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What is your patient's cognitive profile? Three distinct subgroups of cognitive function in persons with heart failure

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Abstract

Purpose—To determine whether patients with heart failure (HF) have distinct profiles of cognitive impairment.

Background—Cognitive impairment is common in HF. Recent work found three cognitive profiles in HF patients— (1) intact, (2) impaired, and (3) memory-impaired. We examined the reproducibility of these profiles and clarified mechanisms.

Methods—HF patients (68.6 ± 9.7 years; $N=329$) completed neuropsychological testing. Composite scores were created for cognitive domains and used to identify clusters via agglomerative-hierarchical cluster analysis.

Results—A 3-cluster solution emerged. Cluster 1 ($n=109$) had intact cognition. Cluster 2 ($n=123$) was impaired across all domains. Cluster 3 ($n=97$) had impaired memory only. Clusters differed in age, race, education, SES, IQ, BMI, and diabetes ($ps \leq .026$) but not in mood, anxiety, cardiovascular, or pulmonary disease ($ps \geq .118$).

Conclusions—We replicated three distinct patterns of cognitive function in persons with HF. These profiles may help providers offer tailored care to patients with different cognitive and clinical needs.

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Conflict of Interest: None.

Keywords

cardiovascular disease; neuropsychological performance; cognitive profiles; older adults; cluster analysis

Background

Heart failure (HF) afflicts millions of individuals in the United States (Go et al., 2013) and is characterized by significant physical symptoms (e.g., edema, shortness of breath) and impaired function (Watson et al., 2000) as well as increased risk for mortality (Go et al., 2013). Recent studies have also documented a high prevalence of neurocognitive symptoms (Bennett & Sauvé, 2003; Pressler et al., 2010; Vogels, Scheltens, et al., 2007; Harkness et al., 2011). For example, up to 80% of patients with HF (Bennett & Sauvé, 2003) have observable deficits on testing across multiple cognitive domains, such as attention, executive function, and memory (Pressler et al., 2010; Vogels, Scheltens, et al., 2007). Further, those exhibiting more severe symptoms of heart failure are more likely to be cognitively impaired (Harkness et al., 2011). Individuals with HF are also at increased risk for neurodegenerative diseases like Alzheimer's disease (Qiu et al., 2006). Beyond the extensive medical burden (Watson et al., 2000), cognitive deficits contribute to diminished self-care (Cameron et al., 2010), greater disability, and increased mortality (Davis et al., 2014; Zuccala et al., 2001; Zuccalà et al., 2003) for individuals with HF.

Cognitive deficits are so commonly associated with HF and vascular diseases that vascular cognitive impairment (VCI) is a term that has been used to describe the pattern of cognitive decline (O'Brien, 2006). Despite the uniformity implied by umbrella terms like VCI, recent work indicates that the cognitive deficits in HF are not uniform across patients (Miller et al., 2012). Miller et al. (2012) conducted the first study to examine different cognitive profiles in HF patients and identified three distinct profiles: (1) persons with intact cognitive abilities, (2) those globally impaired across multiple cognitive domains, and (3) those with isolated deficits in memory. These intriguing results, if replicated, may have important implications for applied settings and future research. For instance, HF treatment providers may need to tailor interventions to individuals with specific profiles in order to address their pattern of cognitive strengths and weakness. Such tailored interventions may improve adherence and outcomes. Likewise, identifying demographic and medical differences between profiles may help to identify subgroups at greater risk for cognitive decline. Lastly, the profiles may reflect unique mechanistic pathways to cognitive impairment in HF, which can be targeted for intervention.

The present study examined whether the three profiles detected by Miller et al. (2012) could be replicated in a different, larger sample of patients with HF. We also sought to extend their findings by examining several factors that have been linked with cognitive function but not examined in relation to the three cognitive profiles (e.g., stroke history (Tatemichi et al., 1994), adiposity (Smith et al., 2011), depression (McDermott & Ebmeier, 2009), anxiety (Mantella et al., 2007), and chronic obstructive pulmonary disease (COPD) (Dodd et al., 2010). Based on previous results, we hypothesized that the following three cognitive profiles

would emerge: (1) intact patients, (2) globally impaired patients, and (2) patients with memory deficits only.

