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COPD is associated with cognitive dysfunction and poor physical fitness in heart failure

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ABSTRACT

Objective: To examine the associations among chronic obstructive pulmonary disease (COPD), cognitive function, and physical fitness in heart failure (HF).
Background: Cognitive impairment in HF in part stems from medical comorbidities and poor physical fitness. COPD, a frequent co-existing condition in HF, is a risk factor for cognitive impairment and a known cause of poor physical fitness. Yet, the interplay among COPD, cognition, and physical fitness has never been examined in HF.
Methods: 191 HF patients completed a cognitive test battery and brief physical fitness assessment. Diagnostic history of COPD was ascertained via medical chart review.
Results: Regression analyses showed HF patients with COPD exhibited worse attention/executive function and poorer fitness relative to their non-COPD counterparts. Worse fitness correlated with cognitive dysfunction.
Conclusions: COPD is associated with reduced cognition and worse fitness in HF. Longitudinal work that employs objective assessments of COPD is needed to determine directionality and clarify mechanisms.

Introduction

Heart failure (HF) increases vulnerability to adverse neurological outcomes such as Alzheimer's disease.[1] Up to 80% of persons with HF also exhibit impairments on formal cognitive testing,[2] including on tasks of attention/executive function and memory.[3] Cognitive impairment in HF is concerning in light of its key role in poor outcomes such as premature death.[4]

Cognitive impairment in HF is most widely believed to stem from brain insult subsequent to alterations in cerebral blood flow.[5] However, the manifestation of cognitive impairment in this population appears to be complex and involves multiple physiological mechanisms. In particular, work from our group has previously shown that medical comorbidities that accompany HF, such as hypertension, diabetes, and sleep apnea, contribute to cognitive dysfunction in this population (for a review, see Alosco et al, 2013).[6] Health-related factors also play a role in the development of cognitive impairment in HF, particularly poor physical fitness levels. Reduced fitness in HF is inevitable due to the combination of cardiac deficiency and high rates of physical inactivity in this population.[7] Extant evidence derived from our team indeed links poor fitness with significant impairment in multiple cognitive domains in HF such as attention, executive function, and memory.[8]

Although not yet examined, chronic obstructive pulmonary disease (COPD) also likely contributes to cognitive impairment in HF. COPD is common in persons with HF, with a recent review showing prevalence rates in the literature range between 8 and 52% and likely hover around 20%.[9] COPD is an independent predictor of death and hospitalizations in persons with HF and has been suggested to confer greater risk for poor outcomes relative to other medical conditions in HF (e.g., hypertension, diabetes).[9] Past research also documents the negative impact of COPD on cognition independent of HF. For example, mid-life COPD is associated with a two-fold risk for mild cognitive impairment[10] and patients with COPD also exhibit greater impairments on neuropsychological testing relative to their healthy and demographically similar counterparts.[11]

Abbreviations: COPD, chronic obstructive pulmonary disease; HF, heart failure.
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Poor physical fitness may represent one mechanism by which COPD increases risk for cognitive impairment in HF. Reduced fitness is a classic characteristic of COPD in light of the respiratory problems (e.g., airflow obstruction) that define this disease.[12] Moreover, a majority of persons with COPD also report failing to engage in recommended levels of physical activity.[13] This pattern of findings raises concern for heightened vulnerability to cognitive dysfunction in HF patients with COPD given the close association between poor fitness and cognitive dysfunction in both HF and COPD populations.[14]

Despites these findings, the interplay among COPD, cognition, and poor physical fitness is not well understood, and no study has examined the impact of COPD on cognitive function in patients with HF. The purpose of the current study was to examine these possible associations and we hypothesized that a physician diagnosed history of COPD (as ascertained via medical chart review) would be associated with cognitive dysfunction and poorer physical fitness levels; worse fitness would in-turn predict decreased cognitive function.

Methods

Study design

The current study was a cross-sectional analysis of the associations among COPD, physical fitness, and cognitive function.

Human subjects

This sample included a total of 191 participants with HF that were enrolled in a National Institutes of Health (NIH) study examining neurocognitive function in patients with HF. For study inclusion, participants must have been between 50 and 85 years of age, English as a primary language, and had a diagnosis of New York Heart Association (NYHA) class II, III, or IV. Participants were excluded for neurological disorders such as dementia, stroke, multiple sclerosis, etc., a head injury with >10 min loss of consciousness, severe psychiatric disorder (e.g., schizophrenia, bipolar disorder), past or current substance abuse/dependence, and stage 5 chronic kidney disease. The current sample included participants with complete medical, cognitive, and physical fitness data.

