient groups. Since the instrument itself was not changed, this different cut-point did not affect the reliability and validity of the measure.

**Stanford Sleepiness Scale (SSS)**—The SSS is one of the oldest subjective sleepiness scales still in use today (Hoddes, Zarcone, Smythe, Phillips, & Dement, 1973). Subjects evaluate their current degree of sleepiness from 1 to 7 with 1 equivalent to feeling vital, alert, or wide-awake and 7 equivalent to feeling that sleep onset is soon. The SSS is said to be sensitive to both sleep deprivation and time of day (Babkoff, Caspy, & Mikulincer, 1991; Johnson, Freeman, Spinweber, & Gomez, 1991). The SSS was shown to be sensitive to deficits in alertness following partial sleep deprivation, although it did not predict individual performance on vigilance tests (Herscotch & Broughton, 1981). In this study we tested a cut-point of 4 on the SSS (sleepy  $\geq 4$  or not sleepy  $< 4$ ), which corresponds to “a little foggy; not at peak; let down”.

**Likert Item**—Rating scales are commonly used to measure attitudes and perceptions. The sensitivity of such items is determined by the number of response choices available. In this

study a single item with a 10-point scale was used. Respondents were instructed to indicate their sleepiness at that moment by choosing a number between 1 (not sleepy at all) and 10 (very sleepy). Others have found that using a single item to measure sleep quality produces reproducible and valid data in other patient groups (Cappelleri, et al 2009). No prior testing of sensitivity and specificity of this approach was located. In this study, a cut-point of 4 (sleepy  $\geq 4$  or not sleepy  $< 4$ ) was tested for sensitivity and specificity.

## Analysis

Demographic and clinical characteristics are described using mean values and standard deviations for continuous variables, and frequencies and percents for categorical variables. Characteristics of the sample were compared according to dichotomized PSQI daytime dysfunction subscale score ( $< 2$  versus  $\geq 2$ ) using two-sample t-tests and chi-square statistics for continuous and categorical variables, respectively. Linear regression models and Pearson correlation coefficients were used to quantify the direction and strength of linear association between PSQI daytime dysfunction subscale score and self-rated measures of daytime sleepiness (ESS, SSS, and Likert item).

For each of the three self-rated daytime sleepiness measures, receiver operating characteristic (ROC) curves were generated by plotting the sensitivity against 1-specificity. The area under the ROC curve (AUC) was calculated to assess the accuracy of each measure against the dichotomized PSQI daytime dysfunction subscale score. AUC measures the ability of a screening tool to correctly classify individuals as having a specific condition or not, in this case excessive daytime sleepiness. Scores can range from 0.5 to 1.0, where 0.5 indicates an uninformative screen, and 1.0 indicates a perfect screen. The predictive capacity of the three subjective rating scales to predict the PSQI daytime dysfunction subscale score was further described by estimating the sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio (+LR), and negative likelihood ratio (-LR), along with their corresponding 95% confidence intervals. Likelihood ratios can be used to determine the odds of a specific outcome in a particular patient.

## Results

Descriptive statistics were used to identify the predominant characteristics of the sample. The sample of 280 was predominantly male (64%), Caucasian (63%), married (81%), older adults ( $62 \pm 12.5$  years) (Table 1). Most had systolic (69%) HF of ischemic origin (37%) and were severely limited in their functional abilities (77% NYHA class III or IV). However, comorbidity measured with the Charlson index (Charlson, Pompei, Ales, & MacKenzie, 1987) was low for most (53%), indicating that overall the subjects had few other major illnesses.

When scores on the PSQI daytime dysfunction subscale were dichotomized at  $\geq 2$ , only 16% ( $n=45$ ) of the sample reported significant daytime dysfunction due to poor sleep quality (Table 1). Using t-tests and chi-square statistics, we found that those reporting daytime dysfunction were likely to be younger ( $p<0.001$ ), to be unmarried ( $p=0.002$ ), to have New York Heart Association (NYHA) functional class IV HF ( $p=0.015$ ), and to report low income ( $p=0.006$ ) and fewer hours of sleep ( $p=0.015$ ).

