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Nutrition and Cognition in Older Adults With Heart Failure: A Systematic Review

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Abstract

Cognitive impairment is commonly observed in older adults with heart failure; nutrition is a possible contributing factor. The purpose of the current systematic review is to examine the relationship between nutrition and cognition in older adults with heart failure. A literature review was performed through August 2015 that examined published, peer-reviewed studies from PubMed, PsycINFO, CINAHL, and Web of Science. Four articles were selected for inclusion. Findings revealed that poorer nutritional habits were associated with poorer attention, executive functioning, and memory in older adults with heart failure. Nutritional biomarkers, including anemia, hyponatremia, hypokalemia, hyperglycemia, and hypoalbuminemia, were also associated with cognitive impairment. More research is needed to explore the relationship between nutrition and cognition in this population. Descriptive studies will inform scientists as they design and test nutritional interventions to optimize cognitive function in older adults with heart failure.

Heart failure affects an estimated 5.1 million Americans and is considered a major public health problem (Go et al., 2013). Projections show that by the year 2030, the prevalence of heart failure will increase 25% and carry an expected medical cost of approximately \$78 billion (Go et al., 2013; Heidenreich et al., 2011). Heart failure incidence and prevalence increases with age and, consequently, represents a major cause of morbidity and mortality in the geriatric Search and, consequently, represents a major cause of morbidity and mortality in the geriatric population (Vigen, Maddox, & Allen, 2012). Approximately 80% of individuals with heart failure are older than 65, and heart failure is the leading cause of hospitalization in this age group (Azad & Lemay, 2014; Desai & Stevenson, 2012; Vigen et al., 2012).

Cognitive impairment is recognized as a common adverse consequence of heart failure; an estimated 24% to 80% of individuals with heart failure experience comorbid cognitive impairment (Athilingam et al., 2011; Bauer & Pozehl, 2011; Bauer et al., 2012; Dardiotis et

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al., 2012; Pressler, 2008; Pressler et al., 2010; Vogels et al., 2007). Most commonly, studies report diminished attention, memory, visuospatial skills, executive function, and psychomotor speed (Alosco et al., 2012; Arslanian-Engoren et al., 2014; Bauer et al., 2012; Gallagher et al., 2013; Hoth, Poppas, Moser, Paul, & Cohen, 2008; Pressler et al., 2010). Cause of cognitive impairment in individuals with heart failure is unknown and likely multifactorial. Recent studies suggest that vascular problems, such as cerebral hypoperfusion, may cause neuronal damage and loss of grey matter in areas of the brain that are important for cognitive processes (Alosco, Brickman, et al., 2013; Alosco et al., 2014; Beer et al., 2009; Hoth et al., 2008; Woo, Kumar, Macey, Fonarow, & Harper, 2009).

Nutritional factors may also contribute to cognitive impairment. Nutrition plays an instrumental role in the development and progression of heart failure (Colin-Ramirez et al., 2014; Kaluza, Akesson, & Wolk, 2014; Son, Lee, & Song, 2011) and may affect cognition directly or indirectly through its impact on the heart failure disease process. In the past decade, there has been increasing interest in the relationship between nutrition, cognition, and chronic diseases, including diseases frequently comorbid with heart failure. One study found that working memory improved in overweight and obese adults following 6 months of consuming four servings of reduced fat dairy every day (Crichton, Murphy, Howe, Buckley, & Bryan, 2012). Another study reported that higher intake of saturated and trans fat was associated with substantially worse global cognition in women with type 2 diabetes (Devore et al., 2009). Evidence also suggests that frequent consumption of fruits and vegetables, fish, and omega-3 rich oils decreases the risk of dementia and Alzheimer's disease (Barberger-Gateau et al., 2007). Given these findings in other chronic disease populations, it is likely that nutrition also affects cognition in individuals with heart failure.

Nutritional status and cognition have also been explored via nutritional biomarkers, such as hemoglobin A1C, vitamin D, hemoglobin, and albumin. One study found that elevated hemoglobin A1C levels in individuals with metabolic syndrome and coronary artery disease were associated with lower cognitive performance across several domains, including executive function, processing speed, and language (Avadhani et al., 2014). Several studies of vitamin D levels in healthy older adult populations have found that low plasma vitamin D levels are associated with greater odds of global cognitive impairment, whereas higher levels of vitamin D are associated with improved cognition (Chei et al., 2014; Taylor & Mulligan, 2014). A recent systematic review of anemia and cognitive performance in the geriatric population suggested low hemoglobin levels are a potential contributing factor to cognitive impairment, including poorer executive function (Andro, Le Squere, Estivin, & Gentric, 2013). Moreover, low serum poorer executive function (Andro, Le Squere, Estivin, & Gentric, 2013). Moreover, low serum albumin has been associated with global cognitive impairment in healthy adults 55 and older (Ng, Niti, Feng, Kua, & Yap, 2009).

