UNIFORMED SERVICES UNIVERSITY, SCHOOL OF MEDICINE GRADUATE PROGRAMS
Graduate Education Office (A 1045), 4301 Jones Bridge Road, Bethesda, MD 20814

DISSERTATION APPROVAL FOR THE DOCTORAL DISSERTATION IN THE MEDICAL AND CLINICAL PSYCHOLOGY GRADUATE PROGRAM

Title of Dissertation: "Social Support, Perceived Stress, and Markers of Heart Failure Severity"

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Doctor of Philosophy Degree
July 10, 2012

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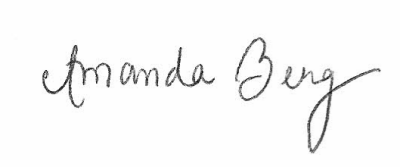

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## Abstract

*Title of Dissertation:* "Social Support, Perceived Stress, and Markers of Heart Failure Severity"

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*Introduction.* Evidence suggests that social support and stress may play important roles in the development and progression of heart failure, an end stage of cardiovascular disease (Mookadam & Arthur, 2004; Murberg & Bru, 2001). Cohen and Wills (1985) posit that social support may influence disease through direct effects and by buffering the impact of stress on health. The present study examined (1) the main effect of functional and structural social support, independently, on markers of heart failure severity; and (2) tested the stress-buffering effects of social support in persons with heart failure.

*Methods.* One hundred forty-seven heart failure patients completed health-related questionnaires (Kansas City Cardiomyopathy Questionnaire, KCCQ), performed functional assessments (Six Minute Walk Test, 6MWT), and supplied a blood sample to assess a physiological biomarker (β-natriuretic peptide, BNP). Functional and structural social support were assessed with the Interpersonal Support Evaluation List (ISEL-12) and Social Network Index (SNI), respectively; perceived stress was measured using the Perceived Stress Scale (PSS).

*Results.* Multivariate analyses revealed that, independent of recognized predictors, greater appraisal support (ISEL Appraisal subscale) was significantly associated with less severe symptom burden (KCCQ Functional Status scores; $\beta = .27$, $p = .003$). ISEL Tangible ($\beta = .21$, $p = .025$), ISEL Appraisal ($\beta = .33$, $p < .001$), overall ISEL scores ($\beta = .27$, $p = .003$), Social Network Size ($\beta = .26$, $p = .005$), Network Diversity ($\beta = .22$, $p = .024$), and the number of Embedded Networks ($\beta = .23$, $p = .014$) were also significantly predictive of better health-related quality of life (KCCQ Quality of Life domain). Interestingly, ratings of perceived stress mediated the majority of these relationships. Limited evidence was found for the stress-buffering hypothesis. Measures of functional and structural social support were unrelated to physiological and functional status heart failure markers.

*Conclusions.* Findings from this study suggest that perceptions of life stress may explain the relationship between social support and markers of heart failure severity, proposing the utility of future, empirically supported stress management interventions to improve symptom perceptions and quality of life for heart failure patients.

**Social Support, Perceived Stress,**

**and Markers of Heart Failure Severity**

By

Amanda E. Berg

Doctoral Dissertation submitted to the

Faculty of the Department of Medical and Clinical Psychology

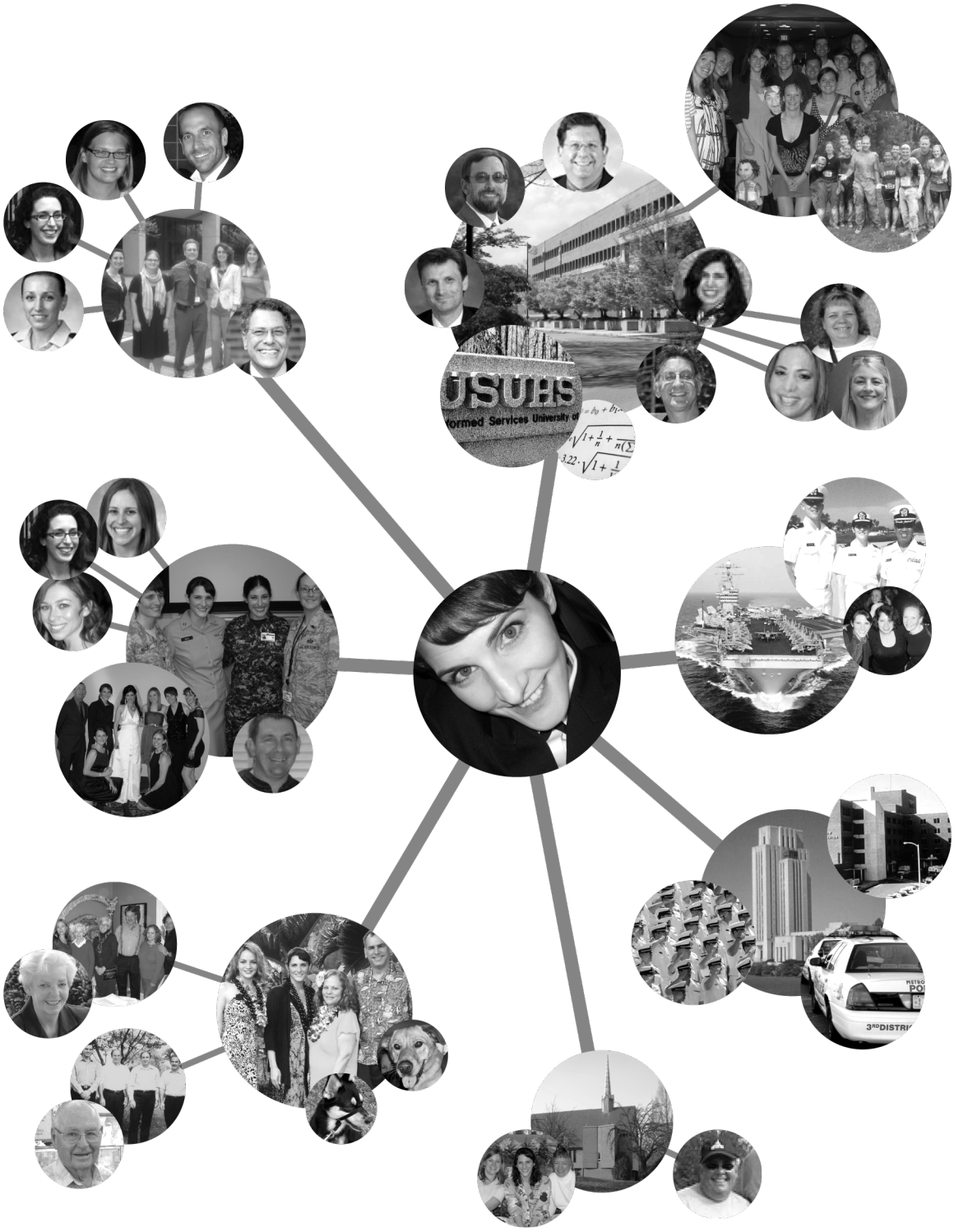
Graduate Program of the Uniformed Services University of the Health Sciences

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy, 2012

## Acknowledgements

Innumerable thanks to the many persons who have bestowed their tangible, emotional, belonging, and appraisal support throughout my graduate career and, in particular, this research project. Your generous support has been much appreciated!



## Dedication

To my grandmother, Joan Zimmerman, who during the course

of this research project was diagnosed with heart failure.

May you always be graced with abundant love and social support.

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## Introduction

Humans have long acknowledged an association between social relationships and health (House, Landis, & Umberson, 1988). “People are nourished by other people” (Wolf, 1992, as cited in Johnson, 1999, para. 1). However, the impact of social connections on cardiovascular health and longevity became scientifically evident when epidemiologists encountered an intimate community of multigenerational Italian-Americans nestled in Roseto, Pennsylvania. Medical researchers were drawn to the community in 1966 as residents were dying from myocardial infarction at roughly half the rate of the national average. Surprisingly, the citizens of Roseto displayed virtually no evidence of cardiovascular disease despite engaging in seemingly unhealthy behaviors such as smoking and poor dietary practices (Bruhn, 1965; Bruhn, Chandler, Miller, Wolf, & Lynn, 1966). After decades of investigation into this small community and neighboring townships, researchers determined that, "Roseto's stable structure, its emphasis on family cohesion, and the supportive nature of the community may have been protective against heart attacks and conducive to longevity" (Egolf, Lasker, Wolf, & Potvin, 1992, p. 1089).

Subsequent research has consistently demonstrated that socially supportive relationships enact beneficial influence on health outcomes (Berkman & Syme, 1979; Cohen & Syme, 1985; Holt-Lunstad, Smith, & Layton, 2010; House et al., 1988; Uchino, 2004). The presence of a supportive other appears to protect individuals from a variety of physical and mental health problems, including cardiovascular disorders such as coronary artery disease and hypertension (Everson-Rose & Lewis, 2005; Lett et al., 2005; Rozanski, Blumenthal, & Kaplan, 1999; Uchino, 2006).