The correlation between the three measures of daytime sleepiness was generally low (.24–.41), with the exception of the relationship between the SSS and the Likert item, which was moderately large with  $r=0.64$  (Table 2). None of the three measures was moderately or highly correlated with daytime dysfunction.

Using ROC curves, the measure of daytime sleepiness that was most sensitive to daytime dysfunction was the Likert item (Table 3). Although sensitivity of the ESS was higher using a cut-point of 6, specificity at this cut-point was low. At the cut-point of 11, the ESS was moderately specific but inadequate in sensitivity. A similar picture was seen with the SSS. Only the Likert item demonstrated adequate sensitivity and specificity.

## Discussion

The results of this study suggest that use of a single scaled question about sleepiness is an effective method of detecting sleep problems that may require further screening in a clinical setting. These findings are important because abnormal sleep patterns are associated with increased risks of morbidity, poor quality of life, and mortality (Zisapel, 2007). Daytime sleepiness is an indicator of the need for further screening for SDB, as well as other chronic conditions such as non-dipping hypertension (Erden et al., 2010), chronic kidney disease (Kumar et al., 2010), depression (Koutsourelakis et al., 2009), and rheumatic disease (Goodchild, Treharne, Booth, & Bowman, 2010). Adding this single scaled question to the routine history may improve the detection of chronic comorbid conditions in adults with HF.

This study is the first to definitively show that neither the Stanford Sleepiness Scale nor the Epworth Sleepiness Scale—regardless of the cut-point used—is sufficiently sensitive and specific for use in clinical practice. In research, a single item measure of daytime sleepiness is not adequate, but in clinical practice it may be the most practical and sensitive method for screening (Schumacher, Gleason, Holloman, McLeod, 2010).

The Stanford Sleepiness Scale has fallen out of favor in recent years, probably because it was suspected of poor sensitivity (Herscovitch & Broughton, 1981). The Epworth Sleepiness Scale, however, is considered the gold standard for the assessment of daytime sleepiness by many. In spite of this, the cut-point of 11 has been questioned by clinicians. Even the instrument author recommends that the cut-point be modified for patients with HF.

In this population of adults with HF we found that only 16% reported daytime dysfunction due to poor sleep quality. This was surprising, as sleep complaints are highly prevalent in other populations. In a survey of 1,935 patients from family practice offices in North Carolina, more than half the patients reported daytime sleepiness (Alattar, Harrington, Mitchell, & Sloane, 2007). In that survey, one group likely to report poor sleep was those with limited activity, similar to our sample of NYHA functional class III patients. The reason that so few of our patients reported daytime dysfunction may be related to the known change in sensitivity to impaired sleep that occurs with age (Bixler, Vgontzas, Ten Have, Tyson, & Kales, 1998). Or, it could be related to the gray and white matter losses in the brain that occur in HF (Woo, Kumar, Macey, Fonarow, & Harper, 2009).

These results support those of prior investigators who have demonstrated that excessive daytime sleepiness is not easily detected in adults with HF, even when they have SDB (Arzt et al., 2006; Javaheri, et al., 1998; Johansson et al., 2010; Kaneko, et al., 2003; Rao et al., 2006). In our study, daytime sleepiness did not differ in subjects with and without SDB. The mean scores on the Epworth Sleepiness Scale in our sample were basically identical to those found by Arzt et al (Arzt, et al., 2006) in their study of daytime sleepiness in patients with HF. Comparing sleepiness in patients with and without HF, Arzt et al also concluded that HF patients have less subjective daytime sleepiness than would be expected given the prevalence of SDB. Clearly, a high level of suspicion needs to be used when considering which patients to refer for further testing.