Methods

Participants

Participants ($N = 329$) were recruited from two large medical systems in northeast Ohio. Inclusion criteria were as follows: (1) 50–85 years old, (2) Physician -documented systolic HF diagnosis at the time of study enrollment, (2) New York Heart Association Class II or III 3 months duration (to maximize the likelihood that the patient would not have reversed left ventricular systolic dysfunction while still having sufficient exposure to the medical system and knowledge of self-management of HF), (3) No cardiac surgery within last 3 months, (4) No history of neurological disorder or injury (e.g., Alzheimer's disease, seizures, cerebrovascular accident), (5) No history of moderate or severe head injury that caused the patient to be unconscious for at least ten minutes (e.g., concussion or the result of trauma), (6) No past or current history of renal failure requiring dialysis, untreated sleep apnea (as evidenced by a physician diagnosis or self-report of sleep apnea without the use of Continuous Positive Airway Pressure therapy), psychotic disorders, bipolar disorder, learning disorder, or developmental disability (7) No current substance abuse or within the past 5 years, and (8) No current use of HF home tele-health monitoring, as our electronic pillbox could interfere with such devices. Participants were predominantly older (age = 68.63, $SD = 9.66$), white (73.21%), male (59.27%) and had completed at least some college (77.81%) (Table 1).

Measures

Cognitive Domains

Memory: The Rey Auditory Verbal Learning Test (RAVLT) was used to assess memory (Lezak, 1995). Three scores were included in our composite score: learning over time, short recall, and long recall.

Attention: Three attention tests were given: Trails A (Reitan, 1958), Stroop Word (Golden, 1978), and Letter-Number Sequencing (Wechsler, 1997). For Trails A, participants connect 25 circles in numerical order.

Executive Function: Three executive function tests were administered: Trails B (Reitan, 1958), Stroop Color-Word (Golden, 1978), and the Frontal Assessment Battery (FAB) (Dubois et al., 2000).

Covariates—We assessed various covariates including: gender (0 = male, 1 = female), age (years), race (0 = white, 1 = black), highest level of education completed (1 = less than high school, 2 = high school, 3 = technical or trade school, 4 = some college, 5 = bachelor's degree, 6 = master's degree), socioeconomic status (SES), medical comorbidity, body mass index (BMI), premorbid intelligence (IQ), global cognitive function, depression, and anxiety. SES z-scores were calculated using subjects' zip code via a method similar to the one described by Roux et al (2001). The Charlson Comorbidity Index (CCI) (Charlson et al.,

1987) was used to assess comorbid conditions. We used the total score for overall medical comorbidity and also examined the presence (0 = no, 1 = yes) of several common medical conditions: diabetes, COPD, cerebrovascular accident (CVA), and myocardial infarction (MI). BMI was calculated as kg/m^2 using weight and height. The North American Adult Reading Test (NAART) (Blair & Spreen, 1989) was used to estimate premorbid intelligence (IQ). Global cognitive function was examined with the Modified Mini-Mental Status Examination (3MS) (Teng & Chui, 1987). Depressive symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9) (Kroenke & Spitzer, 2002). Anxiety symptoms were assessed with the 7-item short form of the Patient-reported Outcomes Measurement Information System (PROMIS) (Pilkonis et al., 2011).

Procedure

This study is part of the larger observational Heart Failure Adherence, Behavior, and Cognition Study (Heart ABC) (Clinicaltrials.gov, 2011). All patients were recruited from cardiology practices in northeast Ohio and gave their written, informed consent to participate. All procedures were approved by the Institutional Review Boards of Kent State University, Summa Health Systems, Inc., and Case Western Research University. After consent, a research assistant conducted the series of neuropsychological testing and self-report questionnaires.

Analyses

All data analyses were conducted using SAS 9.3 or IBM SPSS 20.0. For descriptives and norm-referencing, raw test scores were converted to age-adjusted scaled scores ($M = 10$, $SD = 3$). To facilitate cluster analysis and interpretation, the scaled scores were converted to z -scores ($M = 0$, $SD = 1$) of the sample and an average of the z -scores created a composite score for each of the three domains: attention, executive function, and memory domains. Previous researchers have used 1.5 standard deviations from the mean as a cut-off for impaired cognition (Mertler, 2007). Using this standard, about 12% of our sample had impaired attention, 11% had impaired executive function, and 6% had impaired memory (Table 1). Agglomerative hierarchical clustering was performed in SAS using Ward's minimum-distance method and squared Euclidean distances as the measure of similarity. The number of clusters was determined based on examination of the generated dendrogram. A cluster analysis based on the k -mean algorithm (Norusis, 2012) was used to create the final solution. The identified clusters were then examined for potential differences in demographic, psychological, and medical characteristics in SPSS using ANOVAs or chi-square analyses with Bonferroni-corrected posthoc tests. Any significant group differences (i.e., $p < .05$) were explored using multinomial logistic regression to determine which characteristics predicted cluster membership. Separate regressions were performed for each characteristic (for which group differences were detected) with the characteristic as the predictor, cluster membership as the dependent variable, and the intact group as the referent.