Beyond exerting a direct beneficial influence on health, social support also buffers or protects individuals from the adverse effects that stress can impose on health. The influence of social support on health has been particularly relevant within the domain of cardiovascular health, as stress has been recognized as potent risk factor in the development and progression of cardiovascular conditions (Everson-Rose & Lewis, 2005; Rosengren, Tibblin, & Wihelmsen, 1991). Berkman and Syme (1979), for example, observed that persons who lacked social and community contacts displayed higher rates of all-cause mortality over nine years as compared with persons reporting more extensive social ties.

Despite abundant research examining the influence of social support on health (Berkman & Syme, 1979; Cohen & Syme, 1985; Holt-Lunstad et al., 2010; House et al., 1988; Uchino, 2004), findings remain inconclusive about what specific aspects of social support are health promoting and through what precise mechanisms social support shapes health outcomes. In particular, more research is needed within the domain of cardiovascular health because of the significant risk that modifiable, psychosocial factors such as depression and stress can impose on morbidity and mortality (Everson-Rose & Lewis, 2005; MacMahon & Lip, 2002; Rutledge, Reis, Linke, Greenberg, & Mills, 2006; Sherwood et al., 2007). A growing body of research has begun to examine the effects of psychosocial variables on clinical outcomes in patients with heart failure (Frasure-Smith et al., 2000; Kop, Synowski, & Gottlieb, 2011; Murberg & Bru, 2001), an increasingly prevalent disorder that represents the end stage of cardiovascular disease. Recent research conducted by this investigator has suggested that particular aspects of social support may be important for heart failure patients (Berg, 2011; Wawrzyniak et al., 2011). The present

study aims to expand upon this research by examining the direct and stress buffering effects of various types of social support, including structural and functional components, on markers of heart failure severity.

To provide a background for this investigation, the following manuscript will begin with an overview of heart failure as a health problem. Next, the composition will review the literature on social support and stress, including definitions of these variables as well as conceptual models and evidence linking each construct to health outcomes. Then, aims of the study will be presented in addition to the methods employed to examine these research questions. Finally, the manuscript will conclude with results of the investigation and a discussion of study findings including research limitations, strengths, and clinical implications.

**Heart Failure**

Heart failure is a symptomatic condition that occurs when the heart is unable to pump enough blood and oxygen to adequately supply other organs in the body (CDC, 2010). Nearly 5.8 million adults suffer from heart failure in the United States with 670,000 new cases diagnosed annually (AHA, 2010). According to the National Center for Health Statistics, one in eight deaths are attributable to heart failure (Lloyd-Jones et al., 2010). For those patients fortunate enough to evade mortality, heart failure can generate significant disability and deficits to quality of life due to symptoms associated with the condition (e.g., shortness of breath, chest pain; Westlake et al., 2002). Accordingly, heart failure remains a major contributor to national health care expenses with an estimated $39.2 billion spent annually on direct and indirect costs in 2010 (Lloyd-Jones et al., 2010).

### *Definition and etiology*

The American College of Cardiology and the American Heart Association define heart failure as a "complex clinical syndrome that can result from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill with or eject blood" (Hunt et al., 2005, pp. e158-e160). Simply described, heart failure develops over time as cardiac muscles grow weaker and are challenged to support the necessary pumping functions of the heart due to cardiovascular diseases. Conditions such as coronary artery disease, myocardial infarction, cardiomyopathies, and myocardial ischemia can generate damage to the heart that impairs its ability to pump the blood necessary to adequately maintain bodily systems. When the heart is unable to contract properly due to damage, this adaptive muscle employs compensatory strategies in an attempt to allow more oxygenated blood to reach peripheral systems (Heart Failure Association of the European Society of Cardiology, 2007). The heart may beat faster to keep the blood moving, stretch to expand in size allowing for the organ to hold more blood, or develop thicker muscle to help pump more blood with each beat. Over time these changes put more stress on the heart and body resulting in clinical symptoms such as fatigue, shortness of breath, peripheral edema, and chest discomfort (Chatterjee & Fifer, 2010). This failure of the heart to supply bodily systems with sufficient resources usually represents the end stage of cardiovascular disorders.

While heart failure is known to result from various types of dysfunction (e.g. systolic or diastolic dysfunction), the present study focused primarily on those individuals who are unable to pump more than 40 percent of blood from the left ventricle (systolic heart failure) as evidence suggests that persons with this type of heart failure may benefit

most from interventions due to the etiology of their conditions. Specifically, persons with systolic heart failure may benefit from psychosocial treatments targeting modifiable cardiovascular risk factors such as health behaviors, psychological stress, and social support resources (Das & O'Keefe, 2006).

### *Diagnosis and measurement of heart failure*

Since heart failure is known to result from a variety of structural and functional abnormalities, physicians routinely rely on a collection of diagnostic measures to determine the presence and severity of heart failure including physiological biomarkers, functional limitations, patient-reported symptoms, and health-related quality of life (Hunt et al., 2005).

***Physiological measurements.*** The evaluation of the pumping function of the heart (i.e., ejection fraction) is an important measurement in diagnosing heart failure as various physiological assessments of cardiac function aid in determining the existence and severity of heart failure. Measures such as echocardiograms, stress tests, and biomarkers can provide an objective view into the manifestation and progression of cardiovascular conditions (Hunt et al., 2005). While many objective indicators of heart failure have been identified (e.g., ejection fraction, biomarkers), clinicians and researchers have particularly recognized the utility of the biomarker β-natriuretic peptide (BNP) for the diagnostic assessment of heart failure (Dao et al., 2001; Miller, Redfield, & McConnell, 2007; Yamamoto et al., 1996). Secreted from cardiac myocytes, BNP is a peptide released to counter the physiological effects associated with myocardial stretch resulting from high pressure filling, increased arterial pressure, or cardiac dilation (Miller et al., 2007). BNP is routinely used in the clinical assessment of heart failure severity, although some

evidence suggests that BNP concentrations have the potential to exhibit poor sensitivity and specificity for cardiac dysfunction and may demonstrate within-person variability over time (Hetmanski, Sparrow, Curtis, & Cowley, 2000; Takeda, Takeda, Suzuki, & Kimura, 2009). Nevertheless, BNP has been recognized as a clinically valuable marker for assessing heart failure severity.

***Functional status.*** Understanding the degree to which patients can participate in activities of daily living can provide health care professionals with further indication of heart failure impairment and the functional limitations imposed by heart failure (Hunt et al., 2005). One well-adopted measure of functional status used for persons with heart failure is the Six Minute Walk Test (6MWT), which evaluates the distance a person can walk in six minutes. Developed by the American Thoracic Society (2002), the 6MWT is a safe and easily administered assessment that closely resembles the demands patients encounter in daily life. The 6MWT provides an evaluation of global and integrated responses of pulmonary, cardiovascular, and neuromuscular systems during exercise and has been widely accepted in clinical and research settings as a practical measure of functionality in cardiovascular patients (ATS, 2002).

Functional status for heart failure patients may also be categorized in accordance with the New York Heart Association (NYHA) classification system, which designates ratings of heart failure severity and prognosis. Established by the New York Heart Association (1994), this hierarchy assigns patients to varying classes of heart failure depending on their reported symptoms and functional impairment. Higher classes of heart failure represent greater disability and limitations in physical activity, reflecting more severe cardiac conditions (Hunt et al., 2005).

***Self-reported symptoms and health-related quality of life.*** Patient-reported symptoms such as fatigue, shortness of breath, peripheral edema, and chest discomfort provide further indication to medical professionals that the heart may be overworking to compensate for cardiac damage (Hunt et al., 2005). In addition, descriptive reports of worsened health-related quality of life help health care providers assess the global impact that heart failure imposes on overall patient health. Health-related quality of life has been defined as a multidimensional concept incorporating the subjective evaluation of a person's functional capacity, psychological state, physical health, social functioning, and health perceptions (Guyatt et al., 1985; Kamphuis et al., 2002; Moser & Worster, 2000). To assess the presence and severity of cardiac-related symptoms and health-related quality of life, health care professionals frequently rely on medical interviews and self-reported assessment measures. One routinely used, disease-specific instrument administered to provide a measure of secondary effects related to heart failure is the Kansas City Cardiomyopathy Questionnaire (KCCQ). A validated, self-administered questionnaire, the KCCQ quantifies physical limitations, symptoms, self-efficacy, social interference, and quality of life as specifically experienced by heart failure patients (Green, Porter, Bresnahan, & Spertus, 2000).

### *Heart failure risk factors*

***Demographic and lifestyle risk factors.*** Demographic variables such as advanced age and male gender, for example, have been consistently linked to a higher risk for heart failure, likely due to a greater prevalence of coronary heart disease among persons within these populations (Listerman, Huang, Geisberg, & Butler, 2007). African Americans also exhibit greater heart failure incidence and higher cardiovascular mortality rates as

compared with non-African Americans, often attributed to greater levels of atherosclerotic risk factors and insufficient health behaviors resulting from socioeconomic limitations (Lloyd-Jones et al., 2010; McCullough et al., 2002). Among all persons, poor health behaviors have been identified as contributors to cardiovascular disease risk. Specifically, limited physical activity, cigarette smoking, inadequate nutrition, and alcohol consumption have been significantly associated with an increased risk for heart failure (He et al., 2001; Listerman et al., 2007). For example, active smokers are 30% more likely to die due to heart failure as compared with former smokers (Lightwood, Fleischmann, & Glantz, 2001). Similarly, excessive alcohol consumption has been linked to the development and exacerbation of heart failure secondary to direct toxicity effects imposed on the myocardium (Listerman et al., 2007). Obesity also remains an established risk factor for heart failure in addition to other cardiovascular conditions with the risk of heart failure increasing 5% and 7% in males and females, respectively, for each single unit increment of increasing BMI (Kenchaiah et al., 2002).