The sociodemographic factors characterizing patients with daytime dysfunction due to poor sleep were age, marital status, and income. Sleep complaints are usually attributed to the elderly (Stores, 2007), although others have found sleep problems to be more common in younger individuals, as we found (Kumar, et al., 2010). The finding that single individuals had more daytime dysfunction supports that of Hawkey and colleagues who found that loneliness in socially isolated individuals predicted daytime dysfunction, independent of sleep duration and after adjusting for depression (Hawkey, Preacher, & Cacioppo, 2010). Our finding that individuals with lower income were more likely to report more daytime dysfunction supports results from the 2004–2007 National Health Interview Survey. Lower income was found to be associated with poor sleep in that nationally representative survey of 110,441 noninstitutionalized US adults (Krueger & Friedman, 2009).

One limitation of this study is that the sample of adults with HF may not mirror that of the general population of HF patients, who are generally older. These patients were younger probably because everyone with HF was included, regardless of the type or etiology of HF (systolic or diastolic). This decision influenced the mean age of the sample but may also have made the results more generalizable to HF patients overall.

### **Implications for Practice**

The likelihood ratios in Table 3 can be used to identify the odds of daytime dysfunction associated with daytime sleepiness in a particular patient. The positive likelihood ratio of 2.37 for the Likert item indicates that the likelihood of having daytime dysfunction for a patient scoring 4 or more on that single item has increased by approximately 2.4-fold over someone with a score less than 4. These results suggest that a higher index of suspicion is warranted in HF patients who are relatively young, unmarried, functionally compromised, those with low income and an inadequate amount of sleep. Those reporting sleepiness should be considered for further screening.

### **Supplementary Material**

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgments

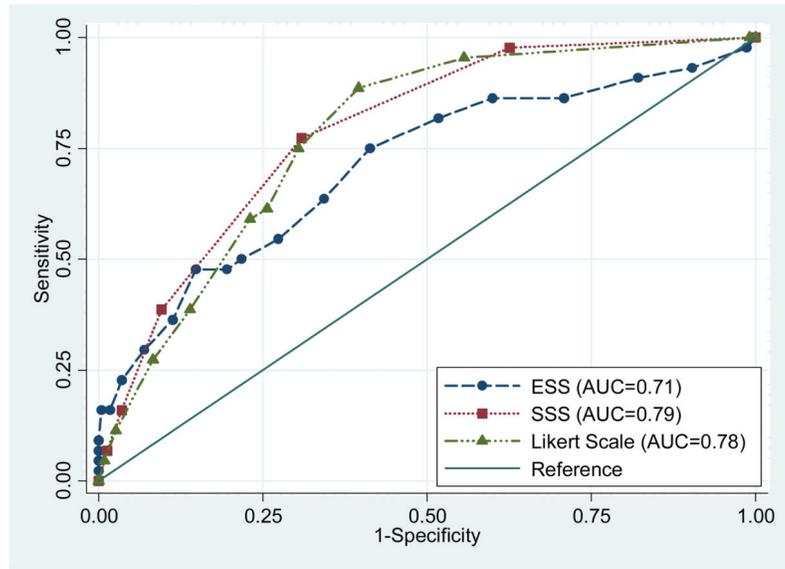
This work was funded by a grant from the National Heart, Lung & Blood Institute (RO1 HL084394-01A1) and by the Philadelphia Veterans Affairs Medical Center, VISN 4 Mental Illness Research, Education, and Clinical Center (MIREC).