Results

Determining Number of Profiles

The dendrogram produced by the hierarchical cluster analysis suggested a three-cluster solution (Figure 1). A k-mean cluster analysis specifying three clusters was then conducted.

Cognitive Profiles in Heart Failure

Based on the mean scores for each domain, we found three unique cognitive profiles (Figure 2). Participants in Cluster 1 ($n = 109$) had intact performance across all cognitive domains (Table 2). Participants in Cluster 2 ($n = 97$) appeared to have impaired memory only. Participants in Cluster 3 ($n = 123$) had impaired performance across all domains. Thus, participants were classified as having an intact, memory impaired, or globally impaired profile.

Demographic, Psychological, and Medical Differences between Cognitive Profiles

ANOVAs and chi-square results revealed significant differences between clusters across multiple covariates (Table 2). Specifically, profiles differed across all demographic variables. With regards to cognitive and psychological covariates, the profiles differed in global cognition and estimated IQ but not depression or anxiety. For the medical covariates, profiles differed in BMI and diabetes but not in overall medical comorbidity (CCI), COPD, CVA, or MI. Pairwise comparisons indicated that the intact group had more females and higher global cognitive scores. The memory impaired group was significantly older than the intact or globally impaired group (Table 2). The globally impaired participants were more likely to be black, and have less than a high school education, lower IQ scores, higher BMIs, and greater prevalence of diabetes.

Predictors of Profile Membership

We selected all variables for which significant cluster differences were detected (i.e., age, gender, race, education level, SES, 3MS score, estimated IQ, BMI, and diabetes diagnosis) to determine whether they would predict profile membership. Each variable was entered separately into a multinomial logistic regression model with the intact profile as referent.

Globally Impaired Profile—Male gender ($OR = 4.10, p < .001$) and Black race ($OR = 2.23, p = .006$) predicted higher likelihood of having the globally impaired profile. Participants with higher education ($OR = .82, p = .027$), IQ ($OR = .91, p < .001$), SES ($OR = .93, p = .023$), and 3MS ($OR = .80, p < .001$) scores were less likely to be globally impaired. Participants with diabetes were more likely to be in the globally impaired group, $OR = 1.44, p = .051$.

Memory Impaired Profile—Older age ($OR = 1.07, p < .001$), male gender ($OR = 7.81, p < .001$), Caucasian race ($OR = 2.33, p = .032$), and higher education ($OR = 1.24, p = .021$) predicted higher likelihood of a memory impaired profile. Participants with higher 3MS scores ($OR = .91, p = .003$) and BMI ($OR = .95, p = .020$) were less likely to have this profile.

Discussion

In this study, we identified three distinct cognitive profiles in older adults with heart failure: globally intact, memory impaired, and globally impaired. These findings replicate the findings of Miller and colleagues (2012) whose cluster analysis resulted in three similar profiles. Our study extended these findings by replicating the results with a different and larger sample and examining whether the profiles were related to multiple factors not previously examined, including stroke history, adiposity, depression, anxiety, and COPD.

The largest percentage of the sample (37.4%) was globally impaired across attention, executive functioning, and memory abilities. This pattern of impairment is in line with the literature documenting deficits in attention, executive function, and memory in patients with HF (Hoth, 2010) and broadly fits with the VCI pattern observed in patients with vascular disease (O'Brien, 2006). In contrast, 29.5% of patients exhibited a memory impaired profile, with intact performance in attention and executive functioning but relative deficits on memory tasks. As Miller et al. (2012) speculate and is discussed below, individuals with a memory impaired profile may be a subgroup at greater risk for the development of Alzheimer's type dementia. The remaining third (33.1%) of our sample demonstrated relatively intact functioning. Given their younger age relative to the other profiles, these intact individuals may have been assessed earlier in the HF disease process and will likely demonstrate greater cognitive impairments over time.