***Medical risk factors.*** Medical comorbidities have, likewise, been shown to be predictive of heart failure independent of other known risk factors (He et al., 2001; van Melle et al., 2010). Among the medical variables associated with heart failure, hypertension is the most common risk factor recognized for contributing to congestive heart failure (Levy, Larson, Vasan, Kannel, & Ho, 1996). Similarly, patients with diabetes are more likely to develop heart failure than nondiabetic patients matched for age and gender (Nichols, Gullion, Koro, Ephross, & Brown, 2004). Adverse cardiac events such as a myocardial infarction (heart attack) can further interrupt the appropriate

functioning of the heart, resulting in cardiovascular damage that greatly increases heart failure risk (Levy et al., 1996; Listerman et al., 2007).

***Psychosocial risk factors.*** A number of psychosocial variables have also been implicated in the development and progression of heart failure (Everson-Rose & Lewis, 2005; MacMahon & Lip, 2002). Depression, for example, has received considerable attention as risk factor for heart failure (Kop et al., 2011; Rutledge et al., 2006). Depressive symptoms are not only common among patients presenting with heart failure, but have also been significantly associated with increased rates of mortality, clinical events, hospital readmission, and health care utilization among persons with heart failure (Jiang et al., 2001; Kop et al., 2011; Rutledge et al., 2006; Sherwood et al., 2007; Vaccarino, Kasl, Abramson, & Krumholz, 2011). The absence of social support and accumulation of stress have also been recognized as risk factors for the onset and exacerbation of heart failure (Das & O'Keefe, 2006; Everson-Rose & Lewis, 2005; MacMahon & Lip, 2002). Given the interest of the present study in these variables, the following sections of this dissertation will review these psychosocial risk factors in greater depth, beginning with the construct of social support.

## Social Support

### *Definition*

Social support is a broad term that refers to a variety of means by which social relationships influence health and well being (Cohen, Underwood, & Gottlieb, 2000). According to Lin (1986), social support can be defined as "the perceived or actual instrumental and / or expressive provisions supplied by the community, social networks, and confiding partners" (p. 18). Oxman and Berkman (1990) offer a framework to

conceptualize the vast construct of social support emphasizing three dimensions of social relationships to include (1) "the quantitative structure and composition of the social network," (2) "the type and amount of social support functions the network provides," and (3) "the qualitative perceived adequacy of that support" (McCauley, 1995, p. 76). Accordingly, the construct of social support is often defined in terms of the structure of one's social relationships or the functions rendered by social contacts (House & Kahn, 1985). Although interrelated, the structure and function of social relations constitute distinct constructs that describe and measure unique facets of social support.

### *Types of social support*

***Structural social support.*** Structural social support refers to the support generated by "the existence of and interconnections between social ties" (Cohen & Syme, 1985, p. 11). Structural aspects of social support provide a sense of the breadth and depth of one's social system, capturing the network of social relations that an individual maintains along with the degree to which a person is integrated within social relationships. The quantitative structure and composition of social relationships may include the number of members within a social network, the frequency of contacts, duration of relationships, or homogeneity of social connections. Such information provides indication of the availability of supportive contacts without attending to the actual use or perceived adequacy of social resources (McCauley, 1995). Interpersonal resources from structural social support are, therefore, garnered through the participation in and contact with social others for the purpose of interaction without the explicit exchange of help or support (Cohen et al., 2000).

*Measuring structural social support.* The measurement of structural social support involves a quantitative assessment of the structure and composition of social relationships. Thus, the multidimensional construct of structural social support is often assessed in the accordance with the number of recognized social positions or identities a person holds in addition to the frequency of social activities and the perceived embeddedness one maintains within a social structure (Cohen et al., 2000). Generally considered to represent objective features of social relationships, assessments of structural support aim to identify network characteristics such as size, density, complexity, homogeneity, and stability (Brissette, Cohen, & Seeman, 2000). One commonly used measurement of structural social support is the Social Network Index (SNI) developed by Cohen and his collaborators (1997) which evaluates participation in twelve varieties of social relationships including marital, familial, and community contacts. Reflecting the composition of social networks, the SNI provides a measure of network diversity, the number of social contacts, and quantity of embedded networks within which the respondent is actively engaged (Cohen et al., 1997). This instrument, among other social network measures, has been shown to be valuable for the assessment of features such as stability, predictability, belongingness, and control afforded by social contacts and group membership (Cohen & Syme, 1985).

***Functional social support.*** Alternatively, functional social support refers to the emotional, informational, instrumental, and companionship resources furnished by social contacts (Cohen et al., 2000). Functional components of social support emphasize the type of support garnered from social ties and often include the perceived adequacy of support resources (McCauley, 1995). According to Cohen and Syme (1985), functional

social support is derived from psychological representations constructed by individuals of support systems based on the subjective appraisal of available resources. Hence, functional social support instruments commonly examine perceived support assets along with resources actually received in the context of formal and informal helping relationships (Cohen et al., 2000).

According to Cohen and colleagues (2000), social relationships can serve many supportive functions to include the provision of emotional, informational, instrumental and companionship resources in response to need. *Emotional support,* for example, permits the expression of feelings and reception of acceptance by others necessary for altering threat evaluation and enhancing self-esteem. *Informational support* (also referred to as *appraisal support*) describes the availability of valuable sources of information and guidance needed to obtain desired services or effectively cope with life events (Cohen et al., 2000). *Instrumental* or *tangible support* denotes resources directed toward resolving practical problems such as providing monetary aid, transportation, or daily care assistance. *Companionship support,* which represents a sense of personal belonging, refers to the accessibility of others with whom to engage in social activities for mood enhancing or problem distraction benefits (Cohen et al., 2000). Although researchers have explored both the structure and function of social support, functional qualities of social relationships are commonly viewed to be better predictors of health and health behaviors (Cohen & Syme, 1985).

*Measuring functional social support.* To evaluate the functions afforded by social relationships, researchers primarily rely on self-report instruments and clinical interviews in determination of the availability of resources granted by social ties. These measures

are designed to assess one or more supportive functions exchanged through social relationships that can be leveraged to manage environmental and psychological stressors (Wills & Shinar, 2000). The Interpersonal Support Evaluation List (ISEL; Cohen & Hoberman, 1983), for example, is a multidimensional inventory that was developed to assess supportive functions of social relationships including informational, instrumental, and companionship resources. Instruments such as the ISEL have frequently been used in health-related research, particularly as social support has been recognized to be a protective factor in the development and progression of disease (Holt-Lunstad et al., 2010; Lett et al., 2005; Uchino, 2006; Uchino, Cacioppo, & Kiecolt-Glaser, 1996).

**Social Support and Health**

Whether arising from the structure or function of social relations, accumulating evidence has recognized the protective influence of social support on a variety of health outcomes (Brady & Helgeson, 1999; Cohen & Syme, 1985; Theorell et al., 1995). The absence of social support has also been identified as a risk factor for psychological well being, the onset and exacerbation of illness, and even mortality (Avison & Gotlib, 1994; Cohen et al., 1997; Holt-Lunstad et al., 2010). For example, in the classic epidemiological study conducted by Berkman and Syme (1979) examining 2,229 males and 2,496 females in Alameda County, California, researchers found that socially isolated persons were more likely to die from both all-cause and cardiac conditions as compared with individuals reporting extensive social contacts. Relationships between social connections and mortality were found across age groups and shown to be independent of self-reported physical health status, socioeconomic status, and health practices

including smoking, alcoholic beverage consumption, obesity, physical activity, and preventative health service utilization over a nine-year period (Berkman & Syme, 1979).

### *Conceptual models linking social support and health*

Given the apparent relationship between social support and health, more recent attention has been directed toward theorizing and testing potential processes by which social support may exert beneficial influence. The most widely cited conceptual framework for the effects of social support on health is provided by Cohen and Wills (1985) who propose two models to explain the link between social support and well being termed the *main effect* and *stress-buffering hypotheses.*

***Main effect hypothesis.*** The *main effect hypothesis* posits that social relationships directly impact health in that social resources enact beneficial effects irrespective of the presence or absence of stress (Cohen & Wills, 1985). Theorists propose that social relations may expose individuals to social pressures that affect normative health behaviors, provide access to services or information, or enhance positive psychological states to enhance health. Integration within a social network presumably offers perceived stability, predictability, belongingness, and recognition of self-worth that can benefit well being and bolster physical and psychological health (Cohen et al., 2000). Medical compliance is one example of a positive main effect of social support on health. Meta-analytic summaries reflecting 51 empirical journal articles, for instance, suggest that individuals who are married are 1.27 times more likely to adhere to recommended medical treatments as compared with those persons who are single (DiMatteo, 2004). Although social influences are primarily thought to be beneficial for health, some social relationships have been shown to negatively impact health behaviors as has been

observed in the spread of obesity. In a hallmark investigation evaluating interconnected social networks of 12,067 individuals, Christakis and Fowler (2007) noted that individuals were 57% more likely to become obese over time if they were acquainted with persons who also became obese during the same time period.