## References

- Achermann P. The two-process model of sleep regulation revisited. *Aviation and Space Environmental Medicine*. 2004; 75(3 Suppl):A37–43.
- Achermann P, Borbely AA. Simulation of daytime vigilance by the additive interaction of a homeostatic and a circadian process. *Biological Cybernetics*. 1994; 71(2):115–121. [PubMed: 8068773]
- Alattar M, Harrington JJ, Mitchell CM, Sloane P. Sleep problems in primary care: a North Carolina Family Practice Research Network (NC-FP-RN) study. *Journal of the American Board of Family Medicine*. 2007; 20(4):365–374.
- Arzt M, Young T, Finn L, Skatrud JB, Ryan CM, Newton GE, et al. Sleepiness and sleep in patients with both systolic heart failure and obstructive sleep apnea. *Archives of Internal Medicine*. 2006; 166(16):1716–1722. [PubMed: 16983049]
- Babkoff H, Caspy T, Mikulincer M. Subjective sleepiness ratings: the effects of sleep deprivation, circadian rhythmicity and cognitive performance. *Sleep*. 1991; 14(6):534–539. [PubMed: 1798887]
- Banno K, Kryger MH. Sleep apnea: clinical investigations in humans. *Sleep Medicine*. 2007; 8(4): 400–426. [PubMed: 17478121]
- Bixler EO, Vgontzas AN, Ten Have T, Tyson K, Kales A. Effects of age on sleep apnea in men: I. Prevalence and severity. *American Journal of Respiratory & Critical Care Medicine*. 1998; 157(1): 144–148. [PubMed: 9445292]
- Brandt, J.; Folstein, MF. Telephone Interview for Cognitive Status. Psychological Assessment Resources, Inc; 2003.
- Buysse D, Reynolds CF 3d, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatric Research*. 1989; 28:193–213.
- Cappelleri JC, Bushmakin AG, McDermott AM, Sadosky AB, Petrie CD, Martin S. Psychometric properties of a single-item scale to assess sleep quality among individuals with fibromyalgia. Health and quality of life outcomes. 2009; 7:54. [PubMed: 19534799]
- Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of Chronic Diseases*. 1987; 40(5):373–383. [PubMed: 3558716]
- Cluydts R, De Valck E, Verstraeten E, Theys P. Daytime sleepiness and its evaluation. *Sleep Medicine Reviews*. 2002; 6(2):83–96. [PubMed: 12531145]
- Dinges DF, Pack F, Williams K, Gillen KA, Powell JW, Ott GE, et al. Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4–5 hours per night. *Sleep*. 1997; 20(4):267–277. [PubMed: 9231952]
- Edgar DM, Dement WC, Fuller CA. Effect of SCN lesions on sleep in squirrel monkeys: evidence for opponent processes in sleep-wake regulation. [earticle]. *Journal of Neuroscience*. 1993; 13(3): 1065–1079. [PubMed: 8441003]
- Erden I, Erden EC, Ozhan H, Basar C, Aydin M, Dumlu T, et al. Poor-quality sleep score is an independent predictor of nondipping hypertension. *Blood Pressure Monitoring*. 2010; 15(4):184–187. [PubMed: 20639701]
- Goodchild CE, Treharne GJ, Booth DA, Bowman SJ. Daytime patterning of fatigue and its associations with the previous night's discomfort and poor sleep among women with primary Sjogren's syndrome or rheumatoid arthritis. *Musculoskeletal Care*. 2010; 8(2):107–117. [PubMed: 20229610]
- Hawley LC, Preacher KJ, Cacioppo JT. Loneliness impairs daytime functioning but not sleep duration. *Health Psychology*. 2010; 29(2):124–129. [PubMed: 20230084]