The geriatric population is especially vulnerable to poor nutrition and thus its adverse effects. Prevalence of malnutrition is generally high in the geriatric population, with at least two thirds being malnourished or at nutritional risk (Kaiser et al., 2010). Deficiencies in iron, protein, fiber, vitamin D, calcium, vitamin A, and folate have all been noted in geriatric populations, which may contribute to impaired cognitive and physical function (Shepherd, 2009). As the population ages and the prevalence of heart failure increases, it is imperative

that nurses consider how to optimize cognitive function in individuals with heart failure. Preventing cognitive impairment and improving cognitive status in older adults with heart failure could effectively decrease the cost of health care, reduce burden on the health care system, improve compliance with therapeutic regimens, and improve performance of instrumental activities of daily living (Pressler et al., 2013). Given the state of the science, the purpose of the current systematic review is to examine the relationship between nutrition and cognition in older adults with heart failure.

Method

Eligibility Criteria

The Preferred Reporting Items for Systematic Reviews (Moher, Liberati, Tetzlaff, & Altman, 2009) guidelines were used to conduct the current review. Four databases, including PsycINFO, PubMed, CINAHL, and Web of Science, were searched from inception of the database through August 2015. Search terms included [*nutrition* OR *eat** OR *food* OR *diet* OR *nutritional supplement* OR *vitamin* OR *whole grain* OR *vegetable* OR *dairy* OR *fruit* OR *refined grain* OR *meat* OR *fat* OR *salt* OR *antioxidant* OR *alcohol* OR *coffee* OR *tea* OR *albumin* OR *prealbumin* OR *hemoglobin A1C* OR *hemoglobin* OR *ferritin* OR *iron* OR *magnesium* OR *potassium* OR *sodium*] AND [*cognitive impairment* OR *cognitive disorder* OR *cognitive decline* OR *cognitive function* OR *cognitive dysfunction* OR *cognition*] AND [*heart failure* OR *chronic heart failure* OR *congestive heart failure*]. Articles were limited to English language, peer-reviewed, and full-text only. Articles that addressed nutrition or nutritional biomarkers, cognition, and heart failure were eligible for inclusion in the current review. Articles that addressed only two of three concepts (e.g., nutrition and heart failure, but not cognitive impairment) or focused on a specific cognitive state, such as Alzheimer's disease, were excluded. Additional articles were identified through ancestral searching of reference lists.

Study Selection

Abstracts were screened for eligibility using the above criteria and two reviewers (M.W.S., A.C.T.) read full-text articles for studies that appeared to fit criteria. If there was disagreement about eligibility between the two reviewers, a third reviewer (L.C.B.) read and discussed the article with the reviewers until consensus was reached.

Data Collection Process

When the final articles were selected, the two reviewers independently extracted data from the articles. For each study, reviewers specifically examined (a) the purpose and design, (b) sample characteristics, (c) instruments used to measure nutritional habits and cognitive status, and (d) main findings. Evidence grading was used to assess the quality of evidence (Harbour & Miller, 2001). Reviewers compared and discussed data extractions and evidence grades before combining them into a single evidence table.

Results

Search Outcome

The search resulted in a total of 272 potential articles. A total of 255 articles were excluded because they were irrelevant, focused on a specific cognitive state, or lacked one or more of three concepts. Seventeen abstracts either appeared to meet inclusion criteria or required further review. Each of these full-text articles was read and four met all criteria to be included in the current review. The Figure depicts the article selection process and provides reasons for exclusion.

Study Characteristics

A brief summary of study characteristics and findings is presented in the Table. All four studies used a quantitative design. Two studies were cross-sectional (Alosco, Spitznagel, et al., 2013; Garcia et al., 2014), one was prospective (Pulignano et al., 2014), and one was a secondary data analysis (Zuccala et al., 2005). None of the studies included an intervention. All studies received an evidence grade of C.