***Stress-buffering hypothesis.*** In contrast, the *stress-buffering hypothesis* contends that social relationships influence health through the prevention or lessening of responses to stress. Cohen and Wills (1985) describe that "support 'buffers' (protects) persons from the potentially pathogenic influence of stressful events," thereby safeguarding or augmenting health (p. 310). According to the stress-buffering model, social support resources intervene in the causal chain linking stress and health through alterations in stress appraisal (i.e., shifts in the perception of threat or coping resources) and adjustments to emotional, physiologic, and behavioral responses (Cohen et al., 2000; Cohen & Wills, 1985). An example of this phenomenon has been observed among breast cancer survivors reporting decreased bodily pain and ameliorated physical activity restrictions due to positive reinterpretation brought about by partner emotional support and oncologist informational support (Brady & Helgeson, 1999).

As the present study is interested in examining both the direct and stress-buffering effects of social support on heart failure severity, the following sections will review the construct of stress and briefly outline empirical evidence for the relationship linking stress with health.

## Stress

### *Definition and brief history*

Hans Selye (1950) — a major pioneer in the area of stress research — originally viewed stress as an "integrated syndrome of closely interrelated adaptive reactions," or biological responses that were activated when an organism encountered intensive stimuli (Selye, 1950, p. 4667). Later, researchers and health professionals reframed views on stress to include the environmental factors that placed adaptive demands on organisms, resulting in vulnerabilities to disease and illness (Holmes & Rahe, 1967; Meyer, 1951). The concept of stress was again reconceived to accommodate interactions between environmental demands and cognitive processes such as appraisal, or the personal evaluation of encountered threats and accessible coping resources (Lazarus & Folkman, 1984).

Accordingly, the expansive construct of stress has been assigned many definitions depending on the stress model or the theoretical perspective to which one prescribes. In accordance with biological perspectives, Selye defined the term "stress" as a "non-specific response of the body to any demand for change" (American Institue of Stress, 2011, para. 2). More contemporary definitions cited by the American Institute of Stress (AIS, 2011) describe stress as a "physical, mental, or emotion strain or tension" as well as "a condition or feeling experienced when a person perceives that demands exceed the personal and social resources the individual is able to mobilize" (para. 1). Lazarus and Folkman (1984) support that "stress be treated as an organizing concept for understanding a wide rage range of phenomena of great importance in human and animal adaption" (p. 11). Modern theoretical views continue to acknowledge the evolving

concept of stress, taking into account these diverse, historical perspectives when examining stress in contemporary research.

A comprehensive review of stress perspectives is beyond the scope of this dissertation. However, as the present study intends to examine models of stress and social support, the following sections will provide a brief review of stress perspectives as related to health outcomes.

### *Stress perspectives*

***Biological stress perspective.*** Based on the work of Walter Cannon (1932) and later research conducted by Hans Selye (1950, 1951), the concept of stress was initially focused on the activation of physiological systems initiated in response to physical and psychological demands. Researchers observed that organisms would engage in compensatory activity to restore disturbances in bodily systems, or maintain "homeostasis" (Cannon, 1932; Selye, 1993). According to the biological stress perspective, prolonged or repeated activation of bodily systems threatened to place an organism at risk for illness and disease (Cohen, Kessler, & Gordon, 1995). In this regard, the construct of stress was considered a response or the resulting effect of noxious conditions that triggered adaptive, defense mechanisms (Lyon, 2000).

Selye (1950, 1951) proposed that pathogens along with environmental and psychological stressors evoked comparable patterns of physiological responding across organisms that, over time, threatened long-term physiological outcomes. Specifically, he noted pituitary-adrenal reactions to stress that seemed to occur in three stages of response, which he termed the General Adaption Syndrome (GAS). Selye (1951)

recognized that the end stage of this process (i.e., exhaustion) was characterized by prolonged stress that placed organisms at risk for organ damage and bodily disease.

*Measuring biological stress.* Biological stress reactions can be measured using a variety of physiological indicators (Cohen et al., 1995). For example, laboratory studies may rely on measures of skin conductance, muscle tension, pupil dilation, or brain activity as physiological markers of stress responses. Similarly, blood samples can be drawn from stressed subjects to examine fluctuations in neuroendocrine and inflammatory markers such as cortisol and catecholamines (White & Porth, 2000). Stress responses can also be quantified using assessments of cardiovascular reactivity to include measuring changes in heart rate, blood pressure, and peripheral blood flow in response to stress (Krantz & Falconer, 1995).

***Environmental stress perspective.*** The 1960's welcomed a conceptual shift in defining the concept of stress as psychologists became interested in understanding how persons are changed by and respond to adverse life experiences. This perspective broadly sought to incorporate psychological and environmental factors into the construct of stress (Lyon, 2000). The tradition of examining environmental stress focuses on the evaluation of environmental events or life experiences, called “stressors,” that are associated with substantial adaptive demands (Cohen et al., 1995). According to the environmental stress perspective, elements within an organism's environment have the potential to impact health when accumulated, chronic, or failed adaption efforts result in vulnerability to physical and mental disease. Accordingly, researchers began to recognize the importance of assessing environmental demands and life events of persons presenting with illness (Holmes & Rahe, 1967; Meyer, 1951).

*Measuring environmental stress.* Early assessments of environmental stress encouraged by psychiatrist Adolf Meyer (1951) relied on life charts whose purpose was to document those circumstantial events experienced by patients to offer insight into the etiology or maintenance of disease. Since these early inventories, formal instruments have been designed to assess potentially stressful environmental events and life experiences (Cohen et al., 1995). For example, the Social Readjustment Rating Scale (SRRS) developed by Holmes and Rahe (1967) was developed to measure life events as well as assign standardized weights based on the perceived difficulty of adjustment, or "life change units," that the event required. Later, self-report environmental stress inventories began to address not only major life events, but also recognized the need for assessing minor daily and weekly stressors (Jones & Brantley, 1989; Zautra, Guarnaccia, & Dohrenwend, 1986). Interview measures were also developed to measure the presence of stressful life events that yielded more detailed, descriptive information concerning reported environmental stressors (Cohen et al., 1995).

***Psychological stress perspective.*** The work of social-personality psychologist Richard Lazarus incorporated an emphasis on the role of cognitive appraisal in the stress process (Lazarus & Folkman, 1984). According to Lazarus and his transactional model, stress did not arise solely in response to a life event, but rather in consequence to a transaction between the person and environment. The psychological stress perspective, accordingly, emphasizes an individual's subjective evaluation of their ability to manage the demands posed by life experiences and events (Cohen et al., 1995). Based in psychological models asserting that events are only influential when appraised as stressful, the psychological tradition of assessing stress emphasizes individual

perceptions of the potential harm posed by objective environmental elements. This stress appraisal, or "perceived stress," is determined not only through the assessment of environmental stimuli, but also incorporates an evaluation of available coping resources that persons may leverage in response to stress. This evaluative process proposed by Lazarus and Folkman (1984) includes two stages of primary and secondary appraisal. In primary appraisal, persons first consider the meaning of the stimulus in determination of whether presenting circumstances are deemed benign, stressful, or irrelevant to the organism (Lazarus & Folkman, 1984). If a stimulus is appraised as requiring a coping response to lessen or eliminate stress consequences, individuals initiate a secondary appraisal to evaluate accessible resources or capabilities for responding (Lazarus & Folkman, 1984). When effective coping resources are available, the threatening stimulus can be mitigated to diminish the stress response. However, when coping resources are not sufficient to outweigh the demands imposed by the presenting stimulus, adverse reactions cannot be attenuated and stressful responding occurs. These appraisal processes take place both following the onset of presenting stimuli as well as over the course of stressful events (Cohen et al., 1995).

*Measuring psychological stress.* Psychological stress is commonly assessed in accordance with individual perceptions of stressful experiences and personal evaluations of coping resources (Monroe & Kelley, 1995). Thus, assessments of psychological stress typically rely upon self-report measures to capture the construct of stress appraisal. According to Monroe and Kelley (1995), the only empirically established instrument of stress appraisal aligned with the theoretical perspective proposed by Lazarus and Folkman (1984) is the Perceived Stress Scale (PSS). The PSS has been developed to

assess “the degree to which respondents [find] their lives unpredictable, uncontrollable, and overloading” (Cohen, Kamarck, & Mermelstein, 1983, p. 387).