- Herscovitch J, Broughton R. Sensitivity of the stanford sleepiness scale to the effects of cumulative partial sleep deprivation and recovery oversleeping. *Sleep*. 1981; 4(1):83–91. [PubMed: 7232973]
- Hoddes E, Zarcone V, Smythe H, Phillips R, Dement WC. Quantification of sleepiness: a new approach. [earticle]. *Psychophysiology*. 1973; 10(4):431–436. [PubMed: 4719486]
- Javaheri S, Parker TJ, Liming JD, Corbett WS, Nishiyama H, Wexler L, et al. Sleep apnea in 81 ambulatory male patients with stable heart failure: types and their prevalences, consequences, and presentations. *Circulation*. 1998; 97:2154–2159. [PubMed: 9626176]
- Johansson P, Arestedt K, Alehagen U, Svanborg E, Dahlstrom U, Brostrom A. Sleep disordered breathing, insomnia, and health related quality of life -- a comparison between age and gender matched elderly with heart failure or without cardiovascular disease. *European Journal of Cardiovascular Nursing*. 2010; 9(2):108–117. [PubMed: 20056491]
- Johns MW. Reliability and factor analysis of the Epworth Sleepiness Scale. *Sleep*. 1992; 15(4):376–381. [PubMed: 1519015]
- Johns MW. Daytime sleepiness, snoring, and obstructive sleep apnea. *The Epworth Sleepiness Scale*. *Chest*. 1993; 103:30–36. [PubMed: 8417909]
- Johns MW. Sensitivity and specificity of the multiple sleep latency test (MSLT), the maintenance of wakefulness test and the epworth sleepiness scale: failure of the MSLT as a gold standard. *Journal of Sleep Research*. 2000; 9:5–11. [PubMed: 10733683]
- Johnson LC, Freeman CR, Spinweber CL, Gomez SA. Subjective and objective measures of sleepiness: effect of benzodiazepine and caffeine on their relationship. *Psychophysiology*. 1991; 28(1):65–71. [PubMed: 1679563]
- Kaneko Y, Floras JS, Usui K, Plante J, Tkacova R, Kubo T, et al. Cardiovascular effects of continuous positive airway pressure in patients with heart failure and obstructive sleep apnea. *New England Journal of Medicine*. 2003; 348(13):1233–1241. [PubMed: 12660387]
- Koutsourelakis I, Perraki E, Economou NT, Dimitrokalli P, Vagiakis E, Roussos C, et al. Predictors of residual sleepiness in adequately treated obstructive sleep apnoea patients. *European Respiratory Journal*. 2009; 34(3):687–693. [PubMed: 19357151]
- Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *Journal of General Internal Medicine*. 2001; 16(9):606–613. [PubMed: 11556941]
- Krueger PM, Friedman EM. Sleep duration in the United States: a cross-sectional population-based study. *American Journal of Epidemiology*. 2009; 169(9):1052–1063. [PubMed: 19299406]
- Kumar B, Tilea A, Gillespie BW, Zhang X, Kiser M, Eisele G, et al. Significance of self-reported sleep quality (SQ) in chronic kidney disease (CKD): the Renal Research Institute (RRI)-CKD study. *Clinical Nephrology*. 2010; 73(2):104–114. [PubMed: 20129017]
- Laffont F, Mallet A, Mayer G, Meunier S, Minz M, N'Doye S, et al. Study of a patient population investigated for excessive daytime sleepiness (EDS). *Neurophysiological Clinics*. 2002; 32(6):343–351.
- MacDonald M, Fang J, Pittman SD, White DP, Malhotra A. The current prevalence of sleep disordered breathing in congestive heart failure patients treated with beta-blockers. *Journal of Clinical Sleep Medicine*. 2008; 4(1):38–42. [PubMed: 18350960]
- Maislin G, Pack AI, Kribbs NB, Smith PL, Schwartz AR, Kline LR, et al. A survey screen for prediction of apnea. *Sleep*. 1995; 18(3):158–166. [PubMed: 7610311]
- Oldenburg O, Bitter T, Wiemer M, Langer C, Horstkotte D, Piper C. Pulmonary capillary wedge pressure and pulmonary arterial pressure in heart failure patients with sleep-disordered breathing. *Sleep Medicine*. 2009; 10(7):726–730. [PubMed: 19135413]
- Rao A, Georgiadou P, Francis DP, Johnson A, Kremastinos DT, Simonds AK, et al. Sleep-disordered breathing in a general heart failure population: relationships to neurohumoral activation and subjective symptoms. *Journal of Sleep Research*. 2006; 15(1):81–88. [PubMed: 16490006]
- Riegel B, Moelter ST, Ratcliffe SJ, Pressler SJ, De Geest S, Potashnik S, et al. Excessive Daytime Sleepiness is Associated with Poor Medication Adherence in Adults with Heart Failure. *Journal of Cardiac Failure*. (in press).
- Riegel B, Moser DK, Powell M, Rector TS, Havranek EP. Nonpharmacologic care by heart failure experts. *Journal of Cardiac Failure*. 2006; 12(2):149–153. [PubMed: 16520265]