In an attempt to explain the presence of three distinct cognitive profiles, we examined potential demographic, medical, and psychological differences across the three profiles. The profiles did not differ in overall medical comorbidity, vascular or pulmonary disease, depression, or anxiety symptoms. However, several important findings emerged. Among them, females were more likely to exhibit intact cognitive function than were males. Past work has shown that females have better prognostic indicators and survival in HF (Simon et al., 2001), and it is possible that these protective effects extend to cognitive outcomes as well. HF patients with intact cognition also had higher estimated levels of premorbid intelligence. This finding is consistent with past work (Miller et al., 2012) and suggests that cognitive reserve plays a key role in moderating the adverse effects of HF on the brain. Cognitive reserve models posit that higher premorbid intelligence and educational status have a buffering effect against cognitive impairment. Thus, individuals with HF may vary cognitively despite have similar HF-related neuropathology. Indeed, cognitive reserve moderates the association between HF severity and cognitive function, such that greater premorbid IQ attenuated cognitive declines typically observed in HF (Alosco, Spitznagel, Raz, et al., 2012).

In contrast, a globally impaired profile was associated with lower IQ and less education, suggesting lower cognitive reserves and consequently less protection against cognitive decline in HF (Stern, 2009). Globally impaired participants were also more likely to be male, African American, and have diabetes. The added disease burden from comorbid diabetes may contribute to the global impairment observed in this profile, as diabetes has been shown to exacerbate the cognitive deficits in attention, executive functioning, and motor functioning observed in HF (Alosco, Spitznagel, van Dulmen, et al., 2012). African

Americans' higher likelihood to have a globally impaired profile may reflect not only their documented higher rates of diabetes (Brancati et al., 2000) (45.9% for African Americans vs. 38.7% for Caucasians in this sample) but also their poorer glycemic control relative to Caucasians (Harris et al., 1999). African Americans also have higher rates of Alzheimer's type dementia (Tang et al., 2001) and stroke (Go et al., 2013). Together, these findings suggest that this subgroup may be at higher risk for multiple adverse brain outcomes, including those observed in HF.

A memory impaired profile was associated with older age, male gender, lower BMI, and lower rates of diabetes in the current sample of adults with HF. This pattern raises the possibility that such persons are at elevated risk for conditions like Alzheimer's disease for several reasons. First, patients with a memory impaired profile were significantly older than patients in the other two profiles, and age has been identified as the number one risk factor for Alzheimer's type dementia (Castellani et al., 2010). Second, the lower BMI of patients with a memory impaired profile may not be a marker of healthier weight but instead a reflection of the accelerated weight loss that has been shown to precede dementia onset (Johnson et al., 2006). Finally, the lower rates of diabetes in the memory impaired profile compared to the globally impaired profile is consistent with evidence of impaired glucose functioning in vascular dementia but not in Alzheimer's type dementia (Curb et al., 1999). In contrast to the older age, lower BMI, and lower diabetes rates, which are consistent with an Alzheimer's-type dementia profile, we also found that the memory impaired profile was more common in males in our sample, which is inconsistent with literature demonstrating that females are more likely to develop Alzheimer's disease (Henderson, 1997). Thus, prospective studies are much needed to determine whether HF patients with an impaired memory profile are at elevated risk for Alzheimer's disease, as a recent study found 22% of HF patients developed this condition over a 9-year period (Qiu et al., 2006).

Our findings have several important implications. To begin, more prospective studies are needed to assess potential differences in the prognosis and survival of individuals with the three profiles. If certain profiles are found to be associated with poorer HF or functional outcomes, HF treatment providers and programs may benefit from screening, identifying, and tailoring interventions to participants' specific cognitive profiles. These screenings may be enhanced by further investigation of demographic and medical differences that confer risk for cognitive impairment in HF. Given that 66.9% of our sample showed some degree of cognitive impairment (profiles notwithstanding) and that cognitive deficits contribute to poorer outcomes (Zuccala et al., 2001; Zuccalà et al., 2003), our findings also highlight the importance of comprehensive cognitive assessment and intervention in patients with HF. This is especially important, as patients with a memory impaired profile obtained normal scores on a cognitive screener and may not be identified as cognitively impaired or receive needed resources or treatments.