### *Unified model linking stress perspectives and health*

Cohen and colleagues (1995) offer a heuristic model integrating the previously outlined stress perspectives to illustrate means by which stress may influence disease and illness. According to the model (Figure 1), the emergence of environmental demands prompt an evaluation in consideration of whether the presented demands pose a threat to the organism and whether the recipient possesses sufficient adaptive capacities for coping with the stressor. If environmental demands are assessed as burdensome and coping

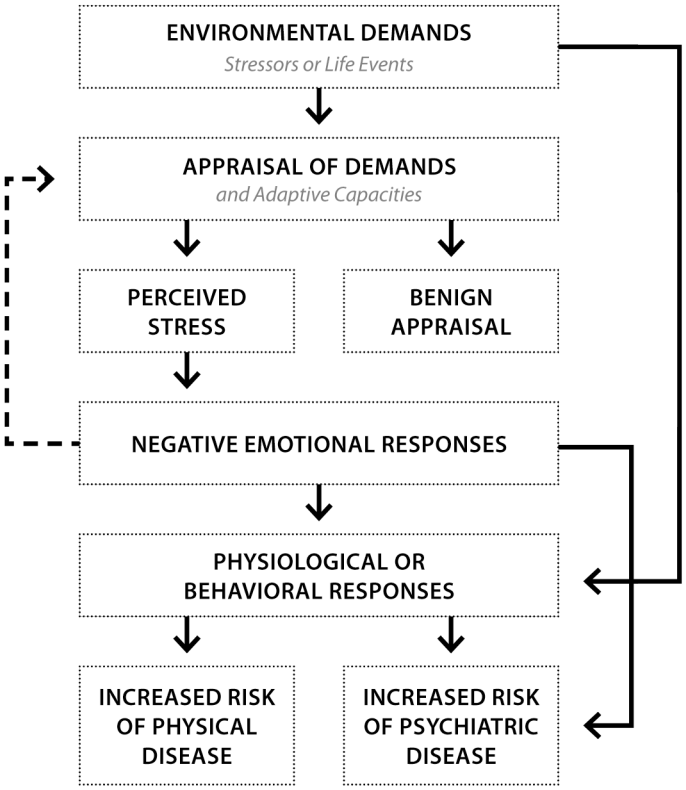



*Figure 1. Heuristic model of the stress process integrating environmental, psychological, and biological approaches to stress measurement (Cohen, Kessler, & Gordon, 1995).*

resources are deemed inadequate, the organism may perceive his or her circumstances as stressful. Such evaluations often provoke negative emotional responses in addition to behavioral and physiological reactions that place the organism at risk for poor health outcomes. Cohen and his collaborators (1995) also acknowledge that environmental demands bear the potential to generate increased risk for physical and psychiatric illnesses independent of appraisal processes based on evidence demonstrating adverse physiological and behavioral changes even among persons who perceive stressors as benign (Cohen, Tyrrell, & Smith, 1993).

The influence of stress on health is particularly relevant within the domain of cardiovascular health. Acute and chronic environmental and psychological stress have been found to be significant risk factors for morbidity and mortality among persons with cardiovascular conditions (Macleod, Smith, Metcalfe, Carroll, & Hart, 2001; Nielsen, Kristensen, Schnohr, & Gronbaek, 2008; Rosengren et al., 1991; Steptoe, 2000). In particular, the INTERHEART study, which investigated 11,119 patients and 13,648 matched controls from 52 countries around the world, revealed that self-reported stress accounted for approximately one-third of the attributable risk for acute myocardial infarction, emerging as a more potent risk factor than recognized predictors such as diabetes, obesity, poor nutrition, and limited physical activity (Rosengren et al., 2004). As such, the following section will review the constructs of stress and social support as specifically related to heart failure.

## Social Support, Stress, and Heart Failure

### *Social support and heart failure*

In the realm of cardiovascular health, social support has been linked to a variety of positive health behaviors and lifestyle factors in addition to being associated with reduced cardiovascular morbidity and mortality (Eriksen, 1994; Everson-Rose & Lewis, 2005; Lett et al., 2005; Rozanski et al., 1999; Strike & Steptoe, 2004; Uchino, 2006; Uchino et al., 1996). As previously reviewed, epidemiological studies have consistently found that social isolation and a lack of social resources place patients at greater risk for disease progression and cardiovascular death (Eriksen, 1994; Everson-Rose & Lewis, 2005; Lett et al., 2005; Rozanski et al., 1999). Even among healthy adults, prospective studies have demonstrated that the absence of structural and functional social support are associated with greater incident coronary heart disease, cardiac events, and mortality (Everson-Rose & Lewis, 2005; Lett et al., 2005). Specifically with respect to heart failure, social networks and perceived social resources have been associated with more favorable health outcomes among heart failure patients including reduced hospitalizations, improved physical limitations, better quality of life, and enhanced survival as previously reviewed (Mookadam & Arthur, 2004; Moser, 2002; Pelle, Gidron, Szabo, & Denollet, 2008). In particular, structural and functional aspects of social support have been examined independently among persons with heart failure.

***Structural social support and heart failure.*** Investigations exploring the relationship between structural social support and heart failure outcomes have yielded mixed results regarding the impact of social networks on heart failure. For instance, a number of studies have found social isolation and single marital status to be predictive

of increased hospital readmission and mortality independent of demographic and clinical predictors (Chin & Goldman, 1997; Friedmann et al., 2006; Murberg & Bru, 2001). Rodriguez-Artalejo and colleagues (2006), specifically, observed that emergency hospital readmission was more frequent among heart failure patients endorsing moderate and small social networks over a six-month period compared with persons reporting large social networks. In another study investigating functional limitations and symptoms, social network size was negatively correlated with functional status among 227 hospitalized heart failure patients (Yu, Lee, Woo, & Thompson, 2004). Lack of social integration has further predicted incident heart failure over a decade in a prospective examination of 5,888 community-dwelling elderly persons ranging from 65 to 100 years of age (Rogers, 2008). Physiological markers of heart failure severity (e.g., Interleukin-6, C-reactive protein, tumor necrosis factor-$\alpha$), although have shown inconsistent relationships with measures of social integration and social support (Rogers, 2008). Rod, Anderson, and Prescott (2011) also did not observe an association between structural aspects of social networks and heart failure hospitalizations in a sample of 8,670 adults free of cardiovascular conditions when followed over 15 years. Likewise, structural social support as determined by marital status was not significantly associated with health-related quality of life endorsed by heart failure patients (Heo, Moser, Chung, & Lennie, 2010).

***Functional social support and heart failure.*** More extensive research has been conducted in the area of functional social support as related to heart failure. In some studies, perceived social support has been observed to be a significant predictor of heart failure hospitalizations and mortality, independent of other known risk factors (Chung,

Lennie, Dekker, Wu, & Moser, 2011; Krumholz et al., 1997; Murberg & Bru, 2001; Tsuchihashi-Makaya, Kato, Chishaki, Takeshita, & Tsutsui, 2009). Namely, Chung and collaborators (2011) found that heart failure patients reporting low perceived social support displayed a 50 percent greater risk of hospitalization and death over 3 years compared with patients endorsing high perceived social support. Heo and colleagues (2010), however, did not observe a significant association between the quality of perceived social support and event-free survival among heart failure patients. In both prospective and cross-sectional studies, results have been inconsistent with respect to the relationship between functional limitations and heart failure symptoms (Bennett, Baker, & Huster, 1998; Clark, Tu, Weiner, & Murray, 2003; Paukert, LeMaire, & Cully, 2009; Rogers, 2008; Shen et al., 2011; Yu et al., 2004). With respect to physiological markers of heart failure severity, the pro-inflammatory cytokine Interleukin-6 (IL-6) has been shown to be inversely related to perceived social support in males, but not females, suggesting that functional social support may impact gender-specific inflammatory response patterns germane to heart failure progression (Rogers, 2008). For health-related quality of life, perceived social support has been significantly linked to physical and emotional quality of life in patients diagnosed with heart failure with the absence of supportive resources associated with elevated depressive symptoms and poorer disease prognosis (Bennett et al., 2001; Clark et al., 2003; Heo et al., 2010; Trivedi et al., 2009).

Overall, studies examining the overarching construct of social support and cardiovascular health largely suggest a beneficial influence of social support on heart failure outcomes (Everson-Rose & Lewis, 2005; Lett et al., 2005; Rozanski et al., 1999;

Uchino, 2006). When investigating structural and functional aspects of social support independently, however, research reveals mixed results concerning the relationship between social networks, functional support resources, and heart failure severity. While a multitude of studies substantiate an association between increased structural and functional social support and favorable heart failure outcomes, particularly with regard to functional status, reported symptoms, medical events, and mortality (Chung et al., 2011; Friedmann et al., 2006; Murberg & Bru, 2001; Tsuchihashi-Makaya et al., 2009), a number of investigations show no relationship between components of social support and heart failure severity (Heo et al., 2010; Rod et al., 2011; Shen et al., 2011). Therefore, the relationship linking structural and functional support with heart failure outcomes remains inconclusive.

***Perceived stress and heart failure***

Literature that specifically examines perceived stress in heart failure suggests a connection between psychological stress and heart failure outcomes. Early research exploring psychological stress as related to health recognized perceived stress as a noteworthy precipitate to heart failure events (Chambers & Reiser, 1953). Decades later, a prospective examination of psychosocial variables and cardiac health found a significant association between higher levels of perceived stress, as determined by repeated assessments of the Perceived Stress Scale (PSS) at three month intervals over two years, and heart failure incidence (Brummett et al., 2004). Koizumi and collaborators (2009) further observed that perceived stress was associated with low plasma BNP concentrations — a known clinical predictor of congestive heart failure — among 806 Japanese participants receiving annual heath checkups. The researchers interpreted these

results to mean that, “perceived stress might reduce plasma BNP concentrations” in a cardioprotective manner through either the “impaired synthesis or increased expression of the natriuretic clearance receptor” (Koizumi et al., 2009, p. 1059).