- Schumacher JA, Gleason SH, Holloman GH, McLeod WT. Using a single-item rating scale as a psychiatric behavioral management triage tool in the emergency department. *Journal of emergency nursing: JEN : official publication of the Emergency Department Nurses Association*. 2010; 36(5): 434–438. [PubMed: 20837212]
- Selim B, Won C, Yaggi HK. Cardiovascular consequences of sleep apnea. *Clinics in Chest Medicine*. 2010; 31(2):203–220. [PubMed: 20488282]
- Sin DD, Fitzgerald F, Parker JD, Newton G, Floras JS, Bradley TD. Risk factors for central and obstructive sleep apnea in 450 men and women with congestive heart failure. *American Journal of Respiratory and Critical Care Medicine*. 1999; 160:1101–1106. [PubMed: 10508793]
- Stores G. Clinical diagnosis and misdiagnosis of sleep disorders. *Journal of Neurology and Neurosurgical Psychiatry*. 2007; 78(12):1293–1297.
- Valdivia-Arenas MA, Powers M, Khayat RN. Sleep-disordered breathing in patients with decompensated heart failure. *Heart Failure Reviews*. 2009; 14(3):183–193. [PubMed: 18758944]
- Verstraeten E, Cluydts R. Executive control of attention in sleep apnea patients: theoretical concepts and methodological considerations. *Sleep Medicine Reviews*. 2004; 8(4):257–267. [PubMed: 15233954]
- Woo MA, Kumar R, Macey PM, Fonarow GC, Harper RM. Brain injury in autonomic, emotional, and cognitive regulatory areas in patients with heart failure. *Journal of Cardiac Failure*. 2009; 15(3): 214–223. [PubMed: 19327623]
- Young TB. Epidemiology of daytime sleepiness: definitions, symptomatology, and prevalence. *Journal of Clinical Psychiatry*. 2004; 65(Suppl 16):12–16. [PubMed: 15575799]
- Zisapel N. Sleep and sleep disturbances: biological basis and clinical implications. *Cellular and Molecular Life Sciences*. 2007; 64(10):1174–1186. [PubMed: 17364142]



**Figure 1.**  
ROC curve for Predicting Sleep Dysfunction (Score  $\geq 2$ )

**Table 1**  
Demographic, Clinical, and Treatment Characteristics of the Sample of Adults with Heart Failure, with Comparisons According to the Presence or Absence of Sleep Dysfunction

	Total N	Percentage of Total		No sleep dysfunction (Score < 2) (n=235)		Sleep dysfunction (Score ≥ 2) (n=45)		P-value
		n	%	n	%	n	%	
Gender:								1.00
• male	180	151	64	151	64	29	64	
• female	100	84	36	84	36	16	36	
Marital status:								0.002
• married or living with a partner	226	198	81	198	84	28	62	
• single	54	37	19	37	16	17	38	
Race:								0.16
• black	96	76	34	76	32	20	44	
• white	175	152	63	152	65	23	51	
• other	9	7	3	7	3	2	4	
Education:								0.28
• <high school	27	25	10	25	11	2	4	
• high school	102	82	36	82	35	20	44	
• At least some college	151	128	54	128	55	23	51	
Income:								0.01
• more than needed	98	90	35	90	38	8	18	
• enough to meet needs	137	113	49	113	48	24	53	
• less than needed	45	32	16	32	14	13	30	
Type of provider caring for HF:								0.89
• Internal medicine	1	1	<1	1	<1	0	0	
• Cardiology	159	134	57	134	57	25	56	
• HF specialist	120	100	43	100	43	20	44	
Charlson Comorbidity score:								0.63
• Low severity	149	124	53	124	53	25	56	
• Moderate severity	101	87	36	87	37	14	31	
• High severity	30	24	11	24	10	6	13	

