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Self-Care in the Older Adult Living with Heart Disease

Author
Szuba, Rochelle

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Self-Care in the Older Adult Living with Heart Disease

by
Rochelle Szuba

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Approved:

DocuSigned by:
Linda Park
F9BCC5CD52134D1...
Linda Park
Chair

DocuSigned by:
Julene Johnson
D7C9C2D3D494455...
Julene Johnson

DocuSigned by:
Mijung Park
B5D5F15FDC59400...
Mijung Park

Committee Members

Dedication

I dedicate this dissertation to my daughter, Piper Jolie.

You are my light, my love, my joy, my inspiration

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Self-Care in the Older Adult Living with Heart Disease

Rochelle Szuba

Abstract

Background: Self-care is an important part of the comprehensive treatment plan for people living with heart disease, specifically, coronary heart disease and heart failure. Physical activity is a key self-care healthy behavior. Older adults face barriers to self-care including symptom burden, comorbidities, depression, and age as well as cognitive in the heart failure population

Objectives: To study factors related to self-care on an individual's mental health, perceived health, and quality of life of older adults living with heart disease. To examine the direct association of physical activity as a primary predictor on these important outcomes. To evaluate the role of depression as a mediator of physical activity and quality of life

Methods: A systematic review was used to evaluate reported cognitive impairment in the older adult living with heart failure. Additionally, survey of 20-year surviving cohort of people living with chronic coronary disease was used to conduct a cross-sectional survey to evaluate the relationship of quality of life and physical activity as well as the mediation effect of depression on the relationship of physical activity and quality of life.

Results: The systematic review found that cognitive impairment was either diagnosed or measured using a validated tool in 8-66% of people living with heart failure over the age of 80 years. However, the population living with heart failure over 80 years old had poorer cognition by either measurement or physician diagnosis when compared to the population living with the heart failure less than 80 years old. Three studies did find the population living with heart failure had poorer measured cognition or a higher amount of diagnosed cognitive impairment when compared to the general population of the same age.

Important findings from the cross-sectional study revealed that regular physical activity is associated with better perceived health and quality of life when adjusted for age, socioeconomic factors, and comorbidities. Heart failure was significantly associated with lower quality of life. It is known from evidence that having heart failure is associated with lower quality of life. Other significant findings included the effect of physical activity on quality of life being mediated by depressive symptoms in the population living with chronic CHD.

Conclusions: Self-care is part of any medical treatment. Physical activity is an essential self-care behavior in CHD, but the benefits reach beyond the heart. Associated with hypertension and diabetes control, physical activity is also known to have primary prevention properties related to the brain including cognition and depression. Importantly, these papers found physical activity is associated with quality of life and better perceived health. Public investment and promotion of physical activity could have lasting benefits towards a healthy aging population. It is our responsibility since any self-care not done, is care not given.

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Introduction

Heart Health

In the United States, coronary heart disease (CHD) affects 20.1 million people (Centers for Disease Control and Prevention [CDC], 2022). As the number one cause of heart disease-related death, CHD takes 365,000 lives annually (Tsao et al., 2022; Virani et al., 2021). Progress has been made in reducing morbidity and mortality, yet in the past decade prevalence rates have plateaued and mortality rates have only slightly decreased. (CDC, 2021; Sidney et al., 2019). The population over 65 years, those most at risk for developing CHD, is expected to grow by 73.1 million from 2017 to 2030. This will lead to an increase in the absolute number of people with CHD. Cases of heart failure, often a consequence of CHD, are expected to increase by 1.8 million between 2020 and 2030 (Heidenreich et al., 2013). There is concern about the ability of the current healthcare system to support and provide adequate healthcare to this growing population (Fulmer et al., 2021).

Coronary heart disease is an accumulation of plaque in the coronary arteries causing a reduction in the adequate flow of oxygen rich blood to the cardiac muscle. Heart failure is often the result of this damage to the cardiac muscle (Flaherty et al., 2010; He et al., 2001). Accompanying symptoms vary by individual and severity of disease in acute, subacute, and chronic CHD (DeVon et al., 2008; DeVon et al., 2017). Percutaneous coronary interventions, coronary artery bypass, and medications can help to restore blood flow to the cardiac muscle improving symptoms, however, obstruction and symptoms may reoccur, or heart failure may develop.

Treatment of CHD and heart failure require a comprehensive plan including self-care, such as symptom monitoring, medication adherence and the adoption of a healthy lifestyle (Yancy et al., 2013) The Framingham risk criteria used to predict the risk of initial cardiovascular events, now serve as a guide for lifestyle changes (Kannel et al., 1961; Lloyd-Jones et al., 2004). The Life's Essential 8's campaign by the American Heart Association, identifies activities to address modifiable cardiac risk factors such as quitting smoking, eating healthy, maintaining a healthy weight, and participation in physical activity (Lloyd-Jones et al., 2022). Physical activity as a healthy behavior contributes positively to control of risk factors such as cholesterol, blood sugar and blood pressure (Agarwal, 2012; Hegde & Solomon, 2015; Leitzmann et al., 2007; Muscella et al., 2020; Myers, 2003). Embracing physical activity reduces the risk of recurrent CHD events and mortality (Loprinzi & Addoh, 2016; Winzer et al., 2018), and is associated with better quality of life (QOL) (Hately & Mandic, 2019; Terada et al., 2022; Vasankari et al., 2021). Similar to CHD, physical activity among the population living with heart failure has been shown to promote secondary prevention (Cattadori et al., 2018) and improve QOL (Doletsky et al., 2018; Heidenreich et al., 2022). But there is a paucity of studies in the CHD and heart failure population investigating the association of physical activity and perceived health, even though a positive relationship was found among the general population (Awick et al., 2017; Eifert et al., 2014; Kaleta et al., 2006). While the benefit of healthy behaviors is clear, participation in self-care is burdened by a multitude of individual, social, and population-based factors.

Self-care recommendation guidelines are based on research and clinical trials that often exclude the older adult for reasons of age, cognition, comorbidities, life expectancy and disabilities, thus, it is not expected that older adults can always achieve treatment goals (Cherubini et al., 2011; Masoudi et al., 2003). Paradoxically, the prescribed self-care recommendations and treatments require a level of autonomy, health, cognitive ability, and physical capability. This can be out of reach for older adults and is often the reason this group was initially excluded from the development of clinical guidelines. Therefore, instruction of self-care behaviors must involve an understanding of the barriers an individual may experience in performing them, especially in the older adult population.

Ecological Theory of Adaption and Aging

The Ecology of Adaption and Aging Theory describes aging as a process of continual adaption by a person to changes in their external environment or internally within their self (Lawton & Nahemow, 1973) Personal competency is referred to as what lies within the person (Lawton, 1977) and was later defined to include physical and functional health, cognitive and affective functioning and QOL (Annweiler et al., 2020). Environmental press is the physical, interpersonal, or social demands that the environment places on a person (Lawton, 1977) . The assumptions are that the personal competency and environmental press interaction is constant; therefore, behaviors cannot be explained based solely on the individual or the environment in which the behavior occurs (Nahemow & Lawton, 1973). Consequently, change that happens in either the person or environment will result in behavior that will be based on the current conditions of both. Similarly, if change in behavior occurs in the other determinant to maintain equilibrium, then adaptation occurs (Nahemow & Lawton, 1973).

To conceptually illustrate this interaction in a model, the environmental press is placed on the X axis of a graph and personal competency is on the Y axis. The positive affect areas are identified where the two axis points are at some level of equilibrium and person perceives the current situation as neutral and is therefore coping or adapting (Nahemow & Lawton, 1973). Negative or maladaptation occurs when personal competency and environmental press are out of balance. Yet, by adjusting personal competencies or the environment along the axis, adaptation and equilibrium can be restored (Nahemow & Lawton, 1973).

Research has established that self-care activities improve outcomes, however, it is necessary to investigate further to begin to understand the barriers. Barriers to self-care for people living with CHD include symptom burden, comorbidities, depression and age (Bethancourt et al., 2014; Chen et al., 2022) as well as cognitive in the heart failure population (Anderson & Birge, 2016; Burholt et al., 2017; Chudiak et al., 2018; Hudani & Rojas-Fernandez, 2016; Uchmanowicz et al., 2017). Lawton's theory of Person-Environment provides a framework for the assessment of these self-care barriers guided by the personal competency of physical, mental and well-being.

Dissertation Aims

The primary purpose of this three-manuscript dissertation is to study factors related to self-care on an individual's mental health, perceived health, and quality of life of older adults living with heart disease. We also examined the direct association of physical activity as a primary predictor on these important outcomes. In the first paper, the approach to understanding self-care and the older adult with heart disease will start with a systematic review of cognition and heart failure in the older adult. This is a logical place to start due to the complexity of self-care in the heart failure patient and the report of cognitive impairment in this population (Cacciatore et al., 1998; Gure et al., 2012; Schall et al., 1989). In examining the impact of heart failure on cognition as it relates to age, we can begin to develop necessary assessments and allocation of supportive resources to ensure self-care.

The second paper is a cross-sectional study that evaluates the association of self-care activities on one's subjective assessment of their health in people with CHD. We used the Heart and Soul Study data (Whooley & Schiller, 2022) that has followed participants with stable coronary heart disease for over 20 years. An older adult's physical, mental, and social well-being vary by individual and from year to year. Understanding the benefits of self-care in the older adult, while living with a potentially physically or cognitive impairing disease will encourage the development of novel approaches to supporting this vulnerable population.

Lastly, the third paper presents an analysis of the Heart and Soul data (Whooley & Schiller, 2022) to study the influence of depression on the relationship between physical activity and quality of life in patients who live with chronic CHD. Specifically, this paper presents moderation and mediation analyses to understand the role of depression to inform clinical practice and ultimately improve QOL.

The specific aims of this dissertation are to:

1. Describe the existing knowledge of cognitive function and heart failure among individuals over the age of 80.

   Hypothesis: Through a systematic review of the literature, there will be a higher rate of impaired cognition in patients with heart failure who are over 80 years old when compared with patients who are less than 80 years old with or without heart failure.

2. Determine the association between self-care (physical activity) and perceived health in patients who have lived with CHD for 20 years or more.

   Hypothesis: Through a cross-sectional study, there will be a strong relationship between engagement in physical activity with perceived health and QOL.

3. Determine whether depressive symptoms are a mediator or moderator on the relationship between self-care (physical activity) and QOL in adults who have lived with CHD for 20 years or more.

   Hypothesis: Through a mediation/moderation analysis, depressive symptoms will be a significant mediating factor on the relationship between physical activity and QOL.

After the presentation of the three dissertation papers, final conclusions related to this body of work are presented. The final synthesis of this work is then summarized with current and future clinical, social, policy, and research implications. The discussion of implications is intended to draw attention to important patient related factors such as cognition, self-care, QOL, and depression among older adults living with chronic heart disease.

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Cognition and Heart Failure in the Oldest Old: A Literature Review

Abstract

Background: Between 25-75% of patients with heart failure of any age have cognitive impairment with an estimated 41.4% having mild cognitive impairment and 19.79% with dementia. Research conducted in persons with heart failure shows cognitive impairment is associated with a decreased ability to perform self-care, including medication maintenance and symptom management.

Objective: The primary aims of this study were to understand (1) the relationship between heart failure and cognition in the population 80 years old and over, and (2) population-specific factors that impact such relationships in the oldest old population.

Methods: A literature search for articles was conducted using the following keywords: heart failure, cognitive function, cognitive impairment, and aged, 80 years and over. MeSH and related terms were added to the search bundle. Five databases including PubMed, CINHAL, Web of Science, EMBASE and Psych Info were searched for articles published October 1, 2006-October 7, 2021. Exclusion criteria includes conditions of cognitive impairment that were temporary, such as delirium, and if the study population had conditions that may not be exclusively related to heart failure (e.g., atrial fibrillation, stroke, cardiac arrest)

Results: The population 85 years and over living with heart failure was found to have cognitive impairment in 8.9% to 45% (p<.001) in two studies and were more likely to have cognitive impairment when compared to younger patients living with heart failure (*OR* 2.75, *p =.33; OR* 9.22, p<.001). The rate of cognitive impairment was higher in people over 80 years living with heart failure when compared to the same age group (41% v 30%, p<.05) without heart failure by differences in cognitive scores (5 points; p=.01) and

Conclusion: The aim of this review was to understand the impact of age and heart failure on an individual's cognition. This review found that age, whether over 80 or 85 years of age, has an influence on cognition that is different in those with heart failure than those without heart failure.

There remains a considerable amount of work to better understand this population in terms specifically how is their cognition impacted and how does this effect their ability to care for themselves.

Key words:

Oldest old, over 80 years, heart failure, cognitive impairment, cognitive function

Cognition and Heart Failure in the Oldest Old: A Literature Review

Introduction

Heart failure is a debilitating and costly chronic disease impacting 6.2 million Americans, of which an estimated 1.45 million are over the age of 80 (United States Census Bureau, 2021; Virani et al., 2020). As the inability of the heart to effectively pump blood, heart failure presents as shortness of breath, weakness, fatigue, fluid retention and loss of appetite. Life threatening symptoms from worsening heart failure cause 1.1 million emergency department visits and one million hospitalizations per year (Jackson et al., 2018; Rethy et al., 2020). The prognosis of heart failure hospitalizations is poor as 1 in 5 will be readmitted in 30 days (Khera et al., 2018; McDermott & Roemer, 2018) and mortality rates are 22-27% within one year of hospitalization (Benjamin et al., 2018; Lin et al., 2017; Loehr et al. 2008). Cognitive impairment in people living with heart failure has been associated with rates of hospital admissions and higher rates of mortality (Dodson et al., 2013; Zuccala et al., 2003)

Cognitive Impairment and Heart Failure

Between 25-75% of heart failure patients of any age have cognitive impairment (Cacciatore et al., 1998; Gure et al., 2012) with an estimated 41.4% having mild cognitive impairment and 19.79% with dementia (Yap et al., 2022). Patients experiencing mild cognitive impairment will have preserved activities of daily living (ADL), conversely, patients with dementia will have ADLs impacted (Petersen et al., 2001). The common cognitive domains impacted people living with heart failure are a slowed processing speed, inattention, poor working memory, or a decreased ability to learn new information (Almeida et al., 2012; Pressler et al., 2010; Gorelick et al., 2011). Research conducted in persons with heart failure shows cognitive impairment is associated with a decreased ability to perform self-care, including medication maintenance (Dolansky et al., 2016) and symptom management (Cameron et al. 2010)

Self-Care and Heart Failure

As a Class 1 (strong) recommendation, self-care education and multidisciplinary team support are recommended for all heart failure patients (Heidenreich et al., 2022). Self-care in the patients with heart failure is associated with maintenance, symptom perception, and management (Riegel et al., 2016). Symptom recognition and symptom change has been found to be one of the most difficult for patients to understand and act upon (Carlson et al., 2001), thus interventions improving symptom recognition are needed. An observational study found patients with good symptom response management are at a reduced risk of hospitalization and mortality (Lee et al., 2018). An intervention focused on management of symptoms with nurse practitioners reduced healthcare utilization (Bryant & Himawan, 2019). Nevertheless, in addition to the barrier of cognitive impairment, older adults also have special needs associated with natural aging (Zavertnik, 2014).

Cognitive Impairment and Aging

Age-related dementia affects 3.2% of the general population 65-74 years of age and increase to 29.9% of the population 85 years and older (Langa et al., 2017). Cognitive changes that occur with natural aging are similar to the changes in the population living with heart failure such as memory, speed, and reasoning (Dardiotis et al., 2012; Murman, 2015; Salthouse, 2010; Vogels et al., 2007). A cross-sectional study of claims data of people over 65 living with heart failure, found 15% had dementia, unfortunately, these data were not specific enough to understand if this rate was higher than the general population (Gure et al., 2012). The undefined age groups when reporting cognitive impairment leaves us to contemplate how well older adults, including over 85 years of age, living with heart failure and cognitive decline are managing their disease (Butrous & Hummel, 2016; Masoudi et al., 2003; Vigen et al., 2012).

Aims

The primary aims of this study were to understand (1) the relationship between heart failure and cognition in the population 80 years old and over, and (2) population-specific factors that impact such relationships in the oldest old population.

Methods

Search Strategy

A systematic literature search was conducted using the following keywords: heart failure, cognitive function, cognitive impairment and age, 80 years and over. MeSH and related terms were added to the search bundle (Supplemental Documents Appendix 1). Terms that reflected temporary cognitive changes such as delirium and confusion were excluded. Search terms for oldest old were put in quotation to avoid articles that simply mentioned old. Filters, when available, were applied to limit the search to 15 years and the population 80 years and over. On December 12, 2020, five databases including PubMed, CINHAL, Web of Science, EMBASE and PsychInfo were searched. Bibliographies of articles specific to this population were reviewed and a search was conducted to discover any additional articles.

Selection criteria

To be included in the review, articles must have:

1. Reported rates of both heart failure and cognitive function
2. Identified heart failure by a provider's diagnosis (in medical record, ICD-9 or 10 code or hospitalization)
3. Used a validated instrument to assess cognition or provider diagnosis (in medical record, ICD-9 or 10 code or hospital admission)
4. Reported data on the population age 80 and over
5. Been published December 12, 2005-December 12, 2020

Articles were excluded if:

1. Conditions of cognitive impairment were temporary such as delirium.
2. The study population included conditions that may not be exclusively related to heart failure (e.g., atrial fibrillation, stroke, cardiac arrest).

Results

Study Characteristics

The search of the combined databases and bibliographies resulted in 1202 unique studies, published between 2006-2020. Figure 1 describes the complete study procedure. After duplicate studies were removed, followed by a review of titles and abstracts, seventeen studies underwent full article review and 12 met the inclusion criteria for this review. Table 1.1 summarizes characteristics of included studies. Studies that received a full article review but were determined not to meet the inclusion criteria are listed in the supplemental documents (Appendix 2). Seven studies were conducted in Europe, four in the United States and one in Asia. The sample sizes for the studies were broad (range: 90 -1,946,497 subjects) with a sample size of the oldest old with heart failure ranging from 42-125,628 subjects. The largest study (Adelborg, et al., 2017) used a nationwide population-based cohort, matching patients with heart failure to the general population 1:5, resulting in 6% of the study population 80 years and over living with heart failure. One study did not provide the sample size of the group 85 and over (Hammond et al., 2018).