Two studies (Alosco, Spitznagel, et al., 2013; Garcia et al., 2014) specifically addressed the impact of nutrition on cognition in older adults with heart failure. The third and fourth studies examined the correlations between nutritional biomarkers and cognition in this population (Pulignano et al., 2014; Zuccala et al., 2005). Only one article (Alosco, Spitznagel, et al., 2013) provided information on participants' race or ethnicity. Participants' ages ranged from 50 to 85 years. Three articles (Alosco, Spitznagel, et al., 2013; Garcia et al., 2014; Pulignano et al., 2014) provided information on participants' sex (females comprised 39.5%, 33.1%, and 46.3% of each study population, respectively). One study (Zuccala et al., 2005) examined hospitalized patients, whereas the other three examined community-dwelling individuals. Sample sizes ranged from 86 (Garcia et al., 2014) to 1,511 (Zuccala et al., 2005).

Instruments used to assess nutritional habits and cognitive status varied for each study. Two studies (Alosco, Spitznagel, et al., 2013; Garcia et al., 2014) used the Starting the Conversation (STC; Paxton, Strycker, Toobert, Ammerman, & Glasgow, 2011) diet assessment tool, and Garcia et al. (2014) also used an abbreviated dairy intake form. The STC diet assessment tool is an eight-item simplified food frequency instrument. Higher self-reported consumption of fast food, sugary beverages, snack chips and crackers, desserts and sweets, margarine, butter, and meat fat yields a higher score, which is indicative of poorer nutritional habits. Higher consumption of fruit, vegetables, beans, chicken, and fish yields a lower score, which is indicative of better nutritional habits (Paxton et al., 2011). For the abbreviated dairy intake form, participants self-reported how much dairy they consumed per day, week, or month, and then researchers converted these amounts to ounces per week (Garcia et al., 2014). The third and fourth studies (Pulignano et al., 2014; Zuccala et al., 2005) did not specifically address nutritional habits; however, biomarkers indicative of nutritional status, including hemoglobin, sodium, potassium, glucose, and albumin, were collected via serum samples.

To assess cognitive status, two studies (Alosco, Spitznagel, et al., 2013; Garcia et al., 2014) used a comprehensive battery that evaluated attention (i.e., Trail Making Test A [Spreeen & Strauss, 1991]), working memory (i.e., Symbol Digit Modalities Test and Letter Number Sequencing [Smith, 1983; Wechsler, 1997]), learning (i.e., California Verbal Learning Test II [Delis, Kramer, Kaplan, & Ober, 2000]), language (i.e., Boston Naming Test [Hawkins et al., 1993] and Animal Fluency [Morris et al., 1989]), memory (i.e., California Verbal Learning Test II [Delis et al., 2000]), executive function (i.e., Trail Making Test B and Stroop Color Word Test interference effect [Dikmen, Heaton, Grant, & Temkin, 1999; Lezak, Howieson, & Loring, 2004; Utl & Graf, 1997]), and psychomotor speed (i.e., Trail Making Test A). Garcia et al. (2014) also evaluated executive function with the Frontal Assessment Battery (Gifford & Cummings, 1999) and memory with the Complex Figure Test–Extended (Loring, Martin, Meador, & Lee, 1990). Two studies (Alosco, Spitznagel, et al., 2013; Pulignano et al., 2014) measured global cognition with the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975). In addition, Pulignano et al. (2014) measured language and executive function (phonemic verbal fluency) and attention and psychomotor speed (Wechsler Adult Intelligence Scale Digit Symbol substitution test [Fisk & Sharp, 2004; Wechsler, 1997]). Zuccala et al. (2014) assessed global cognition with the Hodkinson Abbreviated Mental Test (Gomez de Caso, Rodriguez-Artalego, Claveria, & Coria, 1994).

Data Synthesis

The four articles were reviewed for relevant findings related to the effects of nutrition on cognitive function in older adults with heart failure. Findings could be grouped into two broad categories: nutritional habits and biomarkers associated with (a) cognitive impairment in older adults with heart failure and (b) normal or improved cognitive performance.