In summary, although considerable evidence favors a relationship between stress and cardiovascular health (Das & O'Keefe, 2006; Everson-Rose & Lewis, 2005; Rosengren et al., 2004), limited research has been dedicated to specifically examining the role of perceived stress among persons diagnosed with heart failure. A single study conducted suggests that greater perceived stress is associated with poorer heart failure outcomes (Brummett et al., 2004).

***Social support, stress, and cardiovascular responses***

Accumulating evidence suggests that social support is protective in cardiovascular disease and heart failure (Das & O'Keefe, 2006; Everson-Rose & Lewis, 2005; Lett et al., 2005; Murberg & Bru, 2001; Uchino, 2006). However, limited research has been applied to test the stress-buffering model with respect to cardiovascular diseases, aside from cardiovascular stress reactivity studies conducted in the laboratory. Unfortunately, cardiovascular reactivity research has yielded inconclusive findings and conflicting results with regard to the stress-buffering effects of social support. For instance, structural aspects of support, including social network size, have been found to moderate the relationship between stress and cardiovascular reactivity in laboratory investigations (Gerin, Milner, Chawla, & Pickering, 1995; Phillips, Carroll, Ring, Sweeting, & West, 2005; Roy, Steptoe, & Kirschbaum, 1998). Although, other investigations have reported that the presence of a supportive companion does not appear to attenuate or augment vascular or myocardial response patterns to mental stress (Anthony & O'Brien, 1999;

Christian & Stoney, 2006). Regarding functional social support, subjective appraisals of support both significantly reduced cardiovascular reactivity in response to stress (Cyranowski, Hofkens, Swartz, & Gianaros, 2011; Lee, Suchday, & Wylie-Rosett, 2011; Steptoe, 2000) and resulted in nonsignificant effects to biological outcomes (Christian & Stoney, 2006; Gerin et al., 1995). Moreover, perceived social support did not reduce stress-induced inflammatory markers (e.g., IL-6, CRP, and fibrinogen antigen) in healthy adults (Mezuk, Roux, & Seeman, 2010), however, has been shown to buffer the impact of depression on mortality among heart failure patients following myocardial infarction (Frasure-Smith et al., 2000).

## Summary and Study Rationale

Overall, considerable research supports the direct protective influence of social support on cardiovascular health (e.g., coronary artery disease, hypertension; Das & O'Keefe, 2006; Everson-Rose & Lewis, 2005; Lett et al., 2005; Murberg & Bru, 2001; Uchino, 2006). Although, relatively few studies have specifically examined the stress-buffering hypothesis as related to cardiovascular disease — primarily examining cardiovascular reactivity and atherosclerosis — and those findings remain contradictory (Christian & Stoney, 2006; Gerin et al., 1995; Phillips et al., 2005; Steptoe, 2000). Furthermore, limited research exists to address the stress-buffering hypothesis among heart failure patient populations.

With respect to the influence of specific aspects of social support on persons diagnosed with heart failure, recent research conducted by this investigator in a smaller sample (Berg, 2011) explored relationships linking various functions of social support with heart failure symptoms, functional status, and BNP — a biomarker of heart failure

severity. Among the 97 heart failure patients sampled, multivariate analyses revealed that greater appraisal support was significantly related to better functional status and fewer reported symptoms even after controlling for recognized predictors such as age, body mass index, gender, marital status, smoking status, and depression (Berg, 2011). Functional components of social support — including tangible, appraisal, and belonging resources — were not significantly associated with a physiological biomarker of heart failure severity (BNP). These findings suggest that appraisal support may be an important function of social support associated with heart failure severity, potentially working through behavioral, biological, and psychological processes to reduce the impact of disease morbidity (Berg, 2011).

While the association between social support and heart failure has been observed, the specific effects of structural and functional aspects of social support in heart failure patients is not well understood. In addition, the stress-buffering hypothesis has rarely been studied in persons diagnosed with heart failure and few studies have investigated validated markers of heart failure severity. Extending prior research conducted by this researcher (Berg, 2011), the present study intends to (1) replicate findings of a main effect of social support and (2) a main effect of perceived stress on markers of heart failure severity, (3) determine the relationship between social support and perceived stress, (4) explore whether perceived stress mediates any significant associations between social support and heart failure markers, and (5) examine the stress-buffering hypothesis as related to heart failure by discerning whether social support moderates the relationship linking perceived stress with markers of heart failure severity using validated and

clinically relevant measures of physiological health, functional status, symptom severity, and health-related quality of life.

Based on literature previously reviewed in this dissertation, a conceptual model can be proposed merging the *stress-buffering hypothesis* (Cohen & Wills, 1985) and the heuristic model developed by Cohen and colleagues (1995) linking stress and disease. This framework (Figure 2) posits that, aside from exerting direct effects on heart failure outcomes (e.g., arrow 1), social support may buffer against heart failure severity by influencing perceptions of stress (e.g., arrow 5). This conceptual model will be examined in accordance with the following aims and hypotheses.

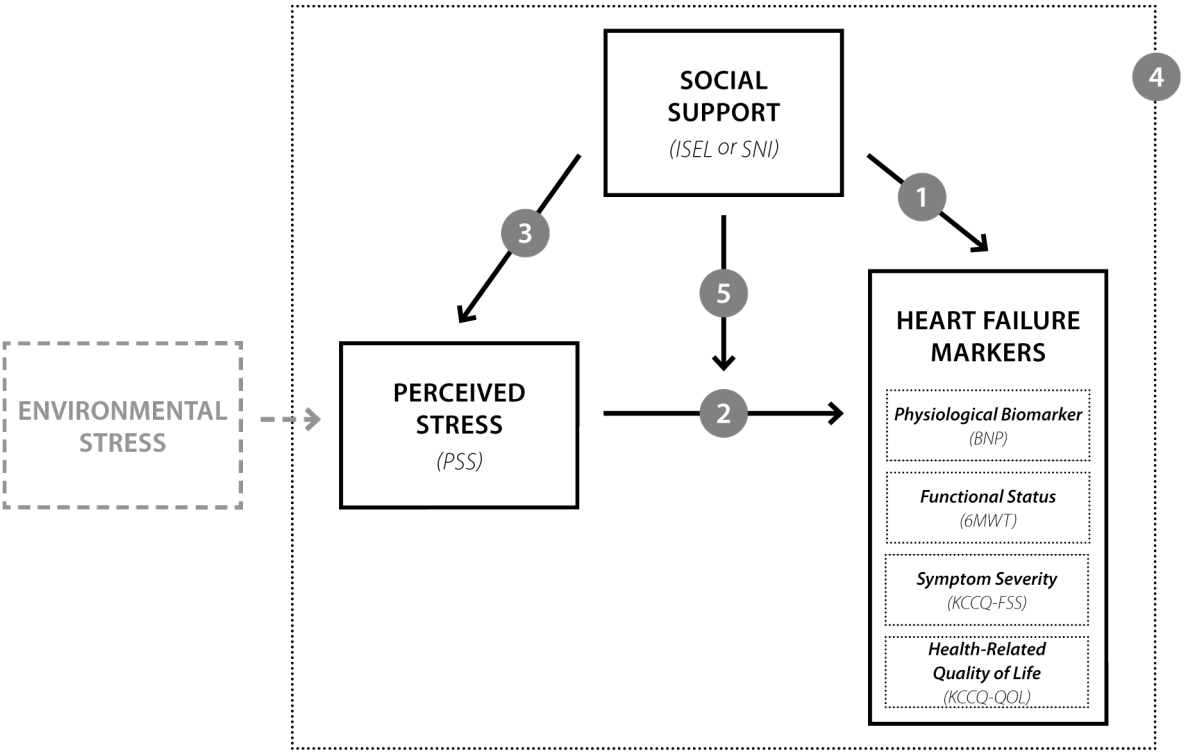



*Figure 2. Conceptual model outling specific aims of the study*

**Specific Aims and Hypotheses**

***Specific Aim 1:*** To determine the relationship between social support and markers of heart failure severity, replicating previous findings (Berg, 2011) in larger sample.

*1a)* To determine the relationship between functional social support and markers of heart failure severity. *It is hypothesized that, of the subscales measured by the Interpersonal Support Evaluation List (ISEL), only the Appraisal Support subscale will be significantly related to measures of heart failure severity, such that greater appraisal support will be associated with less severe heart failure markers (physiological biomarker, functional status, symptom severity, and health-related quality of life).*

*1b)* To determine the relationship between structural social support and markers of heart failure severity. *It is hypothesized that greater structural social support as measured by the Social Network Index (SNI) will be significantly associated with less severe heart failure markers (physiological biomarker, functional status, symptom severity, and health-related quality of life).*

***Specific Aim 2:*** To determine the relationship between perceived stress and markers of heart failure severity. *It is hypothesized that higher levels of perceived stress as measured by the Perceived Stress Scale (PSS) will be significantly associated with more severe heart failure markers (physiological biomarker, functional status, symptom severity, and health-related quality of life).*

***Specific Aim 3:*** To determine the relationship between social support and perceived stress in a sample of heart failure patients.