The aims of the studies varied broadly with four studies evaluating the relationship of heart failure and cognition (Adelborg et al., 2016; Hammond et al., 2018; Levin et al., 2014; Murad et al., 2015) three studies examined findings specific to the oldest old with heart failure (Biagi et al., 2014; Conde-Martel et al., 2012;Hjelm et al., 2014), four reported the association of medications or comorbidities on cognition (Chitnis et al., 2015; Kim & Son, 2019; Klarins et al., 2006; Selan et al., 2016) and one was a randomized controlled trial testing the impact of a multidisciplinary team on outcomes (Del Sindaco et al., 2012).Three longitudinal studies focused on cognitive function in persons with heart failure over time (Adelborg et al., 2016; Hammond et al.,2018; Hjelm et al., 2014). Recruitment strategies included four studies used inpatient hospitalized patients (Biagi et al., 2014; Conde-Martel et al., 2012; Del Sindaco et al., 2012; Levin et al., 2014), two utilized outpatient environments (Kim & Son, 2019; Hjelm et al., 2014), and one analyzed claims data (Chitnis et al., 2015). Four studies that conducted data analysis on larger general population registries (Klarins et al., 2006; Murad et al., 2015) including two that used sub-populations of larger general population registries (Adelborg et al., 2016; Hammond et al., 2018).

Table 1.1
Study Characteristics

Table 1.1

Study Characteristics

Author/Year	*Country*	*Study Aim*	*Study Type*	*Population*	*Total Sample Size (N)*	*HF Sample Size (N)*	*Oldest Old (in years defined by study) Sample Size (N)*	*Oldest Old with HF Sample Size (N)*
Adelborg, et al, 2017	Denmark	Examine potential associations between heart failure and dementia and factors that might mediate this association	Prospective longitudinal, with matched cohort: 35 years	General population	1,946,497	324,428	≥80= 753,117	**HF:** 125,628 (6%) **Non- HF:** 627,489
Biagi et al 2014	Italy	Detect differences between old and very old with CHF in attempt to provide patient tailored care	Cross-sectional, multi-hospital cohort	Inpatient with HF	1444	1444	>85= 328	>85= 328 (23.1%)
Chitnis et al 2015	USA	Test the causal effect of statins on reducing dementia in patients with HF	Retrospective longitudinal: 3 years	Inpatient/ Outpatient with HF on Medicare Claims	8062	8062	>85= 934	>85= 934 (11.59%)
Conde-Martel et al, 2013	Spain	Analyze clinical characteristics, major comorbidities and 1-year survival in heart failure patients >85 compared to younger ages	Prospective, multi-center cohort: 1 year	Inpatients with HF	1172	1172	≥85= 224	≥85= 224 (19.1%)
Del Sindaco et al, 2012	Italy	Influence of cognitive impairment on outcome of older HF patient and if a multidisciplinary program represents an appropriate model of care	Randomized controlled trial	Outpatients following inpatient HF admission	173	173	≥80= 42	≥80= 42 (24.2%)

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Study Characteristics

Author/Year	*Country*	*Study Aim*	*Study Type*	*Population*	*Total Sample Size (N)*	*HF Sample Size (N)*	*Oldest Old (in years defined by study) Sample Size (N)*	*Oldest Old with HF Sample Size (N)*
Hammond et al	USA	Determine association of incident HF and duration with long-term cognitive trajectories	Prospective longitudinal: 5 years	General population (4 representative cohorts in US)	4864	496	Not available	Not available
Hjelm et al 2014	Sweden	Compare prevalence of dementia in individuals ≥80 years with CHF and those in the same age group without CHF to identify factors related to dementia in individuals with CHF.	Prospective longitudinal: 10 years	General population: twins ≥80	702	138	≥80 = 702	≥80= 138 (19.6%)
Kim et al, 2019	South Korea	Investigate the association of anemia with increased risk of cognitive impairment in elderly HF patients	Cross-sectional convenience sample	Outpatient Clinic	181	181	≥80 = 29	≥80 = 29 (16%)
Klarin et al, 2006	Sweden	Investigate drug treatment patterns for heart failure in the very old and to determine if ACEI were under-used by demented persons.	Retrospective longitudinal: 3 years	General population	265	265	80-84= 106 85-89= 66 ≥90= 33	≥80= 205 (77.3%)
Levin et al 2014	USA/ Canada	Investigate the prevalence of impairment in memory, processing speed and executive function	Prospective cohort (secondary cross-sectional analysis)	Inpatient with HF	744	744	≥80 = 223	≥80= 223 (31.6%)

Table 1.1 (continued)

Study Characteristics

Author/Year	*Country*	*Study Aim*	*Study Type*	*Population*	*Total Sample Size (N)*	*HF Sample Size (N)*	*Oldest Old (in years defined by study) Sample Size (N)*	*Oldest Old with HF Sample Size (N)*
Murad et al 2015	USA	Examine the prevalence of key comorbid conditions and measures of functional and cognitive impairment at diagnosis of HF	Prospective longitudinal: 18 years	General population with HF diagnosis (4 representative cohorts in US)	558	558	>85= 90	>85= 90 (16.1%)
Selan et al 2016	Sweden	Investigate the prevalence of self-awareness of one's own HF and the association of age-an HF related factors in people 80 years of age or older	Prospective longitudinal study (secondary cross-sectional analysis)	General population with HF	90	90	≥80 = 90	≥80= 90

Case identification

Identification of Heart Failure

The diagnosis of heart failure was the primary method studies used to identify the study population (Table 1.2). Diagnosis was confirmed at time of hospitalization using the European Society of Cardiology Guidelines in three studies (Biagi et al.,2014; Conde-Martel et al., 2010; Del Sindaco et al., 2012) or similar criteria that includes symptoms coupled with echocardiogram results, chest x-rays and/or medication in five studies in the outpatient or general population (Hammond et al., 2018; Kim et al. 2019; Klarin et al. 2006; Murad et al., 2016; Selan et al., 2016). Diagnosis in both the inpatient and outpatient setting was made using the Framingham criteria (Levin et al., 2014) or a similar method in two studies (Hjelm et al., 2011) which combines heart failure symptoms with physical assessment for evidence of volume overload such as hepatomegaly, jugular venous distention, rales, and ankle edema.

Identification of the Oldest Old

This review is interested in the oldest, old population also known as 80 years and over [MeSH]. Ten studies used the age of at least 80 years and over comparing them to younger populations with heart failure. (Adelborg et al., 2016; Biagi et al.,2014; Chitnis et al 2015; Conde-Martel et al., 2010; Del Sindaco et al., 2012; Hammond et al., 2018; Kim et al. 2019; Klarin et al., 2006; Levin et al., 2014; Murad et al., 2016) Two studies (Hjelm et al., 2011; Selan et al., 2016) used age of 80 and over as a cohort to compare to persons with heart failure to those without heart failure (Table 1.2). The articles used terms such as oldest old, 80 years and over, very elderly, and very old to describe an inconsistent age group varying from 80 years and over to 85 years and over, proving difficult to identify a true age cohort.

Table 1.2
Definitions

Table 1.2

Definitions

Study	*Inclusion criteria*	*Exclusion criteria*	*Oldest Old (years)*	*HF measure/ criteria*	*Cognitive assessment tool*
Adelborg et al 2016	Hospital or outpatient ICD-9 or ICD-10 codes of Primary/secondary diagnosis: HF matched with general population (1:5)	• Diagnosis of dementia on index • Diagnosis of dementia on follow up	≥80	Diagnosis of HF in the Danish National Patient Registry (DNPR)	Diagnosis of dementia, Alzheimer's disease, vascular dementia **or** other dementia in DNPR **or** Central Psychiatric Registry
Biagi et al 2014	Hospitalized patients present on index day admitted with HF	none	>85	European Society of Cardiology 2005 guidelines	Pfeiffer test: • Cognitive impairment ≥ 3 incorrect
Chitnis et al 2015	≥65 years HF Diagnosis on claim (1/1/2008-12/31/2011) One claim after index date	• Dementia • Deceased (prior: 1/1/2009)	≥85	ICD-9 for HF	ICD-9 dementia
Conde-Martel et al 2010	Hospitalized with HF	• Deceased during hospitalization	>85	European Society of Cardiology 2008 guidelines	Pfeiffer test: • # wrong as compare
Del Sindaco et al 2012	≥70 years Hospitalized with HF and reduced ejection fraction NYHA III-IV IV diuretics, inotropes or vasodilator therapy	• Valve surgery • Substance abuse • Dementia • Severe gait impairment • MMSE<11 • Psychiatric disease • Illness likely to reduce life expectancy • Long term inotrope therapy • Living in nursing home	>80	European Society of Cardiology 2001 guidelines	MMSE • Cognitive impairment: ≤ 24

Table 1.2 (continued)

Definitions

Study	*Inclusion criteria*	*Exclusion criteria*	*Oldest Old (years)*	*HF measure/ criteria*	*Cognitive assessment tool*
Hammond et al 2018	No HF at index 1 cognitive assessment at enrollment or follow up	• Stroke	≥80	Medical records: Symptoms of HF with: pulmonary edema on XRAY or clinical findings or medication prescribed for HF	3MSE (100-point scale) • Change in score as compare
Hjelm et al 2011	Same sex twins born 1913 or earlier	none	≥80	Physician review Independent review of medical records for diagnosis	MMSE • 28= normal • 25-27= mild • ≤24= impairment Clock drawing (5 points): • Cognitive impairment: 0-3
Kim et al, 2019	>60 years HF diagnosis x 1 year	• Dementia • Mild cognitive impairment • Paralysis/physical impairment: stroke • Major depression • Terminal illness • Hospice • Palliative care	≥80	ECHO findings Clinical history Symptoms	3MSE (100-point scale) • Cognitive impairment <80
Klarin et al, 2006	HF diagnosis	none	≥80	Physician review of symptoms/ physical findings And One heart failure medication	DSM III criteria by two independent clinicians • Dementia (fulfilled DSM criteria) • Questionable (memory loss but other dysfunction not definitive) • Non-demented

Table 1.2 (continued)

Definitions

Study	*Inclusion criteria*	*Exclusion criteria*	*Oldest Old (years)*	*HF measure/ criteria*	*Cognitive assessment tool*
Levin et al, 2014	Hospitalized with HF	• HF in setting of MI • invasive surgery or iatrogenic volume loading • Non-English speaking • Dementia • Delirium	$\geq$85	Framingham criteria	5 word immediate + delayed Controlled oral word association test Digit Symbol Substitution Test • Specific score range not provided • # domains impacted used as a compare
Murad et al 2016	New HF diagnosis between 1990-2002	none	>85	Diagnosis by a physician **And** Diuretic and digitalis or vasodilator	3MSE (100-point scale) • Cognitive impairment <80
Selan et al 2016	$\geq$80 years at time of HF diagnosis	none	$\geq$80	Documented HF symptoms Pathological ECG Confirmed Xray	MMSE (30-point scale) • Cognitive impairment >26= normal 21-26= mild 11-20= moderate 0-10= severe

Identification of Cognition

The majority of the studies used a validated tool to measure cognition, including three studies using the Modified Mini-Mental State Exam (3MSE) (Hammond et al., 2018; Kim et al. 2019; Murad et al., 2016), three using the Mini Mental State Examination (MMSE) (Del Sindaco et al., 2012; Hjelm et al., 2011; Selan et al., 2016), two studies employed the Pfeiffer test (Biagi et al.,2014; Conde-Martel et al., 2010) and one study used measurement tools specific to domains such as digit span, word recall, word association, digit symbol and substitution (Levin et al. 2014). The 3MSE was used consistently to detect dementia with a score less than 80, whereas the MMSE used either less than 24 or less than 26 to identify dementia (Table 1.2).

Cognitive test scores were utilized in a few different ways. Six studies had predefined cut points to identify those with dementia or cognitive impairment (Biagi et al.,2014; Del Sindaco et al., 2012; Hjelm et al., 2011; Kim et al. 2019; Murad et al., 2016; Selan et al., 2016) whereas one study took the actual score of the oldest old as a comparator with younger groups (Conde-Martel et al., 2010). Two longitudinal studies used a change in score or change in percent score to identify dementia when comparing heart failure groups to non-heart failure groups overtime (Hammond et al., 2018; Hjelm et al., 2011). Another longitudinal study took a different approach by comparing the number of domains impacted in the older persons with heart failure versus the younger. The three remaining studies used ICD-9 codes, DSM III criteria, or medical records to diagnosis dementia (Adelborg et al., 2016; Chitnis et al 2015), including a one study that used the term questionable dementia as an equivalent of mild impairment (Klarins et al., 2006).

Cognition and Age in the Persons with Heart Failure

The 85 year and over population living with heart failure were found to have cognitive impairment in 8.9% to 45% of the population (Biagi et al.,2014; Chitnis et al., 2015; Conde-Martel et al., 2010, Murad et al., 2015). (Table 1.3). This finding was statistically significant in one study when compared to those less than 85 years old (Biagi et al. 2014). The difference in cognition by age was further supported using the Pfeiffer test that showed the score for those who are 85 years and over was almost two times likely to have cognitive impairment when compared to those less than 65 years (2.9 (SD±.3) vs. 1.4 (SD±.9), *p*<.001) (Conde-Martel et al., 2010). Levin et al. (2014) used the Pfeifer test to examine the number of domains impaired and found the older population were 3.8 (1.48 to 9.88) times more likely to have impairment of one domain, increasing to 65.82 (20.22-214.28) times of having three domains impaired when compared to the referent group of less than 65 years.

Using DSM III criteria in a slightly younger population (80 years and over), the rate of dementia was 20.7% and continuously increased to 25.7% and 36.3% in the 85 years and over and the 90 years and over population, respectively (Klarins, et al., 2006). Conversely, Klarins et al. (2006) reported an increase from 8.4% to 19.6% in questionable dementia when comparing the 80-84- to 85–89-year-old populations, though the rate decreased again to 6% in the 90 years and over population. Chitnis et al. (2015) reported a similar dementia rate of 26.34% in the 85 years and over population based on diagnosis. Risk adjusted odds ratios reported in two studies found the oldest old with heart failure were 2.74 (p=.033) and 3.2 (p=.041) times the risk of cognitive impairment when compared to people less than 80 years of age with heart failure (Del Sindaco et al., 2012; Kim et al. 2019).

Heart Failure and Cognition in the Oldest Old

Persons living with heart failure experienced a more rapid decline in cognition when compared with persons without heart failure. Over a 5-year period starting with diagnosis, there was a larger decrease in 3MSE score for all age groups including 80-84.9 years and 85-90 years by 4.4 (2.8 to 6) and 6.7 (4.6 to 8.8) (*p*=.011), respectively, when adjusted for socioeconomic status and comorbidities (Hammond et al., 2018).

Table 1.3
Findings

Table 1.3

Findings

Author	*Measure reported*	*Comparison group*	*Cognitive measure*	*Cognition Results*
Biagi et al 2014	Prevalence	Heart failure population by age (<85 to >85)	Severe impairment/ dementia	<85HF / >85HF Severe Cognitive impairment/dementia: 16.7% / 45% *p*<.001
Chitnis et al 2015	Prevalence	Heart failure population by age (<65, 65-74. 75-84, >85)	Dementia	**Total n/%** / **Dementia** / **No Dementia** **<65 years**: 929 (11.52) / 65 (5.73) / 864 (12.47) *p*<.001 **65-74 years**: 3128 (38.8) / 287 (25.29) / 2841 (41.01) **75-84 years**: 3071 (38.09) / 537 (47.31) / 2534 (36.58) **>85**: 934 (11.59) / 246 (21.67) / 688 (9.93)
Conde-Martel et al 2013	Prevalence	Heart failure population by age (<85 to >85)	Dementia	Total population / <85 / >85 dementia %: 5.6 / 4.9 / 8.9 *p*<.017
	Difference in scores		Pfeiffer test scores	Pfeiffer test mean: 1.7(2.1) / 1.4(1.9) / 2.9(2.3) *p*<.0001
Klarin et al, 2006	Prevalence	Heart failure population by age (75-79, 80-84, 85-89, >90)	Non-demented, questionable dementia, demented	N (%) *: 75-79 / 80-84 / 85-89 / >90 Non-dem: 46(26.2) / 75 (42.6) / 36(20.5) / 19(10.8) Questionable: 5(17.2) / 9(31) / 13(44.8) / 2(6.9) Dementia: 9 (15) / 22(36.7) / 17(28.3) / 12(20) % with dementia: 15% / 20.7% / 25.7% / 36.3% *% within each dementia group
Murad et al 2015	Prevalence	Heart failure population by age (66-77, 76-85, >85)	3MSE <80	66-77 / 76-85 / >85 / p value 3MSE <80: 3.8% / 20.4% / 31.1% / <.00001

Table 1.3 (continued)

Findings

Author	*Measure reported*	*Comparison group*	*Cognitive measure*	*Cognition Results*
Selan et al 2016	Prevalence	Heart failure in population ≥80	MMSE ≤27	Normal cognitive ability 33.% (30/90) mild/mod/severe impairment 66.6% (60/90)
Levin	Prevalence	Heart failure population by age (<65, 65-74. 75-84, ≥85)	Number of domains impaired	Domains impaired(n)* | 0 (151) | 1(240) | 2(230) | 3 (123) <65(n) | 41 | 35 | 18 | 11 65-74 (n) | 30 | 22 | 24 | 20 75-84 (n) | 22 | 30 | 37 | 42 >85 (n) | 7 | 13 | 21 | 27 *p<.001
	Odds Ratio			OR (95%) # domains impaired (n) | 1(224) | 2(215) | 3(114) <65 | referent | referent | referent 65-74 | .83 (.46-1.52) | 2.56(1.3-5.03) | 4.3(1.71-10.98) 75-84 | 1.5 (.8-2.82) | 5.77(2.85-11.6) | 12(4.89-30.58) >85 | 3.82(1.48-9.88) | 22.44(8.36-60.21) | 65.82(20.22- 214.2)
>Kim et al 2019	Odd Ratio	Heart failure population by age (<80 to ≥80)	3MSE ≤80	| OR | p | Adjusted OR | p ≤ 79 | 1 | | | ≥80 | 9.22 (3.477-23.89) | <.0001 | 3.208 (1.048-9.818) | .041 *multiple regression: gender, education**, monthly income, anemia** **p<.001
Del Sindaco et 2012	Odds Ratio	Heart failure population by age (≤80 to >80)	MMSE ≤ 24	| OR | CI | P >80 | 2.746 | 1.084-6.954 | .033 *multiple regression: education < 5 years, anemia, CKD>IV