Having poorer nutritional habits, as defined by a high score on the STC diet assessment tool, was associated with reduced frontal functioning in the areas of attention and executive function (Alosco, Spitznagel, et al., 2013). Increased consumption of sugary beverages was related to poorer performance on measures of executive function and greater reported consumption of snack chips or crackers per week was associated with poorer language and memory performance (Alosco, Spitznagel, et al., 2013). Greater dairy consumption was related to poorer memory (Garcia et al., 2014). Two studies found that anemia was associated with cognitive impairment among older adults with heart failure (Pulignano et al., 2014; Zuccala et al., 2005). Pulignano et al. (2014) reported that participants who had anemia performed significantly worse on tests of global cognitive function, attention, psychomotor speed, and executive function compared to those without anemia, whereas Zuccala et al. (2005) found that anemia was associated with poorer global cognition. Moreover, hyponatremia, hypokalemia, hyperglycemia, and hypoalbuminemia were associated with global cognitive impairment in hospitalized individuals with heart failure (Zuccala et al., 2005).

Conversely, several nutritional habits and biomarkers were associated with normal or improved cognitive performance in older adults with heart failure. Having better nutritional habits, as defined by a low score on the SCT assessment tool, was associated with better frontal functioning in the areas of attention and executive function (Alosco, Spitznagel, et

al., 2013). Hemoglobin levels >15 g/dL were associated with a lower prevalence of global cognitive impairment (Pulignano et al., 2014). Furthermore, normalization of glucose, potassium, and hemoglobin levels during individuals' hospital stays was associated with improved global cognitive performance at discharge (Zuccala et al., 2005).

Discussion

The current review suggests several nutritional habits and biomarkers are associated with cognitive function in older adults with heart failure. Poorer nutritional habits, including increased consumption of sugary beverages and snack foods, greater dairy intake, anemia, hyponatremia, hypokalemia, hyperglycemia, and hypoalbuminemia are associated with cognitive impairment. Conversely, better nutritional habits and normalization of glucose, potassium, and hemoglobin levels are associated with maintained or improved cognition.

Quality scores derived from the Harbour and Miller (2001) scale indicate that the current literature represents a C level of evidence. This grade reflects the lack of meta-analyses and well-designed randomized control trials currently published on this topic. All four studies identified in this review used non-experimental designs (i.e., two cross-sectional, one prospective, and one secondary analysis). Overall, the lack of research (particularly experimental research) on this topic indicates it is an area in need of further exploration.

An important finding from the current review was that poorer nutritional habits, including greater consumption of fast food, sugary beverages, processed foods, and saturated fat and lesser consumption of fruits, vegetables, and lean meats, are associated with reduced frontal function in individuals with heart failure. Item-by-item partial correlation analysis revealed that increased consumption of sugary beverages is associated with poorer performance on measures of executive function; greater consumption of snack chips and crackers is associated with poorer language and memory performance. These findings can be compared with previous research, which demonstrated that higher intake of saturated and trans fats is associated with global cognitive impairment in healthy older adult populations (Morris, Evans, Bienias, Tangney, & Wilson, 2004). Moreover, increased consumption of processed foods, including desserts, snacks, sweets, and sugary beverages, is associated with poorer global cognitive function in individuals older than 65 with existing mild cognitive impairment (Torres et al., 2012). Extrapolating from this finding, it is possible that consumption of processed foods contributes to the development of cognitive impairment and worsens existing cognitive impairment.

Another noteworthy finding was that better nutritional habits, including greater consumption of fruit, vegetables, and fish, and lesser consumption of processed foods and saturated fat, are associated with better attention and executive function in individuals with heart failure. Recent research substantiates these findings, revealing higher consumption of plant-based foods and oily fish and lower consumption of processed food, saturated fat, and simple sugar is associated with improved cognitive function across a variety of domains in healthy older adult populations (Cheung, Ho, Chan, Sea, & Woo, 2014).

The current review suggests that greater dairy intake is associated with poorer memory in older adults with heart failure. This finding is inconsistent with studies of other adult populations, which have reported that higher dairy intake is associated with a decreased risk for dementia (Rahman, Sawyer Baker, Allman, & Zamrini, 2007; Yamada et al., 2003) and lower dairy intake is associated with poorer global cognition (Lee et al., 2001). One reason for this inconsistency may be related to the fact that Garcia et al. (2014) did not differentiate between categories of dairy products and thus the types of fats they predominately contain were not adequately controlled for in analysis. Although higher intake of saturated and trans fat is associated with worse cognitive impairment (Devore et al., 2009), higher intake of n-3 polyunsaturated fatty acids is associated with improved cognitive measures (Nilsson, Radeborg, Salo, & Bjorck, 2012). It is possible that participants in the study by Garcia et al. (2014) consumed dairy products high in saturated and trans fat, hence the decrements in cognition. Another reason for these inconsistencies may be related to differences in sample sizes. Compared to the aforementioned studies examining the relationship between dairy intake and cognition, the study by Garcia et al. (2014) had a significantly smaller sample size.

The current review suggests cognitive impairment in individuals with heart failure is associated with a variety of biomarker abnormalities, including anemia, hyponatremia, hypokalemia, hyperglycemia, and hypoalbuminemia. Association of anemia with cognitive impairment in older adults with heart failure may be expected given that anemia has also been associated with global cognitive impairment, dementia, and poorer executive function in older adults without heart failure (Andro et al., 2013). Similarly, hyponatremia has been associated with poorer global cognitive and executive function in other chronic disease populations (Shavit, Mikeladze, Torem, & Slotki, 2014). Hyperglycemia has been associated with cognitive impairment across several domains in individuals with type 1 and type 2 diabetes (Cox et al., 2005), which is especially important to note given that diabetes and heart failure are common comorbid conditions (Guglin, Lynch, & Krischer, 2014).

Hypokalemia is commonly observed in individuals with heart failure because potassium-wasting diuretics are a cornerstone of heart failure treatment (Peacock et al., 2009). Zuccala et al. (2005) found that hypokalemia was associated with global cognitive impairment in a large sample of hospitalized individuals with heart failure. This finding is consistent with other literature that found patients admitted to the hospital for various medical problems who experienced hypokalemia performed worse on measures of orientation, visuospatial function, executive function, and language tests compared to individuals with normokalemia (Bruce, Harrington, Foster, & Westervelt, 2009). The relationship between hypoalbuminemia and global cognitive impairment in individuals with heart failure is consistent with other studies of geriatric populations without heart failure (Llewellyn, Langa, Friedland, & Lang, 2010). All of these biomarkers are routinely used to help determine nutritional status in adults with chronic illnesses (Higgins, Daly, Lipson, & Guo, 2006; Wells & Dumbrell, 2006). Consequently, it is imperative that nurses understand how biomarker abnormalities and their corresponding nutritional problems may affect cognition in individuals with heart failure.

Although several studies demonstrate an association between nutrition and cognitive function in this population, the lack of research in this area points to a clear need for more studies. The reviewed studies do not provide a comprehensive understanding of the effects of nutrition on cognition in individuals with heart failure. Because only studies published in English were included, there may be selection bias in the current review. In addition, two of the articles relied on individuals' self-report of their nutritional habits. This may have led to limitations with the validity of these studies, as it is known that individuals in self-reported dietary studies tend to misreport their true dietary intake (Black et al., 1993). These same studies were cross-sectional by design, meaning neither causality nor directionality could be inferred. It is essential to note that nutritional risks and needs of community-dwelling and hospitalized individuals with heart failure may be different. As research continues to build around this topic, it will be important to distinguish between these two populations.

Implications for Clinical Practice

Implications for clinical practice may include more specific nutritional interventions for older adults with heart failure to maximize cognitive function. These specific nutritional interventions, such as eating more leafy green vegetables to increase hemoglobin levels or reducing consumption of sugary beverages, could provide a feasible, cost-effective way for individuals with heart failure to achieve optimal cognitive performance. However, it is important to note that nutritional interventions and educational materials should be designed to compensate for domains that are most commonly impaired, including attention, memory, and executive function.

Conclusion

The importance and relevance of this topic to gerontological nursing care cannot be emphasized enough. In the older adult population, intact cognition is crucial for effective self-management and the ability to live independently. As the prevalence of heart failure increases in the aging population, it is essential that nurses generate feasible, targeted, and cost-effective interventions to optimize cognitive function. The current review suggests nutritional interventions may provide a valuable starting point for nurses. However, given the dearth of information available, more research is needed to fully understand how nutritional habits and interventions can impact cognition in older adults with heart failure. Investigators must continue building the science around this topic to better understand how nutritional interventions can be used to prevent cognitive impairment and optimize cognitive function in this population.

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KEYPOINTS

1. Cognitive impairment is commonly observed in older adults with heart failure and nutrition may be a contributing factor.
2. Poorer nutritional habits, including increased consumption of sugary beverages and snack foods, greater dairy intake, anemia, hyponatremia, hypokalemia, hyperglycemia, and hypoalbuminemia, are associated with cognitive impairment in older adults with heart failure.
3. Better nutritional habits and normalization of glucose, potassium, and hemoglobin levels are associated with maintained or improved cognition.
4. More research is needed to fully understand how nutritional habits and interventions can be used to prevent cognitive impairment and optimize cognitive function in this population.

Figure.
Flow diagram of search results.

Table

SUMMARY OF STUDY CHARACTERISTICS AND FINDINGS

Study	Purpose/Design	Sample	Instruments	Main Findings	Evidence Grade
Alosco, Spitznagel, et al. (2013)	<ul style="list-style-type: none"> To examine whether diet quality affects the relationship between heart failure severity and cognitive function in older adults with heart failure Cross-sectional design 	<ul style="list-style-type: none"> $N=152$ Age range = 50 to 85 years (mean = 67 years); 39.5% female; 83.6% Caucasian Diagnosis of NYHA class II or III heart failure 	<ul style="list-style-type: none"> STC diet assessment tool Modified MMSE, Trail Making Test A and B, Digit Symbol Coding, Stroop Color Word Test Interference Effect, Letter Number Sequencing, California Verbal Learning Test-II, Boston Naming Test, and Animal Fluency 	<ul style="list-style-type: none"> Poorer dietary habits associated with reduced frontal functioning ($p = 0.05$) Better dietary habits associated with better frontal functioning ($p < 0.05$) Increased number of sugary beverages associated with poorer executive functioning ($p < 0.01$) Greater reported consumption of snack chips or crackers per week associated with poorer language functioning ($p < 0.01$) A trend emerged between poorer memory performance and increased consumption of chips/crackers ($p = 0.05$) 	C
Garcia et al. (2014)	<ul style="list-style-type: none"> To examine the relationship among dairy consumption, cognitive dysfunction, and cerebral blood flow in a sample of older adults with heart failure Cross-sectional design 	<ul style="list-style-type: none"> $N = 86$ Age range = 50 to 85 years (mean = 70 years); 33.1% female Diagnosis of NYHA class II or III heart failure 	<ul style="list-style-type: none"> An abbreviated dairy intake form and STC diet assessment tool Letter Number Sequencing, Trail Making Test A and B, Symbol Digit Modalities Test, Frontal Assessment Battery, Stroop Interference Task, California Verbal Learning Test-II, Complex Figure Test-Extended, Boston Naming Test-II, and Animal Fluency 	<ul style="list-style-type: none"> Greater dairy consumption associated with poorer memory ($p = 0.01$) 	C
Pulignano et al. (2014)	<ul style="list-style-type: none"> To determine whether anemia is independently associated with impaired cognitive function in 	<ul style="list-style-type: none"> $N=190$ Age >70 years (mean = 77 years); 46.3% female 	<ul style="list-style-type: none"> Hemoglobin biomarker MMSE, verbal fluency, and WDS substitution test 	<ul style="list-style-type: none"> Anemia was present in 42.6% of individuals Participants with anemia performed significantly worse on the MMSE ($p < 0.01$), verbal fluency ($p = 0.015$), and WDS (p 	C

Study	Purpose/Design	Sample	Instruments	Main Findings	Evidence Grade
	<ul style="list-style-type: none"> individuals with heart failure Prospective design 	<ul style="list-style-type: none"> Diagnosis of stage III or IV heart failure 		<ul style="list-style-type: none"> < 0.01) compared to those without anemia Hemoglobin levels >15 g/dL associated with a lower prevalence of cognitive impairment ($p = 0.005$) 	
Zuccala et al. (2005)	<ul style="list-style-type: none"> To assess the correlates of cognitive impairment among individuals with heart failure Secondary data analysis 	<ul style="list-style-type: none"> $N = 1,511$ Participants enrolled in 1993, 1995, and 1997 Age and sex information not provided Diagnosis of heart failure at discharge 	<ul style="list-style-type: none"> Nutritional biomarkers Hodkinson Abbreviated Mental Test 	<ul style="list-style-type: none"> Anemia (OR = 1.42), hyponatremia (OR = 1.62), hypokalemia (OR = 1.51), hyperglycemia (OR = 1.39), and hypoalbuminemia (OR = 1.94) associated with cognitive impairment in individuals with heart failure Normalization of glucose ($p = 0.04$), potassium ($p = 0.002$), and hemoglobin ($p < 0.01$) levels during the hospital stay associated with improved cognitive performance at discharge 	C

Note. NYHA = New York Heart Association; STC = Starting the Conversation; MMSE = Mini-Mental State Examination; WDS = Wechsler Adult Intelligence Scale Digit Symbol; OR = odds ratio.