*3a)* To determine the relationship between functional social support and perceived stress in a sample of heart failure patients. *It is hypothesized that greater functional social support endorsed on all ISEL subscales will be significantly associated with lower levels of perceived stress (PSS).*

*3b)* To determine the relationship between structural social support and perceived stress in a sample of heart failure patients. *It is hypothesized that greater structural social support endorsed on the SNI will be significantly associated with lower levels of perceived stress (PSS).*

***Specific Aim 4:*** To determine whether perceived stress mediates the proposed relationship between social support and markers of heart failure severity.

*4a)* To determine whether perceived stress mediates the proposed relationship between functional social support and markers of heart failure severity. *It is hypothesized that self-reported perceived stress (PSS) will mediate the relationship between functional social support endorsed on all ISEL subscales and heart failure markers (physiological biomarker, functional status, symptom severity, and health-related quality of life).*

*4b)* To determine whether perceived stress mediates the proposed relationship between structural social support and markers of heart failure severity. *It is hypothesized that self-reported perceived stress (PSS) will mediate the relationship between structural social support endorsed on the SNI and heart failure markers (physiological biomarker, functional status, symptom severity, and health-related quality of life).*

***Specific Aim 5:*** To determine whether social support moderates the proposed relationship between perceived stress and markers of heart failure severity.

*5a)* To determine whether functional social support moderates the proposed relationship between perceived stress and markers of heart failure severity.
*It is hypothesized that functional social support endorsed on all ISEL subscales will moderate the relationship between self-reported perceived stress (PSS) and heart failure markers (physiological biomarker, functional status, symptom severity, and health-related quality of life).*

*5b)* To determine whether structural social support moderates the proposed relationship between perceived stress and markers of heart failure severity.
*It is hypothesized that structural social support endorsed on the SNI will moderate the relationship between self-reported perceived stress (PSS) and heart failure markers (physiological biomarker, functional status, symptom severity, and health-related quality of life).*

## Methods

The present study is a cross-sectional, observational examination of psychosocial variables believed to be associated with disease severity among heart failure patients. Data were collected as part of a parent investigation originally designed by a senior investigator in the Cardiovascular Behavioral Medicine Research Lab at the Uniformed Services University in Bethesda, Maryland and sponsored by the National Heart, Lung, and Blood Institute (NIH Grant #1R01 HL085730) to examine biological and behavioral factors precipitating worsening heart failure. The present study focused on data gathered during the baseline and telephone interview segments of the ongoing investigation. The current study builds upon prior, unpublished research reported by this investigator — which examined only a fraction of this heart failure patient sample — by incorporating additional participants and measures used in the parent investigation.

### Study Participants

Participants sampled for the present study were recruited from the Heart Failure Clinic affiliated with the University of Maryland Medical Center (UMMC) in Baltimore, Maryland. Patients presenting at this clinic primarily derive from populations in the local Baltimore area associated with the University hospital and the Department of Veterans Affairs (VA) health care system. During routine visits to their treating physician, those heart failure patients deemed to be medically stable and in compliance with the following inclusion and exclusion criteria were considered eligible for study participation. Inclusion criteria included: (1) a diagnosis of heart failure with a New York Heart Association (NYHA) classification ranging from II to IV for a duration of at least three months; (2) less than 40 percent left ventricular ejection fraction as evaluated by a documented

echocardiogram conducted within the previous year; (3) more than 21 years of age. Exclusion criteria included endorsement of any of the following conditions: (1) clinically significant mitral valve disease; (2) documented myocarditis in the previous 6 months; (3) alcoholism or thyroid dysfunction as the primary etiology of heart failure; (4) implanted left ventricular assistance device; (5) planned heart transplantation; (6) active cancer treatment; (7) residence at a nursing care facility; and (8) cognitive impairments that would preclude informed consent or questionnaire completion.

Study participants who reported comorbid conditions (e.g., history of stroke, previous cancer diagnosis) were expected in the study in light of the demographic and medical characteristics common among individuals with heart failure. Such patients were not excluded from participation unless their condition(s) significantly hindered study involvement. Participants were also encouraged to maintain any current pharmacological regimens, particularly as the investigation endeavored to examine biopsychosocial precipitates of worsening heart failure amidst active cardiovascular treatment.

**Procedures**

Participants deemed eligible in accordance with inclusion and exclusion criteria were scheduled for a baseline visit at the cardiovascular research clinic. Following informed consent procedures, patients completed psychosocial and physical health related questionnaires in addition to providing researchers with general clinical information. Study investigators then conducted measures of functional status and acquired vital statistics in addition to overseeing clinic staff who collected blood samples for laboratory assays. Additional patient information related to clinical and demographic variables, current medications, and medical history were next gathered from direct patient

interviews and a thorough review of patient medical records. In follow up to this baseline visit, participants were contacted by research assistants via phone every two weeks over a three month period wherein patients verbally completed health-related and psychosocial questionnaires. Participants were supplied with a hard copy of each measure at the baseline visit for reference during the telephone interviews. At the close of three months, study participants were scheduled to return to the cardiovascular research clinic to participate in functional assessments, complete additional questionnaires, provide daily ratings of stress, and supply a blood sample. As previously mentioned, the present study relied solely on data collected from the baseline visits and telephone interviews and, therefore, details regarding the three-month and any other clinic visits will not be explicitly reviewed.

## Measures

### *Social support*

***Structural social support.*** To evaluate the structural aspects of social relationships, the present study used the Social Network Index (SNI; Cohen, 1991; Cohen et al., 1997) as a measure of structural social support. The SNI is a 12-item, self-report questionnaire that assesses participation in twelve types of social relationships such as connections with a "spouse, parents, parents-in-law, children, other close relatives, close neighbors, friends, workmates, school mates, fellow volunteers, member of groups without religious affiliations, and members of religious groups" (Brissette et al., 2000, p. 57). For example, the questionnaire includes items such as, "How many children do you have?" and "How many of your neighbors do you visit or talk to at least once every two weeks?" Active participation in social relationships is considered if the respondent

endorses speaking with or sharing company with another at least once every two weeks. Responses on the SNI capture three distinct features of social networks including Social Network Size, the number of high-contact roles (i.e., Network Diversity), and the number of Embedded Networks reported by each participant.

***Functional social support.*** Participants additionally completed the Interpersonal Support Evaluation List – Short Version (ISEL-12; Cohen & Hoberman, 1983) to measure functional components of social support. The ISEL-12 is a self-report questionnaire consisting of 12 statements designed to assess the perceived availability of social resources. Respondents are instructed to endorse whether statements concerning their perceived social support are "definitely true," " probably true," "probably false," or "definitely false." For example, the measure includes statements such as, "If I wanted to have lunch with someone, I could easily find someone to join me" and, "When I need suggestions on how to deal with a personal problem, I know someone I can turn to" (Cohen, Mermelstein, Kamarck, & Hoberman, 1985). With an equal number of positive and negative statements about social relationships, the ISEL-12 is counterbalanced for desirability.

Beyond providing an overall measure of perceived social support, the ISEL-12 assesses three, distinct functions of social support including tangible, appraisal, and belonging resources. Specifically, the *Tangible Subscale* (4 items) is constructed to measure the perceived availability of material aid; the *Appraisal Subscale* (4 items) is designed to survey the perceived availability of others with whom one can share personal problems; and the *Belonging Subscale* (4 items) is intended to assess the perceived availability of persons with whom one can engage in activities (Cohen et al., 1985).

The ISEL-12 represents an abridged version of the original 40-item questionnaire developed and validated by Cohen and Hoberman (1983). The *Esteem Subscale,* which is incorporated into the original version of the ISEL, is not included in the ISEL-12.

Although limited psychometric properties have been published for the ISEL-12, the original author has conducted exploratory research that notes strong relationships between the abridged measure and other widely adopted psychosocial instruments (Pittsburgh Mind-Body Center, 2008). Guidelines developed by Smith, McCarthy, and Anderson (2000) regarding the construction of short-form measures asserts the importance of sufficient validation of the parent measure. Psychometric properties of the original ISEL have been extensively examined, reporting an alpha and test-retest reliability of approximately 0.90 and internal consistency of subscales raging from 0.70 to 0.80 (Cohen et al., 2000). Confirmatory factor analyses suggest that both the subscale and overall scores of the ISEL-40 warrant individual attention as each provides unique information in the assessment of the construct of functional social support (Brookings & Bolton, 1988). With proven adaptability among a variety of populations, the original ISEL has been widely implemented throughout various domains in health-related research, including cardiovascular health (Cohen et al., 2000).