Table 1.3 (continued)

Findings

Author	*Measure reported*	*Comparison group*	*Cognitive measure*	*Cognition Results*
Adelborg et al 2016	Hazard Ratio	Heart failure population compared to general population (all >80)	All-cause dementia Alzheimer's disease Vascular dementia Other dementia	1-10 (years) / 11-35 (years) / 1-35(cumulative) All cause: 1.06 (1.03-1.1) / 6.33(5.33-7.43) / 1.06 (1.02-112) Alzheimer: .94(.88-1) / .35(.13-.92) / .93(.87-.99) Vascular: 1.13 (1.02-1.26) / .53(.16-1.8) / .1.13 (1.01-1.25) Other: 1.14(1.08-1.19) / .95 (.063-1.42) / 1.13 (1.08-1.19)
Hammond et al 2018	Predicted Decline	Predicted year decline in mean score of Heart failure population compared to general population scores by age (80-85, 95-90)	3MSE (DSST not significant)	80-85 years / 85-90 years Difference (incident HF minus no HF) (CI): 4.4 (2.8-6)* / 6.7 (4.6-8.9)* Difference with AF: 4.4(1.3-7.4)† / 5.0(-.05-10.5)† Difference without AF: 3.7 (1.6-5.9) / 6.8 (3.6-10) *p=.011 †p=.084 Risk adjusted birth year, sex, race, edutain, smoking, ETOH, BB use, ACEI, SBP, BMI, CKD, COPD, anemia, diabetes, HTN and CAD
Hjelm et al 2014	Prevalence over time	Heart failure population compared to general population (all >80)	All cause dementia Alzheimer's disease Vascular dementia	IPT 1 (HF% NHF%) / IPT2 (HF% NHF%) / IPT3 (HF% NHF%) / IPT4 (HF% NHF%) / IPT5 (HF% NHF%) All: 39 31 / 41 30* / 38 30* / 37 30 / 37 30 AZ: 17 18 / 19 18 / 18 18 / 17 18 / 17 18 VD: 16 7* / 16 6* / 15 5* / 15 5* / 15 5* *p≤.05

Adelborg et al., (2016) found a higher risk of developing vascular dementia, other types of dementia and all cause dementia in persons with heart failure who are 80 and over, in the first 11 years after the diagnosis (1.13 (1.02 to 1.26), 1.13 (1.08 to 1.19) and (1.06 (1.03 to1.10) respectively) when adjusted for comorbidities, compared to the general population. Interestingly, the risk dropped to less than 1 for the people with heart failure at 11-35 years post diagnosis and was not statistically significant. Yet, the odds ratio overall from 1-35 years showed statistical significance and was similar to that found in years 1-11 with vascular dementia 1.13 (1.01-1.25), other dementia 1.14 (1.08-1.19) and all cause dementia 1.06 (1.02-1.10). Hjelm et al., (2014) found vascular dementia was consistently statistically higher over 10 years for those with heart failure, at each 2-year interval when compared to the general population (baseline: 16% test #2: 16%, test #3: 15%, test #4: 15%, test # 5: 15%; all with $p \leq .050$).

Factors Influencing Cognition in the Oldest Old Heart Failure Patient

Unfortunately, no study identified characteristics for the study population of the oldest old living with heart failure by their cognitive status, therefore the secondary aim could not be met. Studies controlled for factors including education and income, and comorbidities such as arrhythmias and diabetes, suggesting factors that play an important role in cognition and heart failure. Hammond et al., (2018) found a rapid decline in 3 MSE score trajectory the same across all heart failure groups (p=.027) however, the association of decline was not statistically significant in presence of atrial fibrillation (p=.084).

Study Quality Assessment

Each study was evaluated using the Critical Appraisal Skills Programme (CASP) checklist for cohort studies (Appendix 3). All studies were determined to be of good quality on the evaluation of truth to aim, recruitment, confounders (when applicable), applicable to general population and agreement with research. Common areas of weakness were measurement bias and precision. For example, four studies reported cognitive impairment as a dichotomous variable (Biagi et al., 2014; Chitnis et al., 2015; Conde-Martel et al., 2012; Del Sindaco et al.,

2012) even in studies where the authors noted the cognitive assessment tool had the ability to identify more subtle levels of mild cognitive impairment (Biagi et al., 2014). Using a variety of definitions and cut points for cognitive impairment misses the vast differences people with cognitive impairment may experience. Additionally, studies that used claims data or medical records for cognition, used the diagnosis by a physician when seeking care. In the studies where all cognition is compressed into dementia or a general term of cognitive impairment, an incorrect assumption may be made about this population's ability (Biagi et al., 2014; Chitnis et al., 2015, Del Sindaco et al 2012; Kim et al., 2019). Conversely the reliance on a diagnosis from a care provider cognitive impairment may underrepresent those who may need some assistance but are not seeking care related to their cognition (Adelborg et al., 2016; Chitnis et al., 2015).

Discussion

In a systematic review of the literature, we found studies that confirmed that persons over the age of 80 years living with heart failure had poorer measured cognition or were diagnosed more frequently when compared to the younger population living with heart failure or the general population in their age cohort without heart failure. From the reviewed literature, we found that 8.9%-66% of the population living with heart failure had cognitive impairment. A few studies further examined cognitive impairment, reporting milder cognitive impairment in 8-40% of the those who were evaluated (Klarins et al., 2006; Selan et al., 2016). This range of mild cognitive impairment is still quite broad. In an examination of age cohorts, the rate of mild cognitive impairment may peak between 85-89 years and then sharply drop off at the age of 90 years or older while dementia continues to rise (Klarins et al., 2006). A shrinking denominator due to death and the higher risk of dementia in nonagenarians may explain this sudden change.

The study of age on general cognition was measured in a few different ways. The prevalence of cognitive impairment in the population over the age of 85 with heart failure was statistically higher when compared to the younger population (Biagi et al., 2014; Conde-Martel et al., 2013; Murad et al., 2015). Furthermore, the odds ratio indicated a score of less than 80 on the 3MSE was 2.7-9.22 times more likely in the population 80 and over when compared to the younger population living with heart failure. Using the number of domains impaired, Levin et al., (2014), compared those 85 and over to those in the age range of 75-84. The OR of having at least one domain impaired was at least doubled and increased exponentially with the increasing number of impaired domains. These findings indicate a difference in the 85 years and older, supporting the findings by Klarins et al., (2006).

To understand the effect and impact heart failure has on cognition, several studies measured cognition in participants diagnosed with heart failure over time. Persons diagnosed with heart failure develop vascular dementia, but not Alzheimer's Disease (Adelborg et al. 2016; Hjelm et al., 2014). This association was relevant in the first 10 years after diagnosis, but not in years 11-35. Of course, in the over 80 years population it is unlikely they were followed for 35 years, raising questions about those who survive to 90 years and over, and whether they do so because their cognition is intact.

The review found cognitive impairment was more prevalent in those with heart failure than those without heart failure, in the same age group (Adelborg et al., 2016; Hammond et al., 2018; Hjelm et al., 2014). The differences in 3MSE cognitive scores of those with heart failure subtracted from those without were statistically significant across all age groups to 90 years old. This finding is important as the change in score was measured in the same age group of the general population at the time of diagnosis in the group with heart failure. The score differences were larger at older ages. While more research needs to be done in this area, it could raise the question if having a lower cognitive reserve as one ages makes one more vulnerable to the effects of heart failure (Plassman et al., 2007).

Our literature search did not find any studies that identified characteristics specific to persons over the age of 80 years with heart failure who develop cognitive impairment. In fact, the population of 80 years and over was not the focus of most of the studies for review, instead a small subset. This is not unexpected as enrolling the elderly into research studies has proven difficult in part due to comorbidities, including dementia (Masoudi et al., 2003; Piantadosi, et al., 2015). This barrier can be avoided through the use of retrospective studies that use large databases of national registries, medical records, or insurance claims data. However, the compromise is using pre-determined findings such as physician diagnosis, which may contribute little to the specifics of cognitive impairment (Adelborg et al., 2016; Chitnis et al., 2015). Subsequently, a lack of older adults in research studies will lead to the development of guidelines for self-care that includes people with all levels of physical and cognitive abilities.

Several limitations were associated with this study. First, the lack of homogeneity among the studies in measurement and definitions made it difficult to draw larger conclusions about the >80 population living with heart failure and cognitive impairment, especially when some studies showed a difference among those who were 80 versus 85. Next, the lack of studies specific to this population was surprising and disappointing, as most papers on heart failure acknowledge the rise in the aging of people with heart failure along with the wide range of cognitive impairment. Finally, studies using claims data for cognitive impairment may only represent the population that received care for it. In addition, the studies conducted in the hospital population may be choosing the sicker patients. In both these scenarios rates could appear higher than they are.

Conclusions

The aim of this review was to understand the impact of age and heart failure on an individual's cognition. We found that age, whether over 80 or 85 years of age, has an influence on cognition that is different in those with heart failure than those without heart failure. Additionally, we have some indication there is a difference in cognition between those in their early eighties versus those in their mid to late eighties with heart failure. However, there remains a considerable amount of work to better understand this population in terms specifically how is their cognition impacted and how does this effect their ability to care for themselves. Future research is necessary to understand the differences among octogenarians and the specific cognitive deficits so specific interventions can be developed to keep our oldest old healthy.

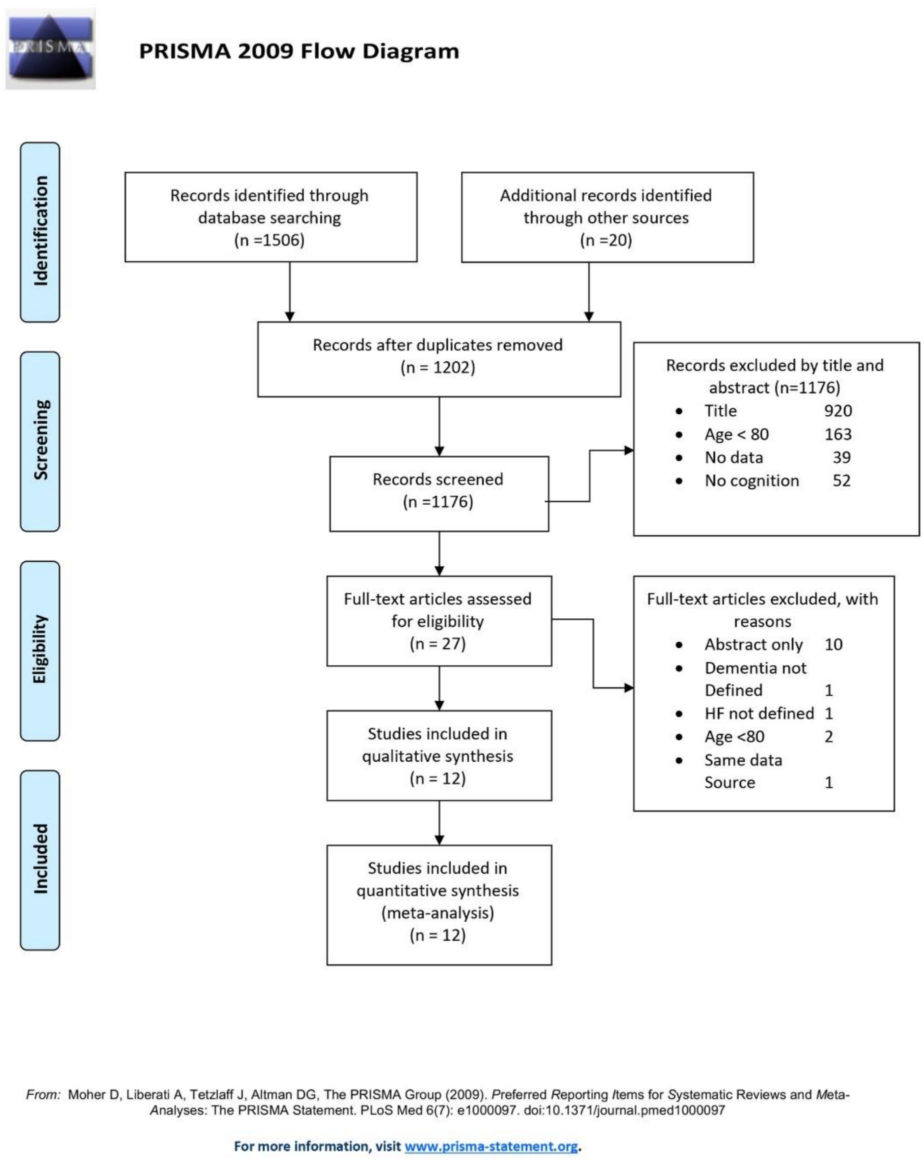

Figure 1
Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Diagram for Article Selection

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Appendix 1

Search Strategy

Search Strategy

PubMED 574	(("Heart Failure"[Mesh] OR "Heart Failure, Diastolic"[Mesh] OR "Heart Failure, Systolic"[Mesh] OR Cardiac Failure OR Heart Decompensation OR Right-Sided Heart Failure OR Myocardial Failure OR Congestive Heart Failure OR Left-Sided Heart Failure OR Diastolic Heart Failures OR Diastolic Heart Failure OR Systolic Heart Failures OR Systolic Heart Failure OR Acute heart failure) AND ("Cognition"[Mesh] OR Cognitions OR Cognitive Function OR Cognitive Functions OR Cognitive Dysfunctions OR Dysfunction, Cognitive OR Cognitive Impairments OR Cognitive Impairment OR Mild Cognitive Impairment OR Mild Cognitive Impairments OR Mild Neurocognitive Disorder OR Mild Neurocognitive Disorders OR Cognitive Decline OR Cognitive Declines OR memory OR executive function)) AND ("Aged, 80 and over"[Mesh] OR "very elderly" OR Oldest Old OR Nonagenarians OR Nonagenarian OR Octogenarians OR Octogenarian OR Centenarians OR Centenarian) AND ((y_10[Filter]) AND (80andover[Filter]))
EMBASE 595	'heart failure'/exp OR 'heart failure' OR 'systolic heart failure'/exp OR 'systolic heart failure OR 'diastolic heart failure'/exp OR 'diastolic heart failure OR 'congestive heart failure'/exp OR 'congestive heart failure' OR 'acute heart failure'/exp OR 'acute heart failure' OR 'heart failure with preserved ejection fraction'/exp OR 'heart failure with preserved ejection fraction' OR 'heart failure with reduced ejection fraction'/exp OR 'heart failure with reduced ejection fraction' NOT 'atrial fibrillation' NOT 'cardiogenic shock' NOT 'heart arrest' NOT 'cardiopulmonary arrest' NOT 'resuscitation' NOT 'heart edema' NOT 'myocarditis' AND 'very elderly'/exp OR 'very elderly' OR (very AND ('elderly'/exp OR elderly)) OR oldest AND old OR 'oldest old' AND ('executive function'/exp OR 'cognition'/exp OR 'attention'/exp OR 'cognitive decline'/exp OR 'cognitive defect'/exp OR memory) NOT delirium NOT postoperative NOT skill NOT perception NOT 'personal experience' NOT awareness NOT amnesia NOT 'left hand' NOT comprehension NOT learning NOT consciousness NOT 'medical decision making' NOT 'decision making' AND [very elderly]/lim AND (2010:py OR 2011:py OR 2012:py OR 2013:py OR 2014:py OR 2015:py OR 2016:py OR 2017:py OR 2018:py OR 2019:py OR 2020:py)
CINHAL 222	heart failure or cardiac failure or CHF or chronic heart failure or congestive heart failure Expanders - Apply equivalent subjects Search modes - Boolean/Phrase AND (aged, 80 and over) OR very elderly OR octogenarian OR nonagenarian OR centenarians OR oldest old) NOT Middle Aged: 45-64 years NOT Adult: 19-44 years Expanders - Apply equivalent subjects Search modes - Boolean/Phrase AND (cognition or cognitive function) OR cognitive impairment OR cognitive decline OR executive function OR memory NOT (anxiety and depression) NOT delirium
Web of Science 29	TS=(heart failure OR systolic heart failure OR diastolic heart failure OR congestive heart failure OR preserved ejection fraction OR reduced ejecti on fraction) NOT TS=atrial fibrillation NOT TS=hypertension *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC Timespan=2010-2020*TS=("oldest old" OR "very elderly" OR octogenarian OR nonagenarian OR centenarian) *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC Timespan=2010-2020* TS=(cognition OR Cognitions OR Cognitive Function OR Cognitive Functions OR Cognitive Dysfunctions OR Dysfunction, Cognitive OR Cognitive I mpairments OR Cognitive Impairment OR Mild Cognitive Impairment OR Mild Cognitive Impairments OR Mild Neurocognitive Disorder OR Mild Neurocognitive Disorders OR Cognitive Decline OR Cognitive Declines OR memory OR executive function) NOT TS=delirium NOT TS=confusion *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC Timespan=2010-2020*
Psych INFO 86	((heart failure) OR (heart failure, systolic) OR (systolic heart failure) OR (Diastolic Heart Failure) OR (heart failure, diastolic) OR (congestive heart failure) NOT (atrial fibrillation) NOT hypertension) AND (('aged 80 and over') OR ('aged, 80 and over') OR ("very elderly") OR octogenarian OR octogenarians OR nonagenarian OR nonagenarians OR centenarian) AND (cognition OR (cognitive function) OR "cognitive assessment" OR "cognitive decline" OR mild cognition impairment OR "executive Function" OR "memory" NOT delirium NOT confusion)Limits applied (years 2010-2020)