	Total N	Percentage of Total	No sleep dysfunction (Score < 2) (n=235)			Sleep dysfunction (Score = 2) (n=45)			P-value
			n	Mean	SD	n	Mean	SD	
HF type:									0.23
• systolic	194	69	164	70		30	67		
• diastolic	53	19	43	18		10	22		
• mixed	32	11	28	12		4	9		
• unspecified	1	0	0	0		1	2		
HF etiology‡									0.09
• ischemic	102	37	90	39		12	27		
• nonischemic	177	63	144	61		33	73		
NYHA Functional Class:									0.01
• Class I	12	4	11	5		1	2		
• Class II	54	19	51	22		3	7		
• Class III	164	59	137	58		26	59		
• Class IV	50	18	36	15		14	32		
Prescribed an ACE inhibitor:									0.25
• no	118	42	103	44		15	33		
• yes	162	58	132	56		30	67		
Prescribed a beta-blocker:									0.12
• no	21	8	15	6		6	13		
• yes	259	92	220	94		39	87		
Typically take a daytime nap‡									0.17
• no	62	23	56	24		6	14		
• yes	213	78	176	79		37	87		
Sleep disordered breathing:									0.51
• no	127	45	107	45		20	44		
• yes	153	55	128	55		25	56		
		<b>Mean (SD)</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>p-value</b>
Age	280	61.9 (12.5)	235	63.7	11.8	45	53.3	12.6	0.00
Hours slept last night‡	279	6.3 (1.7)	235	6.4	1.7	44	5.7	1.9	0.01
Ejection fraction‡	279	35.4 (17.0)	235	35.0	16.8	44	37.6	18.3	0.35

	Total N	Percentage of Total	No sleep dysfunction (Score < 2) (n=235)		Sleep dysfunction (Score ≥ 2) (n=45)		P-value	
Body mass index (BMI)	280	31.0 (7.9)	235	30.9	5	31.9	7.9	0.42

ACE = angiotensin-converting enzyme; NYHA = New York Heart Association; HF=heart failure ¥ missing data

**Table 2**

Correlation coefficients among PSQI Sleep Dysfunction Score and Measures of Sleepiness

	<b>PSQI Sleep Dysfunction Score</b>	<b>Stanford Sleepiness Scale</b>	<b>Epworth Sleepiness Scale</b>
Stanford Sleepiness Scale	0.40		
Epworth Sleepiness Scale	0.40	0.24	
Likert-type rating scale	0.41	0.64	0.29

PSQI = Pittsburgh Sleep Quality Index

**Table 3**  
Sensitivity and Specificity for Sleepiness Measures as a Predictor of Sleep Dysfunction 2

	Cut-off Value	Sensitivity % (95% CI)	Specificity % (95% CI)	+LR (95% CI)	-LR (95% CI)
Epworth Sleepiness Scale	11	47 (32, 62)	81 (75.2, 85.7)	2.44 (1.62, 3.67)	0.66 (0.50, 0.87)
Epworth Sleepiness Scale	6	88 (65, 90)	48 (42, 55)	1.54 (1.27, 2.87)	0.42 (0.23, 0.76)
Stanford Sleepiness Scale	> 3	40 (26,56)	91 (86, 94)	4.27 (2.50, 7.30)	0.66 (0.52, 0.84)
Likert-type rating scale	> 3	76 (61,87)	68 (62, 74)	2.37 (1.84, 3.04)	0.36 (0.21, 0.60)

CI = confidence interval; LR = likelihood ratio