Variables and measures

Cognitive function

Participants were administered a neuropsychological test battery to examine cognitive function. The cognitive measures employed in this study are widely used in clinical settings, brief and easy to administer, and tap into distinct aspects of cognitive abilities. The domains and cognitive measures assessed include:

Attention/executive function. The Trail Making Test A and B,[15] Digit Symbol Coding,[16] Frontal Assessment Battery,[17] and Letter Number Sequencing[18] were used to examined attention/executive function. Trail Making Test A requires participants to connect a series of numbers in order as quickly as possible. It is a valid and reliable measure of visual attention and psychomotor speed. Trail Making Test B has participants connect both number and letters in an alternating (i.e., number then letter) ascending order as fast as possible. This measure is a valid and reliable indicator of executive functions such as multitasking and has a test-retest reliability of up to 0.89.[19,20]

For Digit Symbol Coding, there is a key with nine pairs of numbers and symbols. Participants are instructed to use this key to match symbols with the corresponding numbers as quickly as possible. This measure is a valid measure of attention, psychomotor speed, and working memory and has a strong test-retest reliability of $r = 0.84$.[21] The Frontal Assessment Battery is a brief, but comprehensive, measure of several aspects of executive function, including lexical fluency, abstract reasoning, environmental autonomy, inhibition, sensitivity to interference, and higher-order motor programming. This measure has also been demonstrated to exhibit strong psychometric properties such as high internal consistency (Cronbach's alpha = 0.78) and good concurrent validity with gold measures of executive function (i.e., Wisconsin Card Sorting Test; $r = 0.87$).[17,22]

Lastly, Letter Number Sequencing is a task of working memory that has participants verbally order numbers and letter that are orally presented in an unordered sequence. This task exhibits a test-retest reliability of $r = 0.75$.[18]

Memory. The California Verbal Learning Test-II (CVLT-II) short and long delay free recall, and total recognition hits operationalized memory abilities.[23] Participants are asked to learn, recall, and then recognize a 16-item word list. This measure has strong test-retest reliability ($r = 0.88$) and good concurrent validity with other verbal memory measures ($r = 0.63–0.96$).[23]

Language. Boston Naming Test (BNT)[24] and Animal Fluency test[25] were administered to examine language functions. The Boston Naming Test consists of low to high familiar pictured objects that participants must correctly name. It is a task assessing confrontation naming and demonstrates high correlations with other measures of verbal abilities ($r = 0.83$).[26] For the Animal Fluency Test, participants must name as many animals as possible within a 60-second time period.

Physical fitness

All participants completed the 2-minute step test (2MST) in order to assess physical fitness.[27] For this task, participants are instructed to march in place lifting his/her knees to a marked target set on the wall set at the midpoint between the kneecap and crest of the iliac for a 2-min period. A higher step count reflects better physical fitness. An average step count over two minutes for healthy males between 60 and 85 years ranges from 71 to 115 and between 60 and 107 steps for females.[27] Below average 2MST according to the average age of males in this sample (mean = 68.58, SD = 9.36) is <87 and for females with the average age of the current sample (mean = 68.41, SD = 8.27) is <73.[27] The 2MST is a valid measure of physical fitness, as it is highly correlated with metabolic equivalents.[8,28]

Demographic and medical history

Self-report and a medical chart review were used to ascertain demographic and medical characteristics. Specifically, participants first completed a medical history questionnaire to self-report demographic information and history of medical conditions. A medical chart review was then performed to supplement and corroborate participant's self-report and to ascertain physician-diagnosed history of comorbid medical conditions. Through these methods, a physician-diagnosed history of COPD (i.e., positive or negative diagnostic history) for all participants was obtained along with a history of hypertension, diabetes, sleep apnea (central or obstructive), and depression. For all medical conditions, any history at all was deemed to be a positive diagnostic history. Participants also completed a self-report questionnaire that asked participants to indicate the number of cigarettes smoked per week.

Procedures

The Summa Health System and Kent State University Institutional Review Board (IRB) approved the study procedures and all