Appendix 2

Articles Not Included

Articles Not Included

Article	Exclusion
Arslanian-Engoren, C., Giordani, B. J., Algase, D., Schuh, A., Lee, C., & Moser, D. K. (2014). Cognitive dysfunction in older adults hospitalized for acute heart failure. *Journal of Cardiac Failure*, *20*(9), 669-678.	Data was not specific to 80 and over population
Baldasseroni, S., Mossello, E., Romboli, B., Orso, F., Colombi, C., Fumagalli, S., ... & Marchionni, N. (2010). Relationship between cognitive function and 6-minute walking test in older outpatients with chronic heart failure. *Aging Clinical and Experimental Research*, *22*(4), 308-313.	Data was not specific to 80 and over population
Chaudhry, S. I., McAvay, G., Chen, S., Whitson, H., Newman, A. B., Krumholz, H. M., & Gill, T. M. (2013). Risk factors for hospital admission among older persons with newly diagnosed heart failure: Findings from the Cardiovascular Health Study. *Journal of the American College of Cardiology*, *61*(6), 635-642.	Cognition data was not specific to 80 and over population
González-Guerrero, J. L., Alonso-Fernández, T., García-Mayolín, N., Gusi, N., & Ribera-Casado, J. M. (2015). Effect of a follow-up program in elderly adults with heart failure with cognitive impairment after hospital discharge. *Journal of the American Geriatrics Society*, *63*(9), 1950-1951.	Data was not specific to 80 and over population
Hjelm, C., Dahl, A., Broström, A., Mårtensson, J., Johansson, B., & Strömberg, A. (2012). The influence of heart failure on longitudinal changes in cognition among individuals 80 years of age and older. *Journal of Clinical Nursing*, *21*(7-8), 994-1003.	Duplicate data source by same author chosen for review.
Huijts, M., Van Oostenbrugge, R. J., Duits, A., Burkard, T., Muzzarelli, S., Maeder, M. T., ... & Brunner-La Rocca, H. P. (2013). Cognitive impairment in heart failure: Results from the trial of intensified versus standard medical therapy in elderly patients with congestive heart failure (TIME-CHF) randomized trial. *European Journal of Heart Failure*, *15*(6), 699-707.	Data was not specific to 80 and over population
Kitamura, M., Izawa, K. P., Ishihara, K., Yaekura, M., Nagashima, H., Yoshizawa, T., & Okamoto, N. (2021). Predictors of activities of daily living at discharge in elderly patients with heart failure with preserved ejection fraction. *Heart and Vessels*, *36*(4), 509-517.	Data was not specific to 80 and over population
Muñoz, M. A., Real, J., Del Val, J. L., Vinyoles, E., Mundet, X., Frigola-Capell, E., ... & Verdú-Rotellar, J. M. (2016). Determinants of survival and hospitalization in older, heart	Data was not specific to 80 and over population

Articles Not Included

failure patients receiving home healthcare. *International Journal of Cardiology*, *207*, 145-149.	
Nordlund, A., Berggren, J., Holmström, A., Fu, M., & Wallin, A. (2015). Frequent mild cognitive deficits in several functional domains in elderly patients with heart failure without known cognitive disorders. *Journal of Cardiac Failure*, *21*(9), 702-707.	Data was not specific to 80 and over population
Pierobon, A., Granata, N., Torlaschi, V., Vailati, C., Radici, A., Maestri, R., ... & Giardini, A. (2020). Psychomotor speed as a predictor of functional status in older chronic heart failure (CHF) patients attending cardiac rehabilitation. *Plos One*, *15*(7), e0235570.	Data was not specific to 80 and over population
Piotrowicz, K., Fedyk-Łukasik, M., Skalska, A., & Grodzicki, T. (2018). Is the Clock Drawing Test useful in the screening assessment of aged patients with chronic heart failure? *Advances in Medical Sciences*, *63*(1), 199-204.	Data was not specific to 80 and over population
Rodriguez-Pascual, C., Paredes-Galan, E., Vilches-Moraga, A., Ferrero-Martinez, A. I., Torrente-Carballido, M., & Rodriguez-Artalejo, F. (2014). Comprehensive geriatric assessment and 2-year mortality in elderly patients hospitalized for heart failure. *Circulation: Cardiovascular Quality and Outcomes*, *7*(2), 251-258.	Data for cognitive function was not available in the 80 and over population
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Song, E. K., & Wu, J. R. (2018). Associations of vitamin D intake and sleep quality with cognitive dysfunction in older adults with heart failure. *The Journal of Cardiovascular Nursing*, *33*(4), 392-399.	Data was not specific to 80 and over population
Yaku, H., Kato, T., Morimoto, T., Inuzuka, Y., Tamaki, Y., Ozasa, N., ... & Kimura, T. (2020). Risk factors and clinical outcomes of functional decline during hospitalisation in very old patients with acute decompensated heart failure: an observational study. *BMJ open*, *10*(2), e032674.	Did not contain any data regarding cognition status.

Appendix 3

CASP Quality Assessment

Critical Appraisal Skills Program (CASP) Quality Assessment

	Focus issue	Recruitment	Minimize Bias (exposure)	Accurate measure of outcome	Confounding factors identified + included in design	Follow up complete and in appropriate time	Results	Precision of results	Believe results	Applicable to general population	Agreement with other studies	Implication of study
Adelborg et al.	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	Y	Y
Biagi et al.	Y	Y	Y	M	N	NA	N	NA	Y	Y	Y	Y
Chintis et al.	Y	Y	Y	M	N	NA	Y	Y	Y	Y	Y	Y
Conde et al.	Y	Y	Y	M	N	NA	Y	Y	Y	Y	Y	Y
Del Sindaco et al.	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y	Y
Hammond et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hjelm et al.	Y	Y	Y	M	N	Y	Y	Y	Y	Y	Y	Y
Kim et al.	Y	Y	M	Y	Y	NA	Y	Y	Y	Y	Y	Y
Klarins et al.	Y	Y	Y	M	NA	NA	Y	Y	Y	Y	Y	Y
Levin et al.	Y	Y	Y	Y	N	NA	Y	Y	Y	Y	Y	Y
Selan et al.	Y	Y	Y	M	N	NA	Y	N	Y	Y	N	Y

(Y=met criteria; M=moderately met criteria; N= did not meet criteria; NA=Not Applicable)

The Relationship between Physical Activity on Quality of Life and Perceived Health in Older Adults with Coronary Heart Disease

Abstract

Background: People living with coronary heart disease (CHD) experience decline in physical and social functioning as well as an increase in depressive symptoms, thereby diminishing their perceived health and quality of life (QOL). Evidence shows that physical activity in the adult population is known to be associated with improved QOL and better perceived health.

Objective: Describe the association between physical activity and perceived health as well as QOL among older adults with long-standing CHD (>20 years).

Methods: In this cross-sectional study, 20-year follow-up survey data were collected from 126 survivors from the Heart and Soul prospective cohort study. Ordinal logistic regression was applied to identify unadjusted and adjusted variables. Nested logistic regression models were used to identify significant variables associated with perceived health and QOL with a four-level model.

Results: The mean age of the subjects was 80.9 ± 9.1 years; 71.8% (n=94) were males, less than half were physically active (47.3%, n=62) and 23.7% had heart failure. There was a positive association between being physically active and perceived health after adjusting for socioeconomic status, physical activity, and activities of daily living (*aOR*=2.316, *p*=.023) The association between physical activity and these adjusted variables with QOL was also strong (*aOR*=2.070, *p*=.046). The diagnosis of heart failure was associated with lower QOL after adjustments (*p*<.033).

Conclusions: Older adults with long term CHD who engage in physical activity have higher QOL and perceived health, which are important patient reported outcomes (PRO). Heart failure and low income were related to lower QOL and were not improved by physical activity.

Key words: Chronic coronary heart disease, older adult, perceived health, overall quality of life, physical activity, self-care

The Relationship between Physical Activity on Quality of Life and Perceived Health in Older Adults with Coronary Heart Disease

People living with coronary heart disease (CHD) experience decline in physical and social functioning as well as increases depressive symptoms diminishing their perceived health and quality of life (QOL) (De Leon et al., 1998; Xie et al., 2008). Documented symptoms of angina, fatigue, and dyspnea impact activities of daily living contributing to poor QOL and lower perceived health (Dunlay et al., 2015; Heo et al., 2009; Manolis et al., 2019). Understanding the impacts to CHD patients' QOL and perceived health acknowledges a more holistic view of a patient with CHD and can improve clinical assessment, treatment, and support as well as guidance in self-care behaviors.

Quality of life and Perceived Health

Quality of life can be defined as "patients' appraisal of and satisfaction with their current level of functioning compared to what they perceive to be possible or ideal" (Cella & Cherin, 1988). Conceptually, QOL is a self-reported assessment of physical health, psychological, social relationships, relationship to their environment and facets specific to aging when appropriate (World Health Organization [WHO], 1998a). Perceived health is a holistic patient perspective as it relates to their state of physical and mental health, and well-being (WHO, 1946). Evidence has shown that patient reported outcomes (PROs) such as perceived health and QOL are associated with conventional outcomes such as readmissions and effectiveness of treatment (Dalsgaard et al., 2022; Mols et al., 2023; Rasmussen et al., 2021). More importantly, because symptoms vary by individual circumstances, disease state and severity, a PRO inclusive of both QOL and perceived health provides an absolute interpretation of the patient's burden of disease (Weldring & Smith, 2013). Similarly, responses from PROs are clinically meaningful as they suggest an opportunity for further patient management and engagement (Kornowski, 2023; Rasmussen et al., 2021).

Physical Activity, Quality of Life and Perceived Health

Evidence shows that physical activity in the adult population is known to be associated with improved QOL (Marquez et al., 2020; Vagetti et al., 2014; Zubala et al., 2017) and better perceived health (Awick et al., 2017; Eifert et al., 2014; Kaleta et al., 2006). In the population living with CHD, physical activity contributes to the control of cholesterol, blood pressure, glucose and weight (Agarwal, 2012; Hegde & Solomon, 2015; Leitzmann et al., 2007; Muscella et al., 2020; Myers, 2003), in addition to lowering rates of mortality and morbidity (Loprinzi & Addoh, 2016; Winzer et al., 2018). To achieve significant health benefits, it is recommended that adults participate in 150-300 minutes of moderate-intensity exercise or 75-150 minutes of vigorous-intensive activity and two strength training session per week (Piercy et al., 2018). For adults experiencing new or recent CHD, participation in a comprehensive cardiac rehabilitation, which includes an exercise program, is associated with lower mortality (O'Connor et al., 1989; Suaya Jose et al., 2009), better QOL (Lavie & Milani, 1995; Marchionni et al., 2003) and significant improvements in physical limitations, pain, vitality and general health (Saeidi et al., 2013) which may impact perceived health. Follow up after the completion of the program found the benefits to QOL were sustained at 6 months (Terada et al., 2022) with reduced mortality from cardiac disease (O'Connor et al., 1989) and increased physical activity at one year (Gupta et al., 2007).

Aging and Physical Activity

Unfortunately, when heart disease coincides with the dynamic process of natural aging, which include comorbidities, social, and economic changes, people with CHD may not be able to achieve the recommended amount of moderate-vigorous exercise, thus missing the benefits of exercise that can be gained in the older adult (Bethancourt et al., 2014; Chen et al., 2022). Yet, physical activity can positively influence barriers such as endurance, balance, risk of injury, and cognition through improved mobility, gait, and balance (Chodzko-Zajko et al., 2009). Furthermore, in the older adult, physical activity can contribute to improved QOL (Chou et al., 2012; Valenzuela et al., 2019) as well as protect against dementia and its further decline (Groot et al., 2016; Sofi et al., 2011). In the population living CHD, interventions based on structured or supervised physical activity have been associated with improved QOL (Marchionni et al., 2003; Vasankari et al., 2021; Wang et al., 2012). In patients with stable coronary disease, self-reported good health has been associated with physical activity, whereas poor/average health has been associated with higher risk of myocardial infarction (MI) and mortality (Stewart et al., 2017).

Study Aim

There is a gap in the literature on the benefits of physical activity (except in structured exercise programs) for older adults living with chronic CHD. The aim of this study was to determine the association between physical activity and the outcomes of perceived health status and overall QOL in patients who have lived with CHD for at least two decades.

Methods

We employed a cross-sectional study design by surveying survivors of the Heart and Soul study, which sought to investigate the influence of psychosocial conditions on clinical outcomes of people living with stable CHD (Whooley & Schiller, 2022). As a prospective cohort study, Heart and Soul collected an extensive amount of data starting in 2000 and 2002 (baseline) and at five years with regular follow up of morbidity and mortality outcomes. Details and methods of this study have been previously described (Beattie et al., 2003; Bibbins-Domingo et al., 2003; Gehi et al., 2003). In brief, participants were eligible for the study if they met at least one of the following criteria: history of MI, angiographic evidence of at least 50% stenosis in one or more coronary vessels, prior evidence of inducible ischemia by treadmill or nuclear testing, or a history of coronary revascularization Exclusion criteria included: MI in prior 6 months, unable to walk > 1 block (treadmill test not useful) or planning to move out of area within 2 years making them unavailable for follow-up.

A total of 1,024 participants were enrolled in the Heart and Soul Study (Whooley & Schiller, 2022) from 12 San Francisco Bay area outpatient clinics, including 549 (54%) with a history of MI, 237 (23%) with a history of revascularization without an MI, and 238 (23%) with a diagnosis of CHD documented by their physician with a positive treadmill test or angiography in >98% of the cases. All participants completed a full-day examination including demographics, personal history, medical history, blood work, echocardiograms, treadmill tests and extensive questionnaires assessing depression, symptoms, activity, and psychosocial factors.

For the current study, 168 known survivors of the Heart and Soul Study (Whooley & Schiller, 2022) were mailed questionnaires in February 2022, based on regular tracking of mortality over 20 years. In the welcome letter mailed with the paper questionnaires, participants were asked to call one of the study coordinators to participate in a cognitive assessment using the Pfeiffer Short Portable Mental Status Questionnaire (SPMSQ). At the time of the phone call, the SPMSQ was explained to participants and verbal consent was obtained. We called individuals to invite participation if they did not respond to the mailed questionnaires.

The study protocol was approved by the following Institutional Review Boards: The University of California San Francisco Committee on Human Research, the Research and Development Committee at the San Francisco VA Medical Center, the Medical Human Subjects Committee at Stanford University, the Human Subjects Committee at the VA Palo Alto Health Care System, and the Data governance Board of the Community Health Network of San Francisco. Institutional review board (IRB) approval for “The Heart and Soul Study: Epidemiology of Depression and Heart Failure in Aging” (IRB #10-01301) was obtained and the modification for this study received approval on 1/13/2022.

Data Collection

Perceived Overall Health as Primary Outcome

The primary outcome of perceived health was assessed using a single-item question identical to that in the baseline survey “Compared to other people your own age, how would you rate your overall health? (poor=1, fair=2, good=3, very good=4, excellent=5)?" The higher the score, the higher the perceived health of the participant. The single-item self-reported health (SRH) question has been evaluated in multiple countries, by age, gender, general health to specific illness, compared to mortality, mobility, and function. For persons >65 years of age, when compared to the score "excellent", the risk of all-cause mortality increased with each lower category of health (good [*RR*: 1.23, *CI* 1.09-1.39], fair [RR: 1.44, *CI* 1.21-1.71] and poor [*RR*: 1.92, *CI* 1.64-2.25]) (DeSalvo et al., 2006). In participants who reported poor perceived health, the risk of mortality was higher in the short term and the long term (*OR*: 2.92, *OR*: 2.77, respectively) when compared to those reporting excellent health (Mossey & Shapiro, 1982). Significant concurrent validity was found in the general population with physician assessment (r=.409, p<.01) (LaRue et al., 1979) and among women with symptoms (r=-.39, p<.01), medications (r=-.388, p<.01), and perceived well-being (r=.569, p<.01) (Cousins, 1997). In older adults, there was excellent reliability, with test-retest of 85% (Lundberg & Manderbacka, 1996). Based on this evidence, the single-item, SRH question was chosen as the study's main assessment of perceived health by participants.

Quality of Life as the Primary Outcome

The primary outcome of overall QOL was assessed using a single-item question identical to the baseline survey: "Compared to other people your own age, how would you rate your overall quality of life (poor=1, fair=2, good=3, very good=4, excellent=5)?" The higher score the score, the higher the self-scoring of QOL of the participant. The single-item self-reported QOL question has been evaluated in studies involving individuals or parents of children with disabilities (Siebens et al., 2015; Yohannes et al., 2011). In children with epilepsy, the single question response given by their parents correlated with the composite scores from reliable and valid QOL questionnaires, including Global Quality of Life in Childhood Epilepsy questionnaire (G-QOLCE-76) and KIDSCREEN-27 ($r \geq .53$ and $r \geq .51$, p=.001) (Conway et al., 2018). The test-retest reliability at baseline and 6 months (ICC: 0.49-0.72) (Conway et al., 2018), however, another study found the test retest high (.86, $p<.001$) (Atroszko et al., 2015). Prior studies using the single question QOL measure in older adults was lacking. However, the question posits a person to compare themselves to peers of similar age, which supports face validity and ease of QOL self-scoring. The single-item, self-reported QOL question was adopted as the Heart and Soul Study's main assessment of personal QOL by participants (Odden et al., 2006; Ruo et al., 2003).

Physical Activity as the Primary Predictor

As a component of self-care, physical activity, was considered the primary predictor of the proposed outcome. To assess physical activity, a single-item question identical to the baseline survey was posed "Which of the following statements best describe how physically active you have been during the last month, that is, done activities such as 15-20 minutes of brisk walking, swimming, general conditioning, or recreational sports?" The participants chose one from the following 6 responses:

1. not at all active
2. a little active (1-2 times per month)
3. fairly active (3-4 times per month)
4. quite active (1-2 times per week)
5. very active (3-4 times per week)
6. extremely active (≥5 times per week)

For the multiple regression analysis, low activity group was defined as not at all active or a little active whereas the high activity group answered fairly active, quite active, very active, or extremely active. This classification of physical activity is consistent within the Heart and Soul cohort (Whooley, 2022) and has been shown to be a predictor of CHD events and rates of CHD (Jarvie et al., 2014; Whooley et al., 2008). Physical activity was used as a continuous variable in the mediation analysis. The single-item of self-reported physical activity has been shown to have construct validity when compared to VO_{2max} to reported daily exercise (R^2=.76, p<.001)

(Aadahl et al., 2007), and a cardiorespiratory test to compared to level of activity (*r*=.57, p<.001) (Jackson et al., 2007). A study on cardiovascular fitness reported reliability of the single-item physical activity questionnaire (*r*=.85) (Ainsworth et al., 1993). Based on this evidence, the single-item, physical activity question was chosen as this study's main assessment of performance of physical activity by study participants.

Covariates

Non-modifiable factors that are known to have an impact on QOL were considered for evaluation such as age, depression, income, education, and comorbidities (Blazer et al., 1991; Ross & Van Willigen, 1997; Ross & Wu, 1995). Age was calculated based on date of birth to the date of current mailings. Utilizing baseline data and definitions from the study's baseline questionnaire, income was dichotomized as lower than $20,000/year and equal to greater than $20,000/year. Education was dichotomized to less than or equal to high school and greater than high school. Because heart failure diagnosis is known to impact QOL, (Dracup et al., 1992; Heo et al., 2009; Moradi et al., 2020) the diagnosis was obtained from the baseline data. Additionally, current medical records were reviewed for new diagnosis of heart failure and confirmed with ICD-10 codes or physician documented diagnosis of heart failure.

Cognitive function was assessed using the validated and reliable SPMSQ. SPMSQ for cognitive function is a 10-item questionnaire that is scored on a scale of 0 (best cognitive function) to 10 (worst cognitive function). The SPMSQ score equals the total number of incorrect answers, with 0-2 incorrect answers considered normal cognition and greater than 2 errors indicating cognitive impairment (Pfeiffer, 1975; Smyer et al., 1979). Mild impairment (3-4 errors) is known to have 82% agreement with dementia diagnosis while over 4 errors have a 91% agreement and test/retest of *r*=.82 (Pfeiffer, 1975). When performed by telephone the scores correlated with Mini Mental State Exam (MMSE) (*r*=.73, *p*=.001) with 74% sensitivity and 79% specificity for dementia diagnosis (Roccaforte et al., 1994). The strong reliability and validity evidence of the SPMSQ being used for cognitive assessment of the aging population supported its use in this study.

Instrumental activities of daily living (IADL) were self-reported in which the scale consists of 8 items: using a telephone, driving a car, shopping, providing meals, doing housework, doing laundry, taking medicines, and handling money. Each of the items is scored 0=receives no assistance, 1=receives some assistance, or 2=unable to do alone. Scores are added for a total IADL score that ranges from 0 to 16, with higher scores indicating worse functional status. The reliability was excellent with Cronbach's *α* was previously reported as .9 and .78 (Lawton et al., 1982; Sikkes et al., 2009). The IADL was adopted as this study's assessment of self-evaluation of instrumental functional status.

Self-reported activities of daily living on the Katz scale consisted of 8 items on bathing, dressing, toileting, transferring, feeding, walking, incontinence (average urine and bowel), and house confinement. Each item is scored 0 = receives no assistance, 1=receives some assistance, or 2=unable to do alone. Total scores range from 0 to 16 with higher scores indicating worse function. A widely used assessment, the literature for validity and reliability is found among diverse populations living outside of the United States with a good to excellent Cronbach's α of .838-.94 (Arik et al., 2015; Reijneveld et al., 2007) and in stroke patients .94 (Lindmark & Hamrin, 1988) . The test-retest reliability was perfect at (1.0, 95% confidence level [CI] 1.0-1.0) and high inter-rater reliability (ICC 0.999, CI 95% 0.999-1.000) (Reijneveld et al., 2007). There was fair association with long term mobility limitations and SF-36 physical functioning ($r(296)$ -.60, p<.001) (Reijneveld et al., 2007) and the Barthel Index (r^2=.988, p<0.001) (Arik et al., 2015) The self-reported Katz activities of daily living scale was an excellent fit for this study based on evidence and support for use in diverse populations.

The Patient Health Questionnaire 8 (PHQ 8) is an 8-item questionnaire to assess the presence of depressive symptoms and severity. PHQ 8 consists of 8 of the 9 criteria used by the DSM-IV for the diagnosis of depression. The PHQ-8 does not include the question regarding suicidal ideation but is found to be highly correlated to the PHQ-9 (Kroenke & Spitzer, 2002; Kroenke et al., 2009). The eight questions (little interest or pleasure, feeling down or hopeless or depressed, trouble sleeping, feeling tired, low energy, loss of appetite or overeating, feeling about yourself, trouble concentrating, moving slowly) are scored 0 to 3 (not at all to nearly every day). The score of all questions were added to give a continuous range 0 to 27 where higher scores indicate worse depression. Moderate to severe depressive symptoms scores were 10 or greater. There was good reliability for the PHQ 9 when the score was greater than or equal to 10 (Cronbach's α .89; test retest .84; sensitivity and specificity .88) (Kroenke et al., 2001) and for the PHQ-8, score range 0-24 and cut point of 10 (Cronbach's α .82) (Pressler et al., 2011). The strong reliability and validity evidence of the PHQ-8 being used for depressive symptom assessment of the aging population supported its use in this study.

Statistical Analysis

The baseline characteristics were summarized, with categorical variables presented as counts, and proportions, and continuous variables presented as mean and standard deviation or median and interquartile range if skewed. For scales missing $\leq$ 30% of items, the total score was calculated by dividing the sum of completed items by the proportion of items complete multiplied by the number of questions (i.e., assuming any missing question should have a value equal to the average of all present responses). Any score with >30% missing was considered missing and was removed from the dataset. Data were evaluated for distribution and to characterize the study sample. ADL and IADL were skewed right toward higher independence and were dichotomized to scores 0-2 considered as higher independence. Due to the ordinal characteristic of the outcome variables, the associations between different covariates and self-reported items were calculated using ordinal logistic regression using MASS Package v7.3.54 (Venables & Ripley, 2013) in R v4.1.2 (R Core Team, 2021) for the primary analyses. The results are reported as odds ratio (OR) with 95% confidence interval. The ORs describe the associations of different covariates with increasing levels of self-reported health and self-reported overall QOL. For the test of race/ethnicity the baseline was set to white. The significance level was set as $p<.05$ a priori.

In the multivariable models, covariates chosen for logistic regression nested models for perceived health and overall QOL were based on variables of significance from the ordinal regression and those reported in the literature. The first model included socioeconomic status (SES) and consisted of age, income, and education. The second model added medical history including heart failure and cognition. The third model added physical activity and the fourth model for physical function added ADL. Models were fit using a multiple imputation approach with 50 imputations using the mice v3.14.0 R package (van Buuren et al., 2011). Most variables had near complete data, with the exception of cognition (missing on 27.7% of individuals).

Results

Participant Characteristics

Baseline characteristics of the participants are shown in Table 2.1. Among the 168 participants who were sent questionnaires 126 were included in the analysis (6 were dropped due to missing data, 12 were deceased, and 24 were lost to follow up) and 93 were included in analysis that involved cognition. The mean age was 80 years old (SD=9.1), and 71.8% were male. Based on information from the baseline data obtained in 2000, most participants obtained an education level beyond high school (80.2%), though more than half reported an income of <$20,000 (53.4%). Heart failure history was noted in 23.7%, and the majority had intact cognition (2 or less errors on the SPMSQ) (89%). Physical activity was reported in 47.3% of participants, with most reporting no to minimal assistance with their ADLs (81.7%) and slightly fewer reporting no to minimal assistance with IADL (64.1%). The majority perceived health as good or higher (63.4%) and overall QOL as good or higher (70.2%).

Table 2.1

Heart and Soul Study Characteristics

	N (%)
Demographics	
Age (y) mean/SD	80.9 ± 9.1
>=80 (y)	71 (54.2)
Male gender	94 (71.8)
Race	
White or Caucasian	73 (55.7)
Black or African American	18 (13.7)
Asian or Pacific Islander	21 (16)
Hispanic, Latino, or Latin American	12 (9.2)
Other	5 (3.8)
Socioeconomic Status (SES)	
Income <$20,000 (baseline)	70 (53.4)
Education <=high school (baseline)	24 (18)
Medical History/Status	
Heart Failure	31 (23.7)
Cognition Status (SPMSQ)[1]	
Cognition intact (0-2 errors)	83 (63.4)
Cognition impaired (> 2 errors)	10 (7.6)
Cognition missing	38 (29)
Self-reported Measures	
Depressive Symptoms (PHQ-8)[2]	
None	73 (58.8)
Mild	30 (24.1)
Moderate	12 (9.6)
Severe	9 (7.2)
Physically active	62 (47.3)
ADL (Katz): independent (0-2)	107 (81.7)
IADL (Lawton): independent (0-2)	84 (64.1)
Perceived health	
Excellent	11 (8.4)
Very Good	30 (22.9)
Good	42 (32.1)
Fair	35 (26.7)
Poor	8 (6.1)
Missing	5 (3.8)
Overall QOL	
Excellent	21 (16)
Very Good	36 (27.5)
Good	35 (26.7)
Fair	25 (19.1)
Poor	9 (6.9)
Missing	5 (3.8)

1-Short Portable Mental Status Questionnaire 2-Patient Health Questionnaire (8-item)

Ordinal Logistic Regression

The results of the univariable ordinal logistic regression analysis of the outcome variable perceived health and QOL are shown in Table 2.2. The results show that an income of <$20,000 was significantly associated with lower perceived health (*OR* .42, *p*<.001) and QOL (*OR* .35, *p*<.001) when compared to participants with income =>$20,000. Depression was also associated with lower perceived health and quality of life (*OR* .114, *p*<.001; *OR* .079, *p*<.001). ADL (Katz) and (*OR* 5.62, *p*=.001), instrumental ADL (*OR* 3.84 *p*<.001), and physical activity (*OR* 3.0, *p*<.001;) were significantly associated with higher scores for both perceived health. Additionally, heart failure was significantly associated with lower QOL (*OR* .432, *p*=.027). None of the demographic variables (age, gender, race, and education) were significantly associated with either perceived health or QOL.

Table 2.2
Ordinal Logistic Regression with Perceived Health and Overall QOL

	Perceived Health				Overall QOL			
	OR	CI	P-value	N	OR	CI	P-value	N
Demographics								
Age >=80	1.29	0.684,2.45	.43	126	1.13	.602, 2.11	.71	126
Male	1.36	0.667, 2.76	0.4	126	1.59	0.785, 3.21	.2	126
Race								
Black	0.58	0.23, 1.42	.23	126	.64	0.22, 2.15	.31	126
Asian/Pacific Islander	0.83	0.34,2.02	.68	126	0.79	0.32,1.93	.6	126
Hispanic/Latino	0.638	0.209, 1.94	.43	126	0.687	0.22,2.15	.52	126
Other	2.47	0.469,13	.29	126	3.18	0.584,17.3	.18	126
Socioeconomic Status								
Income <=$20,000	**0.42**	**0.219, 0.806**	**.009**	125	**0.352**	**0.184,0.674**	**.001**	**125**
Education <= high school	0.567	0.258,1.25	.16	126	0.575	0.262,1.26	.17	126
Medical History/Status								
Heart failure	0.51	0.238, 1.09	.083	126	**0.432**	**0.206,0.908**	**.027**	**126**
Cognition intact	1.68	0.477, 5.95	.42	91	1.73	0.43,6.9	.44	91
Measurements								
Depressive symptoms: mod/severe	**0.114**	**0.0441, 0.297**	**<.0001**	**123**	**0.0792**	**0.206,0.211**	**<.001**	**123**
ADL (Katz)	**5.62**	**2.15, 14.7**	**<0.001**	**125**	**3.33**	**1.37, 8.08**	**0.008**	**125**
Instrumental ADL	**3.84**	**1.9, 7.77**	**<0.001**	**126**	**2.92**	**1.46, 5.83**	**0.002**	**126**
Physically active	**3**	**1.54, 5.81**	**0.001**	**123**	**2.82**	**1.47, 5.42**	**<0.001**	**123**

*Higher scores for perceived health and overall QOL indicate better health and QOL

Multivariable Regression Analysis with Nested Models

In Table 2.3, Model 1 shows that adults aged 80 and above have a perceived health adjusted *OR* (*aOR*) of 1.76, but this is not statistically significant (*p*=.11). Having an education level of high school or lower (*OR*=.567, *p*=.019), is significantly associated with lower perceived health as was an income <$20,000 (*OR*=.417, *p*=.012), however only income remained significant when adjusting medical history variable in Model 2 (*aOR*= .417, p=.049). Physical activity is associated with higher perceived health in Model 3 (*aOR*=2.691, *p*<.01). Finally, functional status in Model 4, as measured by ADL (Katz), is significantly associated with perceived health (*aOR*=4.485, $p<.007$) and physical activity remained significant (*aOR* 2.31, $p=.023$).

Overall QOL shows similar associations (Table 2.4). Income <\$20,000/year is significantly associated with lower overall QOL (*aOR*=0.458, $p=.03$), as is a history of heart failure (*aOR*=0.431, $p=.033$) when adjusted for SES and physical activity. Physical activity is associated with higher overall QOL (*aOR*=2.070, $p=.046$).

Table 2.3

Multivariable Regression Perceived Health

Table 2.3

Multivariate Regression Perceived Health

	MODEL 1			MODEL 2			MODEL 3			MODEL 4		
	OR	Confidence Interval	P value	OR	Confidence Interval	P value	OR	Confidence Interval	P value	OR	Confidence Interval	P value
Demographics/SES												
Age >=80	1.76	0.887, 3.499	.11	1.597	0.792,3.223	.19	1.530	0.755, 3.10	0.24	1.547	0.761, 3.141	0.23
Income <$20,000	**0.417**	**0.212, 0.818**	**0.012**	**0.417**	**0.210, 0.826**	**0.049**	0.503	0.250, 1.014	0.057	0.616	0.303, 1.251	0.18
Education <=high school	0.567	0.243, 1.322	.019	0.604	0.248, 1.470	0.27	0.723	0.293, 1.787	0.48	0.705	0.292, 1.702	0.44
Medical History												
Heart Failure				.531	0.242, 1.165	0.12	0.498	0.226, 1.101	0.088	**0.430**	**0.193, 0.963**	**0.042**
Cognition intact				1.241	0.336, 4.575	.75	1.654	0.401, 6.814	0.49	1.44	0.322, 4.064	0.84
Activity												
Physical Activity							**2.691**	**1.326, 5.459**	**0.0072**	**2.316**	**1.132, 4.74**	**0.023**
Function												
ADL (Katz)										**4.485**	**1.542, 13.045**	**0.0069**

Table 2.4
Multivariate Regression Overall QOL

Table 2.4

Multivariate Regression Overall Quality of Life

	MODEL 1			MODEL 2			MODEL 3			MODEL 4		
	OR	Confidence Interval	P value	OR	Confidence Interval	P value	OR	Confidence Interval	P value	OR	Confidence Interval	P value
Demographics/SES												
Age >=80	1.477	0.758, 2.876	0.25	1.315	0.664, 2.602	0.43	1.228	0.617, 2.442	0.56	1.213	0.610, 2.415	0.58
Income <$20,000	**0.357**	**0.184, 0.693**	**0.0029**	**0.359**	**0.183, 0.703**	**0.0034**	**0.411**	**0.207, 0.815**	**0.012**	**0.458**	**0.228, 0.920**	**0.03**
Education <=high school	0.637	0.275, 1.471	0.29	0.661	0.277, 1.579	0.35	0.788	0.321, 1.937	0.6	0.767	0.315, 1.865	0.56
Medical History												
Heart Failure				**0.434**	**0.203, 0.927**	**0.033**	**0.452**	**0.211, 0.971**	**0.044**	**0.431**	**0.200, 0.927**	**0.033**
Cognition intact				1.275	0.303, 5.363	0.74	1.651	0.389, 7.006	0.5	1.045	0.226, 4.826	0.96
Activity												
Physical Activity							**2.308**	**1.153, 4.617**	**0.02**	**2.070**	**1.021, 4.197**	**0.046**
Function												
ADL (Katz)										2.240	0.833, 6.024	0.11

Discussion

Lawton's IADLs and Katz's ADLs along with physical activity were associated with higher scores for perceived health and quality of life in survivors of the Heart and Soul study with chronic CHD. Lower income status was associated with lower scores for perceived health and quality of life. When variables were evaluated together in nested models and adjusted for socioeconomic status and physical activity, a history of heart failure also contributed to lower scores for perceived health and quality of life. Physical activity as a self-care activity was found in almost half of this older adult study sample. Physical activity is known to be associated with positive perceived health status and overall quality of life (Awick et al., 2017; Eifert et al., 2014; Kaleta et al., 2006; Marquez et al., 2020; Vagetti et al., 2014; Zubala et al., 2017). The current study contributes to the evidence by reporting these positive effects of physical activity for older adults with known CHD for 20 years, which may suggest that a small constellation of easily assessed factors in the population living with chronic CHD may bring benefits to their perceived health and quality of life. Heart failure as a comorbidity and low income also add specificity to current evidence contributing to older adults' outlook.

Physical activity is a key recommendation in for people living with CHD as it has been associated with better control over known CHD risk factors of blood pressure, weight and glucose, as well as lower risk of reoccurrence of disease and death (Agarwal, 2012; Hegde & Solomon, 2015; Leitzmann et al., 2007; Loprinzi & Addoh, 2016; Muscella et al., 2020; Myers, 2003; Tsao et al., 2022; Winzer et al., 2018). Unfortunately, as physical activity is associated with better health and lower risk in older adults, participation in regular exercise decreases with age (Suryadinata et al., 2020) and the presence of comorbidities (Office of Disease Prevention and Health Promotion (n.d.). Consistent with the literature of participants who attended cardiac rehabilitation, this study found that participants who report brisk physical activity 3-4 times a month or more had higher odds of experiencing higher perceived health and QOL (Lavie & Milani, 1995; Marchionni et al., 2003; Saeidi et al., 2013; Taylor et al., 2019). Since little is known about the older adult with chronic disease, this study's unique contribution is that participants who are older and are not part of an exercise-based intervention but are physically active report better perceived health and better QOL.

Perceived health is considered a subset of QOL, and both are different than health-related quality of life (HRQOL), however these terms are often used interchangeably (Lin et al., 2013; Rejeski & Mihalko, 2001). Health-related QOL tools were designed to evaluate specific disease, functional state, effectiveness of the treatment and changes over time as they relate to specifically to one's health (Guyatt et al., 2007; Schipper, 1990; Wilson & Cleary, 1995). The HRQOL contains both subjective and objective assessments, in which the latter assesses abilities related to the illness (Lin et al., 2013). In this study, a single-item question was used to evaluate overall QOL. In doing this, the specificity of the core domains of physical, mental health, social and relation to environment, are lost, in exchange for the focus to shift from the effect of the illness onto the broader concepts of QOL (Lin et al., 2013; Wasson, 2019). Nevertheless, this study found that the heart failure population had higher odds of experiencing lower QOL, when adjusting for age, income, education, cognition, and ADL. This finding is in contrast to studies that found QOL was improved with structured physical activity programs among people living with heart failure (Doletsky et al., 2018; Heidenreich et al., 2022), however lower QOL in general has been found among people living with heart failure, as QOL has been shown to be related to the presence of symptoms (Hwang et al., 2014; Megari, 2013; Rector et al., 2006). This may indicate that the people living with heart failure would benefit from a regularly prescribed structured physical activity. Conversely, when asked about perceived health, heart failure was not significant. Unfortunately, a statistical subgroup analysis due to low power could not be performed, to better understand how heart failure influenced QOL, but not perceived health status.