***Perceived stress***

The Perceived Stress Scale, 10-item version (PSS-10; Cohen & Williamson, 1988) was used for the measurement of perceived stress among the sampled participants. The PSS-10 is a 10-item, self-report questionnaire designed to assess the degree to which situations within an individual's life are appraised as stressful. Respondents are tasked with providing ratings for how often personal life circumstances have been appraised as

unpredictable, uncontrollable, or overloading over the past two weeks on a 5-point Likert scale ranging from 0 (never) to 4 (very often). This two-week duration was selected for the measure because of recommendations suggested by the original developers who cite that “the predictive validity of the PSS is expected to fall off rapidly after four to eight weeks” due to the influence of “daily hassles, major events, and changes in coping resources” on levels of appraised stress (Cohen & Williamson, 1988, p. 34). Items include questions such as, "During the past two weeks, how often were you upset because of something that happened unexpectedly?" and, "During the past two weeks, how often did you find that you could not cope with all the things that you had to do?" (Cohen & Williamson, 1988). Scores on the PSS-10 range from 0 to 40 with higher summed scores indicating greater amounts of perceived stress.

Psychometric properties for the PSS-10 demonstrate internal consistency ranging from 0.78 to 0.89 and convergent validity with other notable psychological measures such as the State-Trait Anxiety Inventory (Cohen & Williamson, 1988; Roberti, Harrington, & Storch, 2006). The parent measure (i.e. Perceived Stress Scale, 14-item version) also exhibits discriminant validity from instruments surveying stressful life events, suggesting that the PSS assesses a unique facet of stress not captured by inventories of life experiences (Pbert, Doerfler, & DeCosimo, 1992). Across time, scores on the PSS-10 appear to remain relatively stable as evidenced by comparable means and standard deviations from national surveys sampling respondents in the United States across nearly three decades (Cohen & Janicki-Deverts, 2012). These psychometric findings suggest the stability of the instrument that may capture both state-related stress perceptions as well as trends in perceived stress across time. Overall, the PSS-10 has

been widely implemented in stress-related research, representing the only empirically established index of general stress appraisal (Monroe & Kelley, 1995).

### *Markers of heart failure severity*

***Physiological biomarker.*** While a variety of biomarkers exist in assessing and tracking the disease progression of cardiovascular conditions, the present study relied on β-natriuretic peptide (BNP) for the physiological measurement of heart failure severity. BNP is a cardiac neurohormone that is secreted from the ventricles of the heart in response to myocardial stretch resulting from adverse cardiovascular conditions (Miller et al., 2007). This peptide has been widely recognized as valuable biomarker in facilitating heart failure diagnosis as well as for risk assessment and treatment planning associated with chronic heart failure (Dao et al., 2001; Miller et al., 2007). According to Maisel and colleagues (2002), "β-natriuretic peptide levels by themselves [are] more accurate than any historical or physical findings or laboratory values in identifying congestive heart failure" as determined in their study of 1,586 patients, representing 90% sensitivity and 76% specificity at the 100 pg per milliliter level (p. 161; Peacock, 2005). Much like cholesterol, BNP concentrations are interpreted in accordance with a continuous spectrum wherein elevations, particularly beyond 100 pg per milliliter threshold, are considered indicative of greater disease severity (Maisel et al., 2002).

Blood samples were gathered for the present study from participants during the baseline clinic visit. Samples collected in vacuum tubes (EDTA 4.5 mmol/l) were spun within an hour of collection and stored at -80 degrees Celsius until analyses were performed. Plasma separation occurred using a temperature-controlled centrifugation and assays were analyzed with the Triage BNP test as per quality specifications (Apple et al.,

2005). Laboratory personnel conducting assays on these prepared samples were blind to the purpose of the investigation in an effort to control for biased results.

***Functional status.*** The Six Minute Walk Test (6MWT) was used to evaluate the functional status of heart failure participants in this study to provide a measure of functional impairment and physical limitations. Developed by the American Thoracic Society (ATS, 2002), the 6MWT is a straightforward, functional assessment that measures the distance an individual can walk on a hard, flat surface for six minutes. This performance measure provides an evaluation of global and integrated responses from cardiovascular, pulmonary, and neuromuscular systems during exercise in determination of a patient's functional capacity and impairment. While originally developed for the assessment of pulmonary diseases, the 6MWT has gained recognition in cardiovascular health settings for the measurement of functional limitations among patients with chronic heart failure (ATS, 2002; Guyatt et al., 1985). In particular, the safety and ease of administration of the measure has made the 6MWT a preferred choice over other functional assessments for clinical and research applications (Solway, Brooks, Lacasse, & Thomas, 2001).

***Symptom severity.*** Patient-reported limitations and symptoms were additionally collected using the Kansas City Cardiomyopathy Questionnaire (KCCQ; Green et al., 2000). The KCCQ is a 23-item self-report questionnaire that "quantifies physical limitations, symptoms, self-efficacy, social interference, and quality of life" specifically for persons with heart failure (Green et al., 2000, p. 1245). Summed scores on this disease-specific, health status instrument range from 0 to 100 with higher scores indicating better functioning. Responses load onto several subscale domains including

scores that index physical limitations, symptom frequency, symptom burden, symptom stability, self-efficacy, quality of life, and social limitations in addition to generating a Clinical Summary and Overall Summary score.

Psychometric evidence supports that the KCCQ is a valid and reliable measure of the health status of heart failure patients that remains sensitive to meaningful and substantial clinical changes across time (Green et al., 2000). In fact, Spertus and colleagues (2005) identified that the KCCQ most accurately reflected clinical change over time in 476 patients with heart failure, outperforming other clinical assessments such as the 6MWT and NYHA classification system. Among stable patients, responses on the KCCQ have also appropriately reflected no significant changes across time (Green et al., 2000).

For the assessment of symptom severity, the present study relied on the KCCQ Functional Status score as a measurement of physical limitations and heart failure symptom burden. The KCCQ Functional Status score has demonstrated internal consistency ($\alpha = 0.93$) in addition to being significantly correlated with other heart failure severity dimensions such as the NYHA classification system (Green et al., 2000). Lower KCCQ Functional Status scores (i.e., worse symptom severity) have also been significantly associated with rehospitalization and mortality among heart failure patients, suggesting that this subscale may be a valuable index of heart failure symptom severity (Green et al., 2000).

***Health-related quality of life.*** Again utilizing the KCCQ, the present study also collected a proxy measure of heart failure severity using the Quality of Life domain to evaluate the impact of disease on general health and well being. Specifically, the KCCQ

Quality of Life domain inquires into the influence of heart failure on personal lifestyle and mental health with questions such as, "If you had to spend the rest of your life with your heart failure the way it is right now, how would you feel about this?" and "Over the past 2 weeks, how often have you felt discouraged or down in the dumps because of your heart failure?" (Green et al., 2000, p. 1254). The KCCQ Quality of Life domain further inquires into the degree of limitation that heart failure has imposed upon activity participation over the past two weeks in areas such as hobbies and recreation, work and household chores, visits outside of the home, and one's engagement in intimate relationships (Green et al., 2000). According to Green and colleagues (2000), the KCCQ Quality of Life domain has been shown to be significantly correlated with the NYHA classification system as well as other recognized health-related quality of life instruments including the emotional domain of the Minnesota Living with Heart Failure Questionnaire and the general health perception scale of the Short Form Health Survey (SF-36).

**Analytic Plan**

The present study utilized a variety of statistical analyses using PASW Statistics Version 18.0.3 (IBM, Chicago, Illinois) to examine the variables under investigation. Prior to addressing the specific aims, descriptive statistics were first examined in review of demographic, lifestyle, and medical characteristics of the sample. Correlational analyses were also performed to assess the univariate relationships among variables of social support, perceived stress, and markers of heart failure severity.

Covariates were selected a priori for their anticipated effects on the independent and dependent variables. These demographic, lifestyle, and clinical variables including age, gender, race, smoking status, prior myocardial infarction, body mass index, education, income, marital status, and depression were controlled for in multivariate analyses as outlined in Table 1 (see pp. 45-46 regarding the rationale for the selection and application of covariates).

*Table 1. Covariates to be Applied in Statistical Analyses in Accordance with Psychosocial and Heart Failure Severity Measures*

| | **Interpersonal Support Evaluation List (ISEL)** | **Social Network Index (SNI)** | **Perceived Stress Scale (PSS)** |
|---|---|---|---|
| **β-Natriuretic Peptide (BNP)** | *Age, gender, race, smoking status, body mass index, history of myocardial infarction, education, income, martial status* | *Age, gender, race, smoking status, body mass index, history of myocardial infarction, education, income* | *Age, gender, race, smoking status, body mass index, history of myocardial infarction, education, income* |
| **Six Minute Walk Test (6MWT)** | *Age, gender, race, smoking status, body mass index, education, income, martial status, depression* | *Age, gender, race, smoking status, body mass index, education, income, depression* | *Age, gender, race, smoking status, body mass index, education, income, depression* |
| **Kansas City Cardiomyopathy Questionnaire (KCCQ)** *Functional Status score* *Quality of Life domain* | *Age, gender, race, smoking status, body mass index, education, income, martial status* | *Age, gender, race, smoking status, body mass index, education, income* | *Age, gender, race, smoking status, body mass index, education, income* |
| **Perceived Stress Scale (PSS)** | *Age, gender, race, education, income, