Decreases in Daily Physical Activity Predict Acute Decline in Attention and Executive Function in Heart Failure

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ABSTRACT

Background: Reduced physical activity (PA) may be one factor that contributes to cognitive decline and dementia in heart failure (HF). Yet, the longitudinal relationship between PA and cognition in HF is poorly understood owing to limitations of past work, including single-time assessments of PA. This is the first study to examine changes in objectively measured PA and cognition over time in HF.

Methods and Results: At baseline and 12 weeks, 57 HF patients completed psychosocial self-report measures and a neuropsychological battery and wore an accelerometer for 7 days. At baseline, HF patients spent an average of 597.83 (SD 75.91) minutes per day sedentary. Steps per day declined from baseline to the 12-week follow-up; there was also a trend for declines in moderate-vigorous PA. Regression analyses controlling for sex, HF severity, and depressive symptoms showed that decreases in light ($P = .08$) and moderate-vigorous ($P = .04$) daily PA emerged as strong predictors of declines in attention/executive function over the 12-week period, but not of memory or language.

Conclusions: Reductions in daily PA predicted acute decline in attention/executive function in HF, but not of memory or language. Modifications to daily PA may attenuate cognitive decline, and prospective studies are needed to test this possibility. (*J Cardiac Fail 2015;21:339–346*)

Key Words: Physical activity, heart failure, cognitive function, accelerometry.

Heart failure (HF) affects >5 million American adults and leads to poor outcomes (eg, premature death), including an almost 2-fold increased risk for Alzheimer disease.[1,2] Early-onset cognitive impairment can also be found in ~80% of persons with HF.[3] In particular, cross-sectional work shows that HF participants exhibit greater cognitive impairments in domains such as executive function, episodic memory, and language.[4,5] In addition to these cross-sectional findings, growing longitudinal work now links HF with accelerated cognitive decline in executive function and episodic memory.[6,7] Indeed, the nature and trajectory of cognitive impairments are consistent with what is typically found in vascular and neurodegenerative (eg, Alzheimer disease) populations. Cognitive deterioration in HF is concerning because it can result in early death, loss of functional independence, and decreased quality of life.[8–10]

Contrary to expectations, longitudinal work examining cognitive changes in HF is not entirely consistent, and there is evidence for improvements over time in this population.[11] Based on these findings, it is likely that cognitive decline in HF depends on a wide range of factors. Supporting this notion is past work that shows HF severity and coexisting medical (eg, hypertension, diabetes) and clinical (eg, depression) factors are all key modifiers of poor neurocognitive outcomes in older adults with HF.[12]

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The high levels of daily physical inactivity in HF may represent an important and modifiable risk factor for cognitive decline in this population. Patients with HF rarely engage in any form of meaningful physical activity (PA); this patient population has been shown to spend >550 minutes per day being sedentary[13] and up to 44% of patients are active for <30 minutes each day.[14] Patients with HF often avoid PA as a result of exercise intolerance stemming from the inability of the heart to deliver sufficient blood to the peripheral muscles.[15] Consequently, HF patients experience discomfort during physical exertion due to symptoms such as dyspnea and fatigue.[15] Such discomfort can be negatively reinforcing and lead to avoidance of PA. Exercise intolerance is closely correlated with HF severity and participation in PA is therefore likely to decline over time as HF severity worsens. This is concerning because physical inactivity is a sensitive indicator of traditional prognostic outcomes in HF (eg, all-cause mortality, hospitalizations)[16] and these findings likely extend to the realm of cognitive function. For example, recent work in HF patients demonstrates a cross-sectional relationship between reduced daily step count and cognitive dysfunction and that lower baseline PA levels predict poorer cognitive status at a later time point, with specific effects noted for attention/executive function.[13,17] Yet, work in other older adult samples shows that low levels of PA predicts risk for cognitive decline and Alzheimer disease,[18] suggesting that PA in HF may also affect domains such as memory and language, cognitive hallmarks of aging and Alzheimer disease.

A comprehensive literature review on Pubmed with the use of keywords such as ''heart failure,'' ''physical activity,'' ''cognitive function,'' ''accelerometer,'' ''pedometer,'' ''longitudinal,'' and ''prospective'' revealed that the literature on daily PA and cognition in HF is limited by single-time assessments of PA.[13,17] Indeed, no study to date has simultaneously examined PA and cognitive function over time in patients with HF. The purpose of the present study was to examine whether changes in accelerometer-measured PA predicted cognitive changes over a 12-week period in older adults with HF. Cognitive domains examined in this study included attention/executive function, memory, and language. As described above, these domains are commonly affected in HF and sensitive to PA outcomes, and dysfunction of these domains are also hallmarks of aging and neurologic conditions (eg, vascular cognitive impairment, mild cognitive impairment) that have been found to be associated with cardiac dysfunction.

Materials and Methods

Participants

The original sample consisted of 145 persons with HF that were recruited from a larger prospective National Institutes of Health (NIH)–funded study that examined the benefits of cardiac rehabilitation on neurocognitive function in patients with HF.[19] The larger NIH-funded study involved 2 groups of participants, including those that completed cardiac rehabilitation and those who did not. The present sample consisted of only those participants that did not complete the intervention. All participants were stable HF patients involved in routine cardiology care for cardiac dysfunction and recruited via flyers and/or face-to-face methods from outpatient cardiology clinics at Summa Health System, a midsized Midwestern hospital. Participants underwent identical assessments at baseline and follow-up time points, including, but not limited to, comprehension cognitive testing and accelerometer assessment. The present sample consisted of participants that had complete data at the baseline and follow-up time points. The original sample size of 145 was reduced to 57 after factors such as participant attrition, missing data, and invalid accelerometer data due to invalid wear or mechanical issues were taken into consideration. Those participants excluded were not different from included participants regarding age, sex, education, HF severity, depression, attention/executive function, memory, language, or accelerometer wear time ($P > .05$ for all). These findings suggest that those excluded had similar levels of cognitive function and were just as likely as the included sample to wear the accelerometer as instructed.

The larger NIH study implemented strict inclusion/exclusion criteria which also applied to the present sample. For inclusion, participants must have been aged 50–85 years, been English speaking, and had a diagnosis of New York Heart Association (NYHA) HF functional class II, III, or IV at the time of enrollment. Potential participants were excluded for a history or current diagnosis of a significant neurologic disorder (eg, dementia, stroke), head injury with ≥10 minutes loss of consciousness, severe psychiatric disorder (eg, schizophrenia, bipolar disorder), substance abuse/dependence, or stage 5 chronic kidney disease. The Kent State University and Summa Health System Institutional Review Boards approved the study procedures, and all participants provided written informed consents before study enrollment.

Procedures

At baseline and 12-week follow-up, participants completed demographic, medical history, and psychosocial self-report measures, followed by a brief neuropsychological test battery to examine attention/executive function, memory, and language. Participants then received an accelerometer and were instructed to wear the device each day for 7 days from the moment they wake until they go to sleep. Additional details are provided subsequently.

Measures

Physical Activity. A GT1M accelerometer (Actigraph, Pensacola, Florida) was used to assess PA over a 7-day period. Participants were instructed in how to wear the accelerometer and provided with a set of instructions for wear over the 7 days. Specifically, participants were instructed to place the accelerometer over the right hip, affixed to an elastic belt, and preferably worn under their waistbands. Daily step count was calculated by the accelerometer, and for the present population a daily step count of 0–2,499 represented sedentary, 2,500–4,999 represented limited PA, and 5,000–12,000 represented physically active.[20] Step count was analyzed in conjunction with a diary entry of daily