Practical Implications

In the United States over the next decade, the population greater than 65 years of age will exceed the number of children (Vespa et al., 2018). Effectively managing this aging population with CHD will require cost-effective solutions and evidence-based practices based on studies like this one, that identify specific factors impacting older adults' perceived health and overall QOL.

This is important to further hone clinical practice on identifying the older adults' physical and social-emotional needs and providing the proper intervention at the right time to promote health in patients with CHD. In addition, this study underscores the importance of using PRO regularly in clinical visits with older adults living with CHD. Using PROs regularly at clinical visits could help healthcare providers to identify a change in symptoms, monitor the effectiveness of treatment, and assist in patient-centered communication (Philpot et al., 2018).

This study's findings suggest that physical activity is an essential self-care activity for older adults with chronic CHD. Regular physical activity is positively associated with both perceived health status and overall QOL (Holahan et al., 2008; Lera-López et al., 2017). Furthermore, the study highlights the need to consider factors such as socioeconomic status and comorbidities, like heart failure, when caring for this population. These factors can significantly impact patients' perceived health and QOL. Therefore, healthcare providers must address these factors when caring for older adults with chronic CHD.

One limitation of this study is potential lack of generalizability to females due to the predominance of males in the study population, likely influenced by sex-specific difference in perceptions of health and QOL (Emery et al., 2004; Riedinger et al., 2001). Additionally, the study was restricted to using an existing dataset which prevented inclusion of relevant variables including current medical history, current medications, smoking status, current social factors such as marital status, and living situation due to resource limitation. Use of the existing dataset limited participant inclusion to those who have survived for two decades, therefore sample size was restricted. Some analyses could not be performed due to power. The decision was made not to add depression to the risk adjusted nested model since depression has been well documented to be associated with poorer perceived health and QOL (Akyol et al., 2010; Hansson, 2002; Ho et al., 2014). It was decided to separate depression for a separate analysis because of its known negative effects on perceived health and QOL. Lastly, we were able to perform the SPMSQ on only 93 of the cohort as this questionnaire was only completed by phone with a research team member. Despite some of these limitations, this study was a unique opportunity to provide an updated evaluation of an older adult population who has lived with chronic CHD for 20+ years. We had an excellent response of 126 among the 168 participants we contacted (and confirmed 42 were ineligible due to death, lost to follow up, and incomplete questionnaires).

Conclusion

Older adults with long term CHD who engage in physical activity have higher QOL and perceived health, which are important patient reported outcomes. Efforts to improve access to physical activity in the older adult has many benefits to the individual and the healthcare system as the population continues to age. Although heart failure and low income were related to lower QOL and are not improved by the modifiable risk factor of physical activity, further research into the role of income and heart failure in a larger sample of older adults with cardiovascular disease is needed.

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The Mediating Role of Depression in the Relationship Between Physical Activity and Quality of Life Among Patients with Coronary Heart Disease

Abstract

Background: Depression, a known comorbidity in coronary heart diseases (CHD), is associated with adverse cardiac events, mortality, symptom burden, physical limitation, and poor quality of life. Evidence has shown that depression impedes self-care behaviors including physical activity, similarly, regular physical activity has been shown to lessen depressive symptoms and improve cardiovascular health.

Objective: To investigate the direct effect of depressive symptoms on physical activity and quality of life (QOL). To investigate the mediator effect of physical activity and depressive symptoms on QOL. To Test the moderator effect of depressive symptoms on physical activity and QOL.

Methods: In this cross-sectional study, 20-year follow-up survey data was collected from 126 survivors from the Heart and Soul prospective cohort study. Mediation test was conducted using the steps described by Baron and Kenny.

Results: Physical activity significantly predicted QOL (β=.133, p=.02) and significantly predicted depressive symptoms (β= -.1918, p=.0002), depressive symptoms significantly predicted QOL (β= -0.762, p<.0001). The average causal mediation effect (ACME) was statistically significant (0.1463, p=.0002). Depression was not a moderator of physical activity and QOL.

Conclusions: This study demonstrated that depression mediated the effect of physical activity on QOL. Identifying and treating depressive symptoms simultaneously while addressing physical activity may be of importance to improving QOL in patients with chronic CHD.

Key words:

Chronic coronary heart disease, depression, older adult, overall quality of life, physical activity, self-care

The Mediating Role of Depression in the Relationship Between Physical Activity and Quality of Life Among Patients with Coronary Heart Disease

Depression is a known comorbidity with coronary heart diseases (CHD) and is more common among people with CHD than in the general population (Gonzalez et al., 1996; Schleifer & Macari-Hinson, 1989; Stern et al., 1976). Affecting 20% of people living with CHD (Al-Abbudi et al., 2018; Carney & Freedland 2017, Thombs et al., 2006), and up to 40% of hospitalized cardiac patients (Bahall 2019) depression is associated with adverse cardiac events (Frasure-Smith et al., 1995; Smolderen et al., 2009; Whooley et al., 2008), mortality (Lichtman et al., 2014; Pelletier et al., 2015; Watkins et al., 2013), symptom burden, physical limitation and poor quality of life (QOL) (Ruo et al., 2003). These debilitating outcomes are linked to the key components of QOL such as physical health, emotional state, social interaction, and role activity (Rejeski & Mihalko, 2001). Specifically, depression has been shown to increase when measured physical and mental engagement decrease (Bahall et al., 2020; Lu et al., 2019; Yohannes et al., 2010). The impact of CHD and depression on QOL are straightforward, especially, physical health and emotional state. Unfortunately, in coronary artery disease, treatment of depression with therapy or antidepressants has shown mixed results in decreasing depression and adverse events (Berkman, 2003; Glassman et al., 2002; Lespérance et al., 2007; Lett et al., 2004; Shimbo et al., 2005). Assessing QOL as a patient-reported outcome would provide a subjective interpretation of the patient's burden of disease (Weldring & Smith, 2013) and present an opportunity for further patient engagement and management of comorbidities including depression (Kornowski, 2023; Rasmussen et al., 2021).

Biological, genetic, and behavioral factors have been studied as possible links between depression and CHD, though definitive connections and directionality are inconclusive (Carney & Freedland, 2017; Grippo & Johnson, 2002). Specifically, there is evidence that depression impedes self-care behaviors such as medication adherence (DiMatteo et al., 2000; Gehi et al., 2005; Kronish et al., 2006; Ziegelstein et al., 2000), healthy eating, and exercise (Bonnet et al., 2005; DiMatteo et al., 2000; Ziegelstein et al., 2000). It is also known that physical inactivity is associated with secondary CHD events (Bijnen et al., 1994) and depression (Farooqui et al., 2020; Pearce et al., 2022), contributing to the cyclic nature of depression and CHD (Whooley & Wong, 2013). However, engaging in regular physical activity has been shown to lessen depressive symptoms (Kandola et al., 2019; Schuch et al., 2018), improve cardiovascular health (Agarwal, 2012; Hegde & Solomon, 2015; Leitzmann et al., 2007; Muscella et al., 2020), and promote a better QOL for CHD patients (Lavie & Milani, 1995; Marchionni et al., 2003). Additionally, in a study of participants following an acute myocardial infarction (MI), investigators found that those who were persistently active, with any level of exercise, had significantly lower odds of being depressed compared with those who were persistently inactive (Ernstsen et al., 2016). Consistent with this finding, patients enrolled in an exercise and education based cardiac rehabilitation program had a reduction in depression by 63%, even with a minimal increases in exercise (Milani & Lavie, 2007). A randomized controlled trial of people with CHD and depressive symptoms, found that participants randomly assigned to aerobic exercise group had equally lower rates of depressive symptoms as those randomly assigned to the group who received antidepressant medications, when compared to the placebo group. The aerobic group had the added benefit of improved heart rate variability, indicating increased fitness (Blumenthal et al., 2012). Thus, although physical activity has a positive effect on depression, it is unknown whether it is enough to overcome the impact of CHD and depression on QOL.

Physical functioning and symptom burden contribute to poor quality of life and depression among people living with chronic CHD. Among patients with CHD who experienced persistent angina, associated symptoms include depression, impaired physical functioning, and lower quality of life (Jespersen et al., 2013; Manolis et al., 2019; Stafford et al., 2007). Likewise, symptoms and poor physical function are associated with depression and QOL among people living with heart failure (Bekelman et al., 2007; Mårtensson et al., 2003). In the year following an acute MI, patients with post-MI depressive disorder report poorer quality of life, more symptoms and more disability compared to those without depression (de Jonge et al., 2006). Structured exercise programs have been shown to be beneficial in improving QOL in the stable angina (Devi et al., 2014) in people living with CHD (Terada et al., 2022).

Although physical inactivity and depression are common problems in patients with CHD, and both may impair QOL, this relationship on QOL is rarely investigated in the population living with chronic CHD. There is limited research to determine whether depressive symptoms mediate or moderate the association between physical activity and overall QOL. Therefore, the specific aims of this study are to (a) investigate the direct effect of depressive symptoms on physical activity and QOL; (b) investigate the mediator effect of physical activity and depressive symptoms on QOL while controlling for age, income, education, and heart failure; and (c) to test the moderator effect of depressive symptoms on physical activity and QOL.

Methods

The Heart and Soul Study (Whooley & Schiller, 2022) is prospective, longitudinal cohort study that enrolled 1,024 participants between September 2000 and December 2002 and was designed to investigate how depression and other mental health conditions influence outcomes of people living with stable CHD. While an extensive amount of data was collected at baseline and after 5-years with the original cohort, this current cross-sectional study leveraged the surviving participants of the Heart and Soul Study with mailed surveys to investigate their ongoing level of health. Details and methods of this study have been previously described (Beattie et al., 2003; Bibbins-Domingo et al., 2003; Gehi et al., 2003). In brief, participants were eligible for the study if they met at least one of the following criteria: history of MI, angiographic evidence of at least 50% stenosis in one or more coronary vessels, prior evidence of inducible ischemia by treadmill or nuclear testing, or a history of coronary revascularization Exclusion criteria included: MI in prior 6 months, unable to walk > 1 block (treadmill test not useful) or planning to move out of area within 2 years making them unavailable for follow-up.

The original 1,024 participants were enrolled from 12 San Francisco Bay area outpatient clinics, including 549 (54%) with a history of MI, 237 (23%) with a history of revascularization without an MI, and 238 (23%) with a diagnosis of CHD documented by their physician with a positive treadmill test or angiography in >98% of the cases. All participants completed a full-day examination including demographics, personal history, medical history, blood work, echocardiograms, treadmill tests and extensive questionnaires assessing depression, symptoms, activity, and psychosocial factors.

For the current study, 168 known survivors of the Heart and Soul Study (Whooley & Schiller, 2022) were mailed questionnaires in February 2022, based on regular tracking of mortality over 20 years. In the mailed packet participants were asked to call one of the study coordinators to participate in a cognitive assessment using the Pfeiffer Short Portable Mental Status Questionnaire (SPMSQ). At the time of the phone call, the SPMSQ collected and verbal consent was obtained. Follow-up phone calls to invite participation were made to participants who did not call or return mailed questionnaires.

Approval for "The Heart and Soul Study: Epidemiology of Depression and Heart Failure in Aging" was obtained from the University of California, San Francisco to conduct human subjects research (#10-01301).

Data Collection

Quality of Life as the Primary Outcome

The primary outcome of overall QOL was assessed using a single-item question identical to the baseline survey: "Compared to other people your own age, how would you rate your overall quality of life (poor=1, fair=2, good=3, very good=4, excellent=5)?" The higher score the score, the higher the self-scoring of QOL of the participant. The single-item self-reported QOL question has been evaluated in studies involving individuals or parents of children with disabilities (Siebens et al., 2015; Yohannes et al., 2011). In children with epilepsy, the single question response given by their parents correlated with the composite scores from reliable and valid QOL questionnaires, including Global Quality of Life in Childhood Epilepsy questionnaire (G-QOLCE-76) and KIDSCREEN-27 ($r \geq .53$ and $r \geq .51$, p=.001) (Conway et al., 2018). The test-retest reliability at baseline and 6 months (ICC: 0.49-0.72) (Conway et al., 2018), however, another study found the test retest high (.86, $p<.001$) (Atroszko et al., 2015). Prior studies using the single question QOL measure in older adults was lacking. However, the question posits a person to compare themselves to peers of similar age, which supports face validity and ease of QOL self-scoring. The single-item, self-reported QOL question was adopted as the Heart and Soul Study's main assessment of personal QOL by participants (Odden et al., 2006; Ruo et al., 2003).

Physical Activity as the Primary Predictor

As a component of self-care, physical activity, was considered the primary predictor of the proposed outcome. To assess physical activity, a single item question identical to the baseline survey was posed "Which of the following statements best describe how physically active you have been during the last month, that is, done activities such as 15-20 minutes of brisk walking, swimming, general conditioning, or recreational sports?" The participants chose one from the following 6 responses:

7. not at all active
8. a little active (1-2 times per month)
9. fairly active (3-4 times per month)
10. quite active (1-2 times per week)
11. very active (3-4 times per week)
12. extremely active (≥5 times per week)

For the multiple regression analysis, low activity group was defined as not at all active or a little active whereas the high activity group answered fairly active, quite active, very active, or extremely active. This classification of physical activity is consistent within the Heart and Soul cohort (Whooley & Schiller, 2022) and has been shown to be a predictor of CHD events and rates of CHD (Jarvie et al., 2014; Whooley et al., 2008). Physical activity was used as a continuous variable in the mediation analysis. The single-item of self-reported physical activity has been shown to have construct validity when compared to VO_{2max} to reported daily exercise (R^2=.76, p<.001) (Aadahl et al., 2007), and a cardiorespiratory test to compared to level of activity (*r*=.57, p<.001) (Jackson et al., 2007). A study on cardiovascular fitness reported reliability of the single-item physical activity questionnaire (*r*=.85) (Ainsworth et al., 1993). Based on this evidence, the single-item, physical activity question was chosen as this study's main assessment of performance of physical activity by study participants.

Covariates

Non-modifiable factors that are known to have an impact on QOL were considered for evaluation such as age, depression, income, education and comorbidities (Blazer et al., 1991; Ross & Van Willigen, 1997; Ross & Wu, 1995). Age was calculated based on date of birth to the date of current mailings. Utilizing baseline data and definitions from the study's baseline questionnaire, income was dichotomized as lower than $20,000/year and equal to greater than $20,000/year. Education was dichotomized to less than or equal to high school and greater than high school. Because heart failure diagnosis is known to impact QOL, (Dracup et al., 1992; Heo et al., 2009; Moradi et al., 2020) the diagnosis was obtained from the baseline data. Additionally, current medical records were reviewed for new diagnosis of heart failure and confirmed with ICD-10 codes or physician documented diagnosis of heart failure.

Cognitive function was assessed using the validated and reliable SPMSQ. SPMSQ for cognitive function is a 10-item questionnaire that is scored on a scale of 0 (best cognitive function) to 10 (worst cognitive function). The SPMSQ score equals the total number of incorrect answers, with 0-2 incorrect answers considered normal cognition and greater than 2 errors indicating cognitive impairment (Pfeiffer, 1975; Smyer et al., 1979). Mild impairment (3-4 errors) is known to have 82% agreement with dementia diagnosis while over 4 errors have a 91% agreement and test/retest of *r*=.82 (Pfeiffer, 1975). When performed by telephone the scores correlated with Mini Mental State Exam (MMSE) (*r*=.73, *p*=.001) with 74% sensitivity and 79% specificity for dementia diagnosis (Roccaforte et al., 1994). The strong reliability and validity evidence of the SPMSQ being used for cognitive assessment of the aging population supported its use in this study.

Self-reported activities of daily living on the Katz scale consisted of 8 items on bathing, dressing, toileting, transferring, feeding, walking, incontinence (average urine and bowel), and house confinement. Each item is scored 0 = receives no assistance, 1=receives some assistance, or 2=unable to do alone. Total scores range from 0 to 16 with higher scores indicating worse function. A widely used assessment, the literature for validity and reliability is found among diverse populations living outside of the United States with a good to excellent Cronbach's α of .838-.94 (Arik et al., 2015; Reijneveld et al., 2007) and in stroke patients .94 (Lindmark & Hamrin, 1988) . The test-retest reliability was perfect at (1.0, 95% confidence level [CI] 1.0-1.0) and high inter-rater reliability (ICC 0.999, CI 95% 0.999-1.000) (Reijneveld et al., 2007). There was fair association with long term mobility limitations and SF-36 physical functioning ($r(296)$ -.60, p<.001) (Reijneveld et al., 2007) and the Barthel Index (r^2=.988, p<.001) (Arik et al., 2015) The self-reported Katz activities of daily living scale was an excellent fit for this study based on evidence and support for use in diverse populations.

The Patient Health Questionnaire 8 (PHQ 8) is an 8-item questionnaire to assess the presence of depressive symptoms and severity. PHQ 8 consists of 8 of the 9 criteria used by the DSM-IV for the diagnosis of depression. The PHQ-8 does not include the question regarding suicidal ideation but is found to be highly correlated to the PHQ-9 (Kroenke & Spitzer, 2002; Kroenke et al., 2009). The eight questions (little interest or pleasure, feeling down or hopeless or depressed, trouble sleeping, feeling tired, low energy, loss of appetite or overeating, feeling about yourself, trouble concentrating, moving slowly) are scored 0 to 3 (not at all to nearly every day). The score of all questions were added to give a continuous range 0 to 27 where higher scores indicate worse depression. Moderate to severe depressive symptoms scores were 10 or greater. There was good reliability for the PHQ 9 when the score was greater than or equal to 10 (Cronbach's α .89; test retest .84; sensitivity and specificity .88) (Kroenke et al., 2001) and for the PHQ-8, score range 0-24 and cut point of 10 (Cronbach's α .82) (Pressler et al., 2011). The strong reliability and validity evidence of the PHQ-8 being used for depressive symptom assessment of the aging population supported its use in this study.