The current findings are limited in several ways. First, the cross-sectional design precludes our ability to determine how disease duration and progression over time may influence the expression of certain profiles. It is possible that individuals with HF progress over time from having intact cognitive function to having single domain impairment and, ultimately, to having multi-domain impairment. However, assuming that increasing age is associated with

longer HF duration, this possibility seems less likely in this study because those with single domain impairment (memory impaired group) were significantly older than those with multi-domain impairment (globally impaired). Second, we did not have the results of stress testing to quantify heart failure severity or neuroimaging to detect adverse brain changes. Because greater HF severity is associated with higher cognitive impairment risk (Vogels, Oosterman, et al., 2007), assessment of patients' HF severity with stress testing might help improve profile classification; however, many patients cannot tolerate stress testing. Similarly, advanced neuroimaging may provide important insight into pathological brain changes in HF and validate whether the profiles are due to structural or functional changes over time. Third, we did not screen for undiagnosed sleep apnea in participants. Future studies should include this screening given that sleep apnea is common in people with heart failure and there is an association between sleep apnea and cognition (Kielb, 2012; Kasai, 2012). Another limitation of our paper is its generalizability to patients with preserved EF and various other demographics characteristics that weren't as well-represented in our sample (e.g., non-white race). For example, we encourage the conduct of future studies in more diverse samples to confirm whether our results will replicate in patients who have preserved ejection fraction or who are non-white. Finally, we did not have the opportunity to determine whether the cognitive impairment in the current sample led to reduced function in activities of daily living (ADLs). Past work has shown high rates of disability in HF (Wong et al., 2011) and that cognitive impairment may lead to these difficulties (Alosco et al., 2011; Zuccala et al., 2001). As a result, it is possible that the distinct subgroups of cognitive function have different levels of daily function.

In conclusion, cognitive impairment in HF is common but not homogenous. In this sample of patients with HF, three cognitive profiles emerged: intact, impaired, and memory impaired. Providers should be aware of these profiles and their potential impact on patient outcomes. These profiles may reflect unique mechanistic pathways to impaired cognition in HF as well as different cognitive outcomes (e.g., vascular versus Alzheimer's type dementias). Patients with a memory impaired profile may be overlooked, given the lack of adequate cognitive screening. Additional research is needed to further validate the three profiles and determine their influence on clinical outcomes, such as increased risk for complications associated with HF or functional impairment. Such information can then be used to tailor interventions for each profile.

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Figure 1.
Dendrogram Produced by Hierarchical Cluster Analysis. *Note.* Dendrogram created using SAS 9.3.

Figure 2.
Composite Performance on Cognitive Domains in Patients with Heart Failure ($N = 329$).
Note. Composites scores are average of z-scores ($M = 0$, $SD = 1$)

Table 1Characteristics of Participants ($N = 329$)

	<i>M(SD) or N(%)</i>
Age	68.63(9.66)
Female	134(40.73)
Black	85(25.84)
SES z -Score	0.07(4.27)
Education	
Less than High School	38(9.12)
High School Degree	96(29.18)
Technical or Trade School	36(10.94)
Some College	86(26.14)
Bachelor's Degree	42(12.77)
Master's Degree	31(9.42)
Ejection Fraction at Study Enrollment	29.73(8.30)
Charlson Comorbidity Index	3.28(1.75)
Global Cognition (3MS)	91.87(6.77)
Estimated IQ	110.01(10.51)
Attention	
Trails A	7.74(3.09)
Stroop Word	7.88(2.83)
Letter-Number Sequencing	9.06(3.12)
Impaired	40(12.2)
Executive Function	
Trails B	7.53(3.56)
Stroop Color-Word	8.48(3.04)
Frontal Assessment Battery	9.96(2.56)
Impaired	35(10.6)
Memory	
Learning over time	9.83(3.20)
Short recall	6.87(3.36)
Long recall	6.60(3.45)
Impaired	20(6.1)

Note. SES = socioeconomic status. 3MS = Modified Mini-Mental Status Examination. Means and standard deviations are presented for continuous variables. Sample size and percentages are presented for categorical variables. Test scores for attention, executive function, and memory are presented as age-adjusted scaled scores ($M = 10$, $SD = 3$). Impaired cognition was defined as < 1.5 standard deviations from the mean composite score (a composite score < 35) for each domain.

Table 2
Demographic, Psychological, and Medical Characteristics for each Cognitive Profile

Variable	Intact <i>n</i> = 109 <i>M</i> ± <i>SD</i> or <i>N</i> (%)	Memory Impaired <i>n</i> = 97 <i>M</i> ± <i>SD</i> or <i>N</i> (%)	Globally Impaired <i>n</i> = 123 <i>M</i> ± <i>SD</i> or <i>N</i> (%)	Test Statistic (<i>F</i> or χ^2)	<i>p</i>
<i>Demographic Factors</i>					
Age	65.94 ± 9.18 ^a	71.91 ± 8.89 ^b	68.42 ± 9.96 ^a	10.38	<.001*
Female	73 (54.48) ^b	20 (14.93) ^a	41 (30.60) ^a	50.13	<.001*
Black	25 (29.41) ^a	11 (12.94) ^a	49 (57.65) ^b	23.70	<.001*
SES z-score	0.24 ± 3.73 ^{a, b}	1.30 ± 4.52 ^a	-1.05 ± 4.27 ^b	8.55	<.001*
<i>Education</i>					
Less than High School	8 (21.05) ^a	4 (10.53) ^a	26 (68.42) ^b	33.73	<.001*
High School Degree	36 (37.50) ^a	23 (23.96) ^a	37 (38.54) ^a		
Technical or Trade School	10 (27.78) ^a	8 (22.22) ^a	18 (50.00) ^a		
Some College	34 (39.53) ^a	32 (37.21) ^a	20 (23.26) ^b		
Bachelor's Degree	13 (30.95) ^a	15 (35.71) ^a	14 (33.33) ^a		
Master's Degree	8 (25.81) ^a	15 (48.39) ^a	8 (25.81) ^a		
<i>Psychological Factors</i>					
Global Cognition (3MS)	95.26 ± 3.90 ^a	93.24 ± 5.59 ^b	87.80 ± 7.5 ^c	46.43	<.001*
Estimated IQ	112.80 ± 9.85 ^a	114.96 ± 8.06 ^a	103.64 ± 9.62 ^b	47.86	<.001*
Depression	4.90 ± 5.2 ^a	3.78 ± 4.58 ^a	5.08 ± 4.78 ^a	2.15	.118
Anxiety	12.77 ± 5.57 ^a	12.16 ± 4.45 ^a	13.45 ± 5.22 ^a	1.71	.182
<i>Medical Factors</i>					
Charlson Score	3.31 ± 1.72 ^a	3.23 ± 1.72 ^a	3.31 ± 1.81 ^a	0.07	.930
Body Mass Index	30.95 ± 7.60 ^{a, b}	28.75 ± 5.40 ^b	31.06 ± 7.01 ^a	3.70	.026*
Diabetes ^f	41 (37.96) ^{a, b}	28 (28.87) ^b	64 (52.03) ^a	12.52	.002*
COPD	34 (31.48) ^a	20 (20.62) ^a	36 (29.27) ^a	3.36	.186
CVA	9 (8.33) ^a	8 (8.25) ^a	13 (10.57) ^a	0.48	.787

Variable	Intact <i>n</i> = 109 <i>M</i> ± <i>SD</i> or <i>N</i> (%)	Memory Impaired <i>n</i> = 97 <i>M</i> ± <i>SD</i> or <i>N</i> (%)	Globally Impaired <i>n</i> = 123 <i>M</i> ± <i>SD</i> or <i>N</i> (%)	Test Statistic (<i>F</i> or χ^2)	<i>p</i>
Myocardial Infarction	54 (50.00) ^a	54 (55.67) ^a	57 (46.34) ^a	1.89	.388
<i>Cognitive Factors</i>					
Attention z-score	0.21 ± 0.70 ^a	0.56 ± 0.49 ^b	-0.65 ± 0.48 ^c	316.70	<.001*
Executive Function z-score	0.33 ± 0.63 ^a	0.45 ± 0.50 ^a	-0.66 ± 0.68 ^b	138.40	<.001*
Memory z-score	0.95 ± 0.41 ^a	-0.37 ± 0.55 ^b	-0.55 ± 0.51 ^c	113.57	<.001*

Note. SES = socioeconomic status, 3MS = Modified Mini-Mental Status Examination, IQ = Intelligence Quotient, COPD = chronic obstructive pulmonary disease, CVA = cerebrovascular accident. ANOVAs (continuous variables) and chi-square tests (categorical variables) were used to assess differences in demographic and medical variables across cognitive profiles.

Means and standard deviation (continuous variables) and sample size and percentages (categorical variables) are presented. Profiles with the same superscript (a,b,c) do not differ from one another across each factor.