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# Poor sleep quality and reduced cognitive function in persons with heart failure

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Cognitive dysfunction is common in persons with heart failure (HF), with an estimated 25–75% of HF patients exhibiting deficits on neuropsychological testing [1]. Deficits are particularly common on tests of attention, memory, and executive functioning [2–3]. A growing number of factors have been shown to contribute to the cognitive dysfunction found in persons with HF, including decreased cerebral blood flow velocity [4]. It appears likely that poor sleep is another contributor to cognitive dysfunction in HF as past studies suggest 50–80% of HF patients experience sleep difficulties [5–6]. In turn, poor sleep is associated with cognitive impairment in both patient and healthy samples in past work [7–8]. The current study examined whether reported sleep problems are associated with poorer cognitive functioning in a sample of older adults with HF. Additional analyses were performed to examine whether poor sleep quality would also be associated with other psychosocial outcomes in persons with HF, including activities of daily living, quality of life, and depressive symptoms.

One hundred and fifty-nine older adults diagnosed with systolic HF were recruited from Summa Health System in Akron, OH (68.53±9.30 years; 36.2% female). Comorbid medical conditions included hypertension (79.8%), elevated cholesterol (68%), coronary artery bypass graft (35.2%), and type 2 diabetes (30.4%). All participants were between 50–85 years of age, English-speaking, and had an established diagnosis of New York Heart Association (NYHA) class II or III HF. Exclusion criteria included a history of significant neurological disorder (e.g. dementia, stroke), head injury, severe psychiatric disorder (e.g. schizophrenia, bipolar disorder), and substance use. As sleep apnea is common in persons



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with HF [9] and known to independently suppress cognitive function in other samples [10–11], HF patients with a diagnosis of sleep apnea were excluded from the current analyses.

All procedures were approved by the local Institutional Review Board and written consent was obtained from all participants. Participants completed a 90-minute neuropsychological battery, followed by the 2-minute step test. A series of medical history and self-report questionnaires, including the Pittsburgh Sleep Quality Index (PSQI), Beck Depression Inventory (BDI-II), Lawton-Brody Activities of Daily Living Questionnaires (ADL), and the 12-Item Short Form Health Survey (SF-12) were then completed by all participants.

Consistent with past work [5–6], sleep problems were common within our sample of older adults with HF, as the sample had an average Global PSQI of 15.23 ± 7.12 and 96.0% had a Global PSQI score in the impaired range (>5). Difficulties falling asleep (20.8%), staying asleep (49.6%), as well as interruptions in sleep due to bathroom use (56.0%) were those problems most commonly reported. Cognitive impairment was also prevalent as participants averaged 92.87 ± 5.49 on the Modified Mini-Mental Status Exam (3MS), with 24.8% of the sample scoring below 90, 30.4% between 90–95, and 40% above a 95.

After adjusting for age, gender, education, HF severity, diabetes, and hypertension, Global PSQI demonstrated incremental predictive validity for executive functioning and attention ($\Delta F(1,117) = 3.96$, $\Delta R^2 = .02$, $p < .05$) and a trend emerged for memory ($\Delta F(1,118) = 2.94$, $\Delta R^2 = .02$, $p = .09$). In each case, poorer sleep was associated with poorer cognitive function. Poorer sleep quality was not associated with language ($\Delta F(1,117) = 0.73$, $\Delta R^2 = .01$, $p > .05$). See Table 1.

Again, after adjusting for age, gender, education, HF severity, diabetes, and hypertension, partial correlations revealed that Global PSQI was significantly associated with SF-12 MCS ($r(117) = -0.44$, $p < .01$), SF-12 PCS ($r(117) = -0.37$, $p < .01$), the BDI-II ($r(117) = 0.38$, $p < .05$), instrumental ADL ($r(117) = -0.22$, $p < .05$), and basic ADL ($r(117) = -0.19$, $p < .05$). Poorer sleep quality was associated with reduced quality of life, increased depressive symptomatology, and reduced instrumental and basic ADL performance.

The current results show that poor reported sleep quality is associated with reduced performance on tests of attention/executive function and a similar trend emerged for memory. This relationship between sleep quality and cognitive impairment has been reported in other samples, including healthy adults [12–13] and less severe forms of cardiovascular disease [14]. While many HF patients already experience decreased cerebral blood flow, impaired sleep has also been linked to similar effects on blood flow and could further exacerbate cognitive impairment [15]. Additional work is needed to clarify this possibility.

Within this sample of older adults with HF, greater reported sleep problems are also associated with poorer psychosocial outcomes. Similar to other populations [16–17], poor sleep is associated with reduced quality of life, greater depression, and reduced functional independence. Such findings raise the possibility that sleep problems are a possible therapeutic target to improve outcomes in persons with HF. Exercise and sleep education have been beneficial to quality of sleep, mood, and quality of life in other populations [18–19]. Likewise, treatment of depression may improve sleep, as the directionality of this relationship is unclear [20].

The current findings are limited in several ways. Future research is needed to clarify the mechanisms by which sleep influences cognitive functioning in this population as well as the types of sleep problems which lead to impairment. Neuroimaging studies may provide clues to how sleep and heart failure contribute to cognitive decline [21]. The cognitive

dysfunction found in HF may cause patients to over- or under- estimate their sleep problems and objective measures would clarify possible discrepancies and provide information for future treatment interventions [22]. Finally, prospective studies should also be conducted to better understand how sleep problems progress in HF and how they might correspond to cognitive function and other outcomes. For example, cognitive impairment is associated with elevated mortality risk in persons with HF [23] and the contribution of poor sleep and other factors to this risk are unknown.

The authors of this manuscript have certified that they comply with the Principles of Ethical Publishing in the International Journal of Cardiology [24].

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## Table 1

Association of Sleep Quality with Cognitive Functions in Older Adults with Heart Failure (*N* = 125): A summary of hierarchical regressions.

| | Executive Function/Attention | Memory | Language |
|---|---|---|---|
| **Variable** | ***b*(*SE b*)** | ***b*(*SE b*)** | ***b*(*SE b*)** |
| *Model 1* | | | |
| Gender | 0.22 (±1.31) | -- | −0.95 (±1.90) |
| Education | 0.65 (±.23) | 0.47 (±.27) | 0.80 (±.33) |
| BDI-II | −0.40 (±.09) | −0.24 (±.11) | −2.2 (±.13) |
| 2MST | 0.08 (±.03) | 0.01 (±.03) | 0.09 (±.04) |
| Diabetes | −3.11 (±1.40) | −1.18 (±1.70) | −2.89 (±2.03) |
| Hypertension | −1.02 (±1.52) | 0.07 (±1.84) | −0.65 (±2.19) |
| $R^2$ | .36 | .08 | .20 |
| *P* | .00* | .06 | .00* |
| *Model 2* | | | |
| Global PSQI | −0.20 (±.10) | −0.21 (±.12) | −0.13 (±.15) |
| $R^2$ | .38 | .11 | .20 |
| *F* for $\Delta R^2$ | 3.96 | 2.94 | .73 |
| *P* | .05* | .09 | .39 |

Note.

* denotes $p < 0.05$;

** denotes $p < .001$

Abbreviations: b – unstandardized regression coefficients, SE – standard error, BDI-II = Beck Depression Inventory-II; 2MST = 2-minute step test; AMNART = American National Adult Reading Test