Statistical Analysis

The baseline characteristics were summarized, with categorical variables presented as counts, and proportions, and continuous variables presented as mean and standard deviation or median and interquartile range if skewed. For scales missing $\leq$ 30% of items, the total score was calculated by dividing the sum of completed items by the proportion of items complete multiplied by the number of questions (i.e., assuming any missing question should have a value equal to the average of all present responses). Any score with >30% missing was considered missing and was removed from the dataset. Data were evaluated for distribution and to characterize the study sample. ADL and IADL were skewed right toward higher independence and were dichotomized to scores 0-2 considered as higher independence.

Covariates chosen for logistic regression nested models for overall QOL were based on variables of significance from the ordinal regression and those reported in the literature. The first model with socioeconomic status (SES) variables consisted of age, income, and education. The second model added medical history including heart failure, depressive symptoms, and cognition. The third model added physical activity and the fourth model added ADL. The quality and model fit as well as the descriptive statistics were evaluated using the R v4.1.2 (R Core Team, 2021).

The steps for mediation analysis followed the guide by Baron and Kenny (Figure 1) (Baron & Kenny, 1986). The mediation effect of depressive symptoms on the relationship between physical activity and QOL were both examined using multiple regression, controlling for age, income, education, and heart failure. According to Baron and Kenny, the variable functions as a mediator when the following conditions are met: 1) the variations in the independent variable significantly account for variations in the dependent variable (Path A), 2) variation of independent variable accounts for variation on mediator variable (Path B), 3) variation in mediator variable accounts for variation in outcome variable (Path C) and 4) when independent variable and mediator variable are both entered in the model, the previous significant relationship between the independent and dependent variable is no longer significant then the mediator effect is supported (Path A^1). To determine if the mediation effect is statistically significant, the mediation package R v4.1.2 in R was used with 10,000 nonparametric bootstraps; non-parametric bootstrap was also used for the linear regression models in Baron and Kenny's step (Tingley et al., 2014).

We also tested for moderator effects of depressive symptoms with physical activity as interaction term in a regression model (Baron & Kenny, 1986).

Results

Baseline characteristics of the participants are shown in Table 3.1. Among the 168 participants who were sent questionnaires, 126 were included in the analysis (6 were dropped due to incomplete questions of more than 30% missing, 12 were deceased, and 24 were lost to follow up). The mean age was 80 years old (SD=9.1) and 71.8% were male. Based on information from the baseline data obtained in 2000, most participants obtained an educational level beyond high school (80.2%), though more than half reported an income of less than or equal to $20,000 (53.4%). Heart failure history was noted in 23.7% of this sample, and the majority had intact cognition (two or fewer errors on the SPMSQ) (89%). Physical activity was reported in 47.3% participants, with most reporting no to minimal assistance with their ADLs (81.7%). Overall QOL varied, with the majority of participants rating it as good or very good.

Table 3.1

Characteristics of the 20-year Heart and Soul Cohort

	N (%)
Demographics	
Age (y) mean/SD	80.9 ± 9.1
>=80 (y)	71 (54.2)
Male gender	94 (71.8)
Race	
White or Caucasian	73 (55.7)
Black or African American	18 (13.7)
Asian or Pacific Islander	21 (16)
Hispanic, Latino, or Latin American	12 (9.2)
Other	5 (3.8)
Socioeconomic Status (SES)	
Income <$20,000 (baseline)	70 (53.4)
Education <=high school (baseline)	24 (18)
Medical History/Status	
Heart Failure	31 (23.7)
Cognition Status (SPMSQ)[1]	
Cognition intact (0-2 errors)	83 (63.4)
Cognition impaired (> 2 errors)	10 (7.6)
Cognition missing	38 (29)
Self-reported Measures	
Depressive Symptoms (PHQ-8)[2]	
None	73 (58.8)
Mild	30 (24.1)
Moderate	12 (9.6)
Severe	9 (7.2)
Physically active	62 (47.3)
ADL (Katz): independent	107 (81.7)
Perceived health	
Excellent	11 (8.4)
Very Good	30 (22.9)
Good	42 (32.1)
Fair	25 (19.1)
Poor	8 (6.1)
Missing	5 (3.8)
Overall Quality of Life	
Excellent	21 (16)
Very Good	36 (27.5)
Good	35 (26.7)
Fair	25 (19.1)
Poor	9 (6.9)
Missing	5 (3.8)

1-Short Portable Mental Status Questionnaire 2-Patient Health Questionnaire (8-item)

A multiple regression analysis (Appendix 1) showed that an income of less than $20,000 per year (Odds Ratio [OR]=0.36, $p<.003$), is significantly associated with lower overall quality when compared to participants with an income of $20,000 per year or more. With the addition of medical history (heart failure, cognition, and depressive symptoms) to the model, income remained significant with an adjusted OR [*aOR*] .411 (p=.013) as was depressive symptoms, with lower overall QOL (*aOR* .94, $p<.001$). When added to the model, physical activity was not significant, however, depressive symptoms remained significant and were explored as a potential mediator.

Mediation Effect of Depressive Symptoms

Using Baron and Kenny's 3 step process (Figure 1, Table 3.2) (Baron & Kenny, 1986), in Step 1 physical activity significantly predicted QOL after adjusting for covariates (β=.1318, p=.02). In Step 2, physical activity significantly predicted depressive symptoms (β= -.1916, p<.001). In Step 3, depressive symptoms significantly predicted QOL (β= -.768, $p<.001$); however, because the effect of physical activity on QOL is no longer significant, it is determined that depressive symptoms mediates physical activity (Kim, 2016). Therefore, a mediation analysis was conducted and was found to be statistically significant (*ACME* .147, $p<.001$) proportion mediated 1.10 (Table 3.3).

Table 3.2
Mediation Analysis

	Predictor	Outcome	Standard β	Confidence Interval	p value	Adjusted R^2
Step 1	Physical Activity	QOL	0.1318[1]	0.0184, 0.2478	**.0244***	.156
Step 2	Physical Activity	Depressive symptoms	-0.1916[1]	-0.2781, -0.1068	**.0002***	.263
Step 3	Depressive symptoms	QOL	-0.7683[2]	-0.9648, -0.5544	**p<.0001***	.3847
Step 4	Physical Activity	QOL	-0.0153[3]	-0.1107, 0.0821	.758	

[1]adjusted for age, income, education, heart failure
[2]adjusted for age, income, education, heart failure, physical activity
[3]adjusted for age, income, education, heart failure, depressive symptoms

Table 3.3
Causal Mediation Analysis

Quality of life, physical activity, depressive symptoms (mediator) (adjusted)				
	Estimate	CI lower (95%)	CI Upper (95%)	p-value
ACME	0.1472	0.0733	0.24	**<.001**
ADE	-0.0154	-0.1107	0.08	.785
Total Effect	0.1318	0.0181	0.25	**.024**
Prop. Mediated	1.1166	0.5589	3.84	**.024**

Mediation Analysis of Physical Activity

The assessment of physical activity as the mediator of depression on quality of life using multiple regression was conducted and presented in Appendix 2. Depressive symptoms predicted QOL (*β*= -1.306, *p*<.001) and physical activity (*β*= -1.508, *p*=.013); however, the effect of physical activity was not statistically significant in predicting QOL, when depression was added to the model (*β*= 0.23, *p*=.249). Because the relationship between depressive symptoms and quality of remained unchanged (*β*= -1.2327, *p*<.001), it was determined that physical activity did not mediate the relationship between depressive symptoms and QOL.

Moderator Effect of Depression

There was no significant interaction effect of physical activity and depression (Appendix 3). Therefore, further analysis was not pursued in determining a moderating effect.

Discussion

The main findings of this study were consistent with published literature, showing that independently, physical activity was associated with better QOL (Hung et al., 2004; Ståhle et al., 1999) and depression was associated with lower QOL (de Jonge et al., 2006; Müller-Tasch et al., 2007; Stafford et al., 2007). This study employed a mediation analysis that contributes further to the body of evidence with significant findings that the effect of physical activity on QOL was mediated by depressive symptoms, in the people living with chronic CHD. These findings suggest that a focus exclusively on cardiac self-care modalities, specifically physical activity, overlooks other key factors associated with QOL. Coronary heart disease in the presence of depression may require an enhanced clinical lens. These findings indicate that assessment and treatment of CHD patients should include depression and QOL due to mediating effects.

This study finds the effect of physical activity in the presence of depressive symptoms did not improve overall QOL. The findings differ from a clinical trial that showed despite a sustained improvement in depression and overall QOL among three different exercise groups during the intervention phase, mental QOL decreased, even as physical QOL increased after the intervention was ended (Terada et al., 2022). Though the specific domains of QOL were not investigated in this clinical trial, studies with exercise interventions may be contributing to QOL in different ways. Structured exercise and training programs may provide a sense of personal connection followed by loss when the program ends (Awick et al., 2017). A 12-week Tai Chi in-person group showed that an improvement in self-efficacy correlated with QOL, when compared with the health education only group (Luberto et al., 2020). Virtual cardiac rehabilitation improved both self-efficacy and QOL, as well as social QOL, which increased at 6 months, yet changes in depression were not significant (Devi et al., 2014).

The current study has significant implications for clinical practice, highlighting the complex relationship between physical activity, depressive symptoms, and QOL in patients with CHD. While physical activity offers numerous benefits and is an important self-care behavior for CHD patients, it is important to recognize the impact of depressive symptoms on self-care and QOL. Evidence suggests that depression has a greater influence on lower QOL and physical activity than the physiological aspects of ejection fraction and ischemia of the disease (Ruo 2003). Further investigation of outcomes related to depression found adverse secondary events were more closely associated with behavioral factors of medication adherence (Davidson, 2012; Gehi, 2007) or physical inactivity rather than biological factors or disease severity alone (Carney 2016, Hamer 2008; Larsen 2013, Whooley, 2008; Win 2011).

Given the significant impact of depression on patient outcomes and QOL, screening for depression is recommended in all CHD patients. While various screening tools can be utilized, basic screening using the Patient Health Questionnaire-2 (PHQ-2) has a sensitivity of 83% and specificity of 92% (Kroenke, 2003) in identifying individuals with depression requiring a further assessment with the PHQ-9 (Jha et. al., 2019; Lichtman et al., 2008). Unfortunately, investigators have found that only 3% of individuals living with CHD without a history of depression are screened (Bhattacharjee et al., 2018). Furthermore, a review of a program that implemented depression screening tool for patients admitted to a hospital with an acute myocardial infarction found 25% of eligible individuals did not receive the screening (Smolderen et al., 2011). Thus, depression screening is currently under-utilized for patients living with CHD.

The implementation of a depression screening tool may be impeded by various barriers at both the provider and patient levels. Providers may face challenges related to inadequate knowledge about depression screening; difficulties in integrating the screening tool into their workflow; and a lack of ownership or responsibility for conducting screenings (Peltzer et al., 2020; Reuter et al., 2022; Smolderen et. al., 2011). On the other hand, patients may encounter barriers such as limited knowledge about depression, mobility issues that hinder their ability to attend appointments, denial of symptoms, and the stigma associated with mental health conditions (Reuter et al., 2022). To overcome these barriers, educational initiatives to enhance provider knowledge, communication to promote the importance of depression screening, environmental restructuring using electronic medical records (EMR) and best practice alerts can facilitate workflow (Kahalnik, 2019) to increase opportunities for screenings (Reuter et al., 2022; Smolderen et al., 2011). Creating a resource list of available mental health services that addresses patient barriers such as language, ability to pay, and accessibility, as well as providing quality improvement feedback to providers, destigmatizing depression (Kahalnik et. al., 2019) and actively soliciting feedback from both providers and patients can contribute to overcoming barriers and improving the implementation of depression screening tools (Reuter et al., 2022).

Once depression is diagnosed, a variety of treatment option can be recommended including medical management. For patients with severe depression or suicidal ideation a collaborative team approach with psychiatrists is recommended (Jha et al., 2022; Lichtman et al., 2008). For mild to moderate depression, initial management can be carried out by primary care physicians or cardiologists and may involve cognitive-behavioral therapy, physical exercise, or the use of selective serotonin reuptake inhibitors (SSRI; Jha et. al., 2022, Lichtman, et. al., 2008). The Canadian Cardiac *Evaluation of Antidepressant and Psychotherapy Efficacy* trial (CREATE) examined the efficacy of the SSRI Celexa, along with clinical management or therapy, and reported a reduction in readmissions and self-reported depression using the Beck

Depression Inventory (BDI) (Lespérance et al., 2007). The results indicated that individuals with a history of depression showed better outcomes compared to those experiencing depression for the first time following a MI. Another study, Sertraline Against Depression and Heart Disease in CHF (SADHART), found Sertraline as a standalone treatment had significant improvements in scores on the Clinical Global Impressions-Improvement (CGI-I) scale, although not on the provider assessment tool (Glassman et al., 2002). The Enhancing Recovery in Coronary Heart Disease (ENRICHD) randomized clinical trial reported use of a SSRI was associated with lower morbidity and mortality (Taylor et al., 2002).

Research has primarily concentrated on a singular treatment approach, despite the link between depression, CHD, and adverse outcomes, including QOL. Studies have demonstrated that exercise or medication can potentially decrease secondary events, but the effects on depressive symptoms and QOL have produced mixed results, with QOL often not being measured (Blumenthal et al., 2004; Blumenthal 2012; Lespérance et al., 2007; Peterson et al., 2014). Our study revealed that depression acts as a mediator between physical activity and QOL, emphasizing the necessity for a holistic approach in people living with CHD including older adults. This approach should focus on reducing depressive symptoms, enhancing QOL, and promoting healthy behaviors such as physical activity. Further research is required to determine the optimal combination of pharmacologic and non-pharmacologic treatments for depression in patients with heart disease.

Limitations

This cross-sectional study leveraged a sample population from a prospective cohort study that was started 20+ years ago, thus we are limited to data provided by the participants of the Heart and Soul Study (Whooley & Schiller, 2022). We did not request updated data that may have been relevant covariates to consider such as current medical history (except for heart failure), current medications, smoking status, current marital status, and living situation. Social support was not included in this analysis but may have been a significant confounder in the relationship of depression, physical activity, and QOL. Inclusion of the prior sample also restricted the sample size to those who have survived, although we were able to perform robust statistical analyses and draw important conclusions. Lastly, we were able to perform the SPMSQ on only 93 individuals from the cohort as this questionnaire was only completed by phone with a research team member. Despite some of these limitations, this study was a unique opportunity to provide an updated evaluation of an older adult population who has lived with chronic CHD for 20+ years.

Conclusion

This study demonstrated that depression mediated the effect of physical activity on QOL. As an important patient-reported outcome, quality of life provides insight into physical, mental, social, and role aspects of a person’s life. Although physical activity may satisfy the physical domain measurement of QOL, QOL is a holistic assessment and may not adequately address emotional, social or role aspects of individuals living with CHD. Identifying and treating depressive symptoms simultaneously while addressing physical activity may be of importance to improving QOL in patients with chronic CHD.

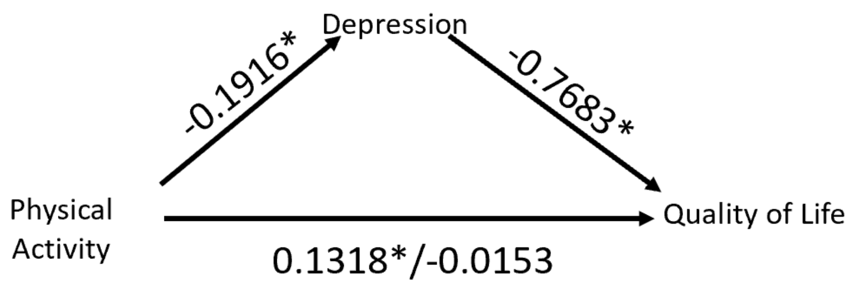

Figure 3.2
Mediator Effect of Depressive Symptoms on Quality of Life

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Supplemental Documents

Appendix 1

Multiple Regression QOL with Depression

	MODEL 1			MODEL 2			MODEL 3			MODEL 4		
	OR	Confidence Interval	P value	OR	Confidence Interval	P value	OR	Confidence Interval	P value	OR	Confidence Interval	P value
Demographics/SES												
Age >=80	1.44	0.758,2.876	.25	0.962	0.481,1.924	0.91	0.956	0.477, 1.917	0.9	0.948	0.471, 1.907	0.88
Income <$20,000	0.357	0.184, 0.693	0.0029	**0.373**	**0.188, 0.741**	**0.0057**	0.411	**0.205, 0.821**	**0.013**	**0.433**	**0.211, 0.886**	**0.024**
Education <=high school	0.637	0.275, 1.471	0.29	0.608	0.245, 1.509	0.29	0.716	0.282, 1.817	0.48	0.667	0.267, 1.668	0.39
Medical History												
Heart Failure				0.780	0.351, 1.730	0.54	0.780	0.350, 1.737	0.54	0.732	0.328, 1.631	0.45
Cognition intact				1.107	0.265, 4.625	0.89	1.286	0.355, 4.660	0.7	1.054	0.263, 4.228	0.94
Mod-Severe dep symptoms				**0.081**	**0.028, 0.230**	**<.0001**	0.094	**0.033, 0270**	**<.0001**	**0.097**	**0.033, 0.287**	**<.0001**
Activity												
Physical Activity							1.747	0.864, 3.531	0.12	1.659	0.810, 3.397	0.17
Function												
ADL (Katz)										1.435	0.514, 4.003	0.49

Appendix 2
Mediator Analysis of Physical Activity

	Predictor	Outcome	Standard β	Confidence Interval	p value	Adjusted R2
Step 1	Depressive symptoms	QOL	-1.306[1]	-1.83, -0.70	<.0001	.282
Step 2	Depressive symptoms	Physical Activity	-1.263[1]	-2.02, -0.45	<.004	.119
Step 3	Physical activity	QOL	0.069[2]	-0.04, 0.18	.198	.285
	Depressive symptoms	QOL	-1.219[3]	-1.75, -0.61	<.001	

[1]adjusted for age, income, education, heart failure
[2]adjusted for age, income, education, heart failure, depressive symptoms
[3]adjusted for age, income, education, heart failure, physical activity

Appendix 3

Moderator Analysis of Depression on Physical Activity and Quality of Life

	Estimate	Confidence interval		P value
Intercept	4.493	2.344	6.479	<.001
Age	-0.009	-0.0311	0.0124	.40
Income 20K-39K	0.088	-0.3803	0.5744	.70
Income 40K +	0.402	-0.0056	0.8430	.05
Education (no degree)	-.383	-0.746	0.0020	.05
Heart failure	-0.354	-0.7465	0.0180	.06
Physical activity	-0.057	-0.239	0.1144	.51
PHQ 8 mod_severe	-0.836	-1.202	-0.4772	<.001
Physical active_active: PHQ8 mod_severe	0.032	-0.0719	0.1424	.54

Conclusions

Objective of Dissertation

The overall objective of this dissertation was to present factors associated with self-care on the mental health, perceived health, and quality of life (QOL) of older adults living with heart disease. First, the systematic review presented published evidence of comorbidity cognitive impairment among people over the age of 80 years, living with heart failure worldwide. Second, the results of the cross-sectional study demonstrated the positive association of physical activity on quality of life and perceived health. Finally, the role of depression in mediating physical activity's effect on quality of life was presented. The results of these studies highlight self-care barriers found in aging adults who live with heart disease, both heart failure and CHD.

Summary of Dissertation Findings

The systematic review addressed studies published between 2006 and 2020 and found that cognitive impairment was either diagnosed or measured using a validated tool in 8-66% of people living with heart failure over the age of 80 years. These findings were consistent with the literature that reports 5-75% cognitive impairment among people of all ages living with heart failure. However, the population living with heart failure over 80 years old had poorer cognition by either measurement or physician diagnosis when compared to the population living with the heart failure less than 80 years old. This finding is not unexpected as the risk of dementia and Alzheimer disease increases in the general population over the age of 80 (Plassman et al., 2007; Prince et al., 2014). Yet, these studies did find the population living with heart failure had poorer measured cognition or a higher amount of diagnosed cognitive impairment when compared to the general population of the same age. These findings indicate that age and heart failure together may indicate a higher risk of developing cognitive impairment. Limitations of these findings include the lack of homogeneity in measurement tools and age groups along with the lack of specificity about the degree of cognitive impairment.

Important findings from the cross-sectional study revealed that regular physical activity is associated with better perceived health and quality of life when adjusted for age, socioeconomic factors, and comorbidities. Cognitive impairment was not significant for either outcome, however, heart failure was significantly associated with lower quality of life. It is known from evidence that having heart failure is associated with lower quality of life. Existing literature has also found that structured physical activity programs improve quality of life in the heart failure population after an acute event. This study discovered contrasting evidence in a sample of participants who had chronic heart failure for at least 20 years. Structured physical activity programs may be indicated for those with long-standing heart failure, to benefit ongoing quality of life.

Other significant findings included the effect of physical activity on quality of life being mediated by depressive symptoms in the population living with chronic CHD. This is again in contrast with existing literature that reports physical activity improves aspects of quality of life such as physical QOL, overall quality of life as well as depressive symptoms. Again, the research reported in the literature is often conducted using exercise interventions, in contrast to this study which evaluates typical day-to-day activity in the general population living with CHD without the influence of a structured program.

Overall Implications of Research

As the population over 65 years increases within the next few decades, it is inevitable the CHD population will also rise, placing an increased burden on the healthcare system as it is currently structured (Mohebi et al., 2022; Sidney et al., 2019). The older adult population is heterogeneous in aging and severity of disease. Known comorbidities such as heart failure and depression, along with physical inactivity and cognitive impairment are only parts of a larger picture that healthcare providers, public health officials and policymakers must navigate to ensure high level care and good patient related outcomes. Reducing and preventing hospital admissions could provide relief in a system where heart failure and CHD rank among the top 10 diagnoses for readmission in the United States (Elixhauser & Steiner, 2013). Physical activity as a powerful healthy behavior has been shown to have many benefits in preventing secondary events, stabilizing cognitive decline as well as improving quality of life. However, to achieve the benefits of physical activity on quality of life, the presence of depressive symptoms needs to be assessed and treated.

Clinical Implications

The challenge for healthcare providers is interpretation of assessment findings and logistically incorporating patient reported outcome measures (PROMs) into their daily workflow (Kornowski, 2023). Single-item assessment questions are a good start such as, "Compared to other people your own age, how would you rate your overall quality of life?" and "Compared to other people your own age, how would you rate your overall health?" These PRO questions have been shown to have reliability and validity (Atroszko et al., 2015; Conway et al., 2016; Cousins, 1997; DeSalvo et al., 2006; LaRue et al., 1979; Mossey & Shapiro, 1982), despite lacking specificity. These questions, when answered by the older adult patient with CHD, will require further probing by the clinician to get to the root cause of the patient's answer. Then the challenge for the healthcare provider is acting on the findings.

Treatment of depression has been associated with lower mortality, myocardial infarction as well as improved depressive symptoms; however, quality of life was not evaluated in prior trials (Lespérance et al., 2007; Taylor et al., 2005; Wells et al., 2018). Cardiac rehabilitation is beneficial in reducing depressive symptoms (Milani & Lavie, 2007) and improving physical function (Saeidi et al., 2013) but, lack of provider knowledge, cost, availability, transportation (Chindhy et al., 2020), and depression (Bermudez et al., 2022) are some of the barriers to attendance. In addressing barriers related to social determinants of health, 44% lacked community resources to deal with their personal barriers (Kovach et al., 2019). Taking a broader population health approach has been successful in consolidating resources and targeting community partnerships (Reves et al., 2019). Leadership and commitment in healthcare organizations and the community is necessary to promote awareness of the benefits of assessing and treating depression and creating solutions that assist older adults to achieve optimal health.

Social Implications

Black individuals have a higher rate of mortality than non-Hispanic whites (NHW), though the prevalence of CHD is lower in black men than in NHW (Colantonio et al., 2017). The Heart and Soul cohort did not find race was significantly associated with either perceived health or quality of life. However, lower income was associated with lower quality of life when adjusted for age, education, heart failure, cognition, physical activity, and physical function (Beattie et al., 2003). Low-income Americans who make less than $35,000 have higher rates of heart disease, physical limitations and comorbidities when compared to Americans who make more than $35,000 (Schultz et al., 2018). Low-income communities have fewer open spaces and parks, less access to fresh food and higher exposure to daily environmental stress (Khullar & Chokshi, 2018). Engagement with community leaders in low-income neighborhoods to support access to healthy foods and local fitness programs is necessary to improve quality of life for older adults with CHD.

Policy Implications

As the population of older adults increases, the number of adults on Medicare will increase from 54 million in 2015 to 80 million in 2030 (Medicare Payment Advisory Commission, [MediPAC] 2015). In addition, healthcare costs are expected to reach 19.6% of the economy at that time (Poisal et al., 2022). Therefore, policies that support holistic care of chronic CHD patients of older age are not only inclusive by acknowledging social determinants of health, but fiscally responsible, by focusing on evidence-based findings such as this study, which seek to promote healthier living in this population. Shifting CHD treatment from an illness-based model to a preventive model, such as the “delayed heart disease” model, could couple prevention strategies with up-and-coming innovations (Gaudette et al., 2015). It is estimated that adopting this strategy would result in a continuous reduction in health care spending through 2060, even as the absolute population increases. The prospect of this seems dire as health care coverage disruptions in the safety net program, Medicaid, are common (Sugar et al., 2021). This results in further gaps in social determinants of health: the uninsured population faces healthcare financial burdens (Tolbert et al., 2020), lower access to healthcare (Christopher et al., 2016) lower perceived health and increase in mortality (Sommers et al., 2012), making it unlikely that they will have the opportunity to join the "delayed heart disease" model.

Policy implications from this study include support of reduction of health care burdens for older adults with chronic CHD and the clinical providers who care for them. Assessment questions that can be integrated into electronic medical records to evaluate older adults with CHD on their perceived health status, quality of life, depression, and physical activities, would elevate clinical focus to more specific prevention in CHD patients. Likewise, priority support for further research to clarify and validate this study's unique findings could result in outcomes that benefit the U.S. fiscally through more specific assessments and clinical treatments, including patient self-treatment of advancing illness.

Future Direction

The future of healthcare is complex, as some are optimistic of a healthier older population (Gaudette et al., 2015), some are advising of workforce expansion (Fulmer et al., 2021), while others are concerned over the current population of uninsured (Tolbert et al., 2022). It is difficult to know which of these scenarios should take priority over the next decade. Currently, the inability of the healthcare system and insurers to provide consistent basic care for the older adult with chronic CHD, leaves the burden and responsibility on the individual. The future of health care is to bolster support for this population, not only in terms of access to care, but through prevention as self-care. Public health campaigns and policies such as smoking cessation (Greenlund et al., 2012; Wakefield et al., 2008) and participation in physical activity

(Ford et al., 2007) have been shown to reduce unhealthy behaviors and have contributed to lower prevalence and better outcomes. Health care policies could begin to include the fast-growing elder population with chronic disease in preventative assessment and treatment. Engaging this population in understanding their self-care barriers and promoting regular physical activities could benefit their perceived health status, reduce depression symptoms, and possibly show effects on quality of life.

Summary

Self-care is part of any medical treatment. Physical activity is an essential self-care behavior in CHD, but the benefits reach beyond the heart. Associated with hypertension and diabetes control, physical activity is also known to have primary prevention properties related to the brain including cognition and depression. Importantly, these papers found physical activity is associated with quality of life and better perceived health. Public investment and promotion of physical activity could have lasting benefits towards a healthy aging population. It is our responsibility since any self-care not done, is care not given.

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Supplemental Documents

Heart and Soul Study Questionnaires

The Heart and Soul Study
20 Years Follow Up Questionnaires
www.heartandsoulstudy.net

ACTIVITIES OF DAILY LIVING

Please answer these questions about how you take care of yourself AT THIS TIME. Each question is about some activity of daily living, things we all need to do as part of our daily lives.

AT THIS TIME, do you receive assistance with:	**Receive no assistance**	**Receive some assistance**	**Unable to do alone**
1. Washing or bathing yourself?	**0**	**1**	**2**
2. Dressing and undressing (other than tying shoes)?	**0**	**1**	**2**
3. Going to the toilet or cleaning yourself?	**0**	**1**	**2**
4. Getting in and out of bed or a chair?	**0**	**1**	**2**
5. Eating (other than precutting meat or buttering bread)?	**0**	**1**	**2**
6. Walking (other than using a single, straight cane)?	**0**	**1**	**2**
7. Using the telephone, including looking up and dialing numbers, and answering the phone?	**0**	**1**	**2**
8. Getting to places out of walking distance by using public transportation or driving your car?	**0**	**1**	**2**
9. Shopping for groceries or clothes?	**0**	**1**	**2**
10. Preparing, serving, and providing meals for yourself?	**0**	**1**	**2**
11. Doing light housework, such as dusting or washing dishes?	**0**	**1**	**2**
12. Doing laundry?	**0**	**1**	**2**
13. Taking pills or medicines in the correct amounts and at the correct times?	**0**	**1**	**2**
14. Handling your own money, including writing checks and paying bills?	**0**	**1**	**2**

AT THIS TIME:	**Never**	**Sometimes**	**Often**
15. How often do you have accidents with your bowels during the day or night?	**0**	**1**	**2**
16. How often do you wet yourself during the day or night?	**0**	**1**	**2**
IN THE PAST 2 WEEKS:	**$\geq$ 3 days**	**1 or 2 days**	**0 days**
17. How many times have you been outside of your house (or residence)?	**0**	**1**	**2**

PHYSICAL ACTIVITY

18. Which of the following statements best describes how **physically active** you have been during the last month, that is, done activities such as 15-20 minutes of brisk walking, swimming, general conditioning, or recreational sports?

0__Not at all active
1__A little active
2__Fairly active (1 to 2 times a month)
3__Quite active (3 to 4 times per month)
4__Very active (3 to 4 times a week)
5__Extremely active (5 or more times a week)

19. During the last month, how often have you been doing **light exercise** such as 15-20 minutes of walking at an average pace, sweeping or vacuuming, bowling, or gardening, etc.?

0__Not at all
1__Less than once per week
2__1-2 times per week
3__3 or more times per week

20. During the last month, how often have you been doing **moderate exercise** such as **15-20 minutes** of brisk walking, lawn mowing, light cycling, golf, or dancing, etc.?

0__Not at all
1__Less than once per week
2__1-2 times per week
3__3 or more times per week

21. During the last month, how often have you been doing **heavy exercise** such as 15-20 minutes of swimming laps, jogging, vigorous cycling, basketball, tennis, skiing, weightlifting, or hiking, etc.?

0__Not at all
1__Less than once per week
2__1-2 times per week
3__3 or more times per week

22. Thinking about the things you do (including recreation, exercise, work, and housekeeping), how would you rate yourself as to the amount of exercise you get compared with others of your age and sex?

1__Much less active
2__Somewhat less active
3__About the same
4__Somewhat more active
5__Much more active

PHQ-8				
Over the **LAST 2 WEEKS**, how often have you been bothered by any of the following problems?	**Not at all**	**Several days**	**More than half the days**	**Nearly every day**
23. Little interest or pleasure in doing things.	**0**	**1**	**2**	**3**
24. Feeling down, depressed, or hopeless.	**0**	**1**	**2**	**3**
25. Trouble falling or staying asleep or sleeping too much.	**0**	**1**	**2**	**3**
26. Feeling tired or having little energy.	**0**	**1**	**2**	**3**
27. Poor appetite or overeating.	**0**	**1**	**2**	**3**
28. Feeling bad about yourself, or that you are a failure or have let yourself or your family down.	**0**	**1**	**2**	**3**
29. Trouble concentrating on things, such as reading the newspaper or watching television.	**0**	**1**	**2**	**3**
30. Moving or speaking so slowly that other people could have noticed. Or the opposite, being so fidgety or restless that you have been moving around a lot more than usual.	**0**	**1**	**2**	**3**
31. Skip this question	**0**	**1**	**2**	**3**

MEDICATIONS

32. Overall, in the past month, how often did you take your medications as the doctor prescribed?

0__Less than half of the time
1__About half of the time (~50%)
2__Most of the time (~75%)
3__Nearly all the time (~90%)
4__All of the time

SOCIAL NETWORK

45. How many relatives do you have that you feel close to?

[0] None [1] 1 or 2 [2] 3 to 5 [3] 6 to 9 [4] 10 or more

46. How many close friends do you have? (People that you feel at ease with, can talk to about privet matters, and can call on for help.)

[0] None [1] 1or 2 [2] 3 to 5 [3] 6 to 9 [4] 10 or more

47. How many of these friends or relatives do you see at least once a month?

[0] None [1] 1 or 2 [2] 3 to 5 [3] 6 to 9 [4] 10 or more

48. Do you have as much contact as you would like with someone you feel close to, someone in whom you can trust and confide?

[1] Yes [0] No

49. Do you belong to any of these kinds of groups?

a) A social of recreational group:	[1] Yes	[0] No
b) A labor union, commercial group, or professional organization:	[1] Yes	[0] No
c) Church group:	[1] Yes	[0] No
d) A group concerned with children (PTA, Boy Scouts):	[1] Yes	[0] No
e) A group concerned with community betterment, charity, or service:	[1] Yes	[0] No
f) Any other group: **(if yes, please specify):**	[1] Yes	[0] No

PERCEIVED HEALTH AND QUALITY OF LIFE

50. Compared to other people your own age, how would rate your **overall health**?

__Excellent
__Very good
__Good
__Fair
__Poor

51. Compared to other people your own age, how would you rate your **overall quality of life?**

__Excellent
__Very good
__Good
__Fair
__Poor

THE SHORT PORTABLE MENTAL STATUS QUESTIONNAIRE (SPMSQ)

Question	Response	Incorrect Responses
1. What are the date, month, and year?		
2. What is the day of the week?		
3. What is the name of this place?		
4. What is your phone number?		
5. How old are you?		
6. When were you born?		
7. Who is the current president?		
8. Who was the president before him?		
9. What was your mother's maiden name?		
10. Can you count backward from 20 by 3's?		

SCORING:*
0-2 errors: normal mental functioning

3-4 errors: mild cognitive impairment

5-7 errors: moderate cognitive impairment

8 or more errors: severe cognitive impairment

*One more error is allowed in the scoring if a patient has had a grade school education or less.

*One less error is allowed if the patient has had education beyond the high school level.

Source: Pfeiffer, E. (1975). A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. Journal of American Geriatrics Society. 23, 433-41.

Heart and Soul Study Reference Table

Study Year:	0	1 to 4				5	6 to 11				12 to 15				20
Calendar Year	**2000-2002**	**2001-2005**				**2005-2007**	**2006-2011**				**2012-2015**				**2022**
Assessment:	IN PERSON (N=1024)	PHONE				IN PERSON (N=667)	PHONE				MEDICAL RECORDS				PHONE, MAILED SURVEY + MEDICAL RECORDS
Past medical history															
Demographic information	x	x	x	x	x	x									
Past medical history	x					x									
Psychiatric Interview	x	x	x	x	x	x									
Medication details	x	x	x	x	x	x									
Height, weight & waist:hip ratio	x					x									
Social Support	x	x	x	x	x	x									x
Cardiac measures															
Exercise treadmill test	x					x									
Resting & stress echocardiogram	x					x									
Electrocardiogram	x					x									
Blood pressure	x					x									
24 hour holter monitor	x														
6 minute walk test	x														
Lab measures															
24 hour urine cortisol	x					x									
24 hour urine catecholamines	x					x									
Inflammatory markers	x					x									
Lipids, kidney function	x					x									
NT-proBNP, BNP	x					x									
hs-Cardiac Troponin T	x					x									
Multiple other biomarkers	x					x									
Health behaviors															
Medication adherence	x					x									x
Physical activity	x					x									x
Smoking	x					x									
Outcomes (detailed chart review)															
Myocardial infarction		x	x	x	x	x	x	x	x	x					
Heart failure		x	x	x	x	x	x	x	x	x					x
Stroke or TIA		x	x	x	x	x	x	x	x	x					
Revascularization		x	x	x	x	x	x	x	x	x					
Arrhythmias		x	x	x	x	x	x	x	x	x					
Cardiovascular death		x	x	x	x	x	x	x	x	x					
All cause mortality		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Functional status															
Quality of life	x	x	x	x	x	x									x
Overall health	x	x	x	x	x	x									x
NYHA classification	x	x	x	x	x	x									
Activities of daily living	x	x	x	x	x	x									x
Cognitive function	x	x	x	x	x	x									x
Other															
Stored serum and plasma	x					x									
Stored urine	x					x									
Stored DNA	x					x									
Teleomere length	x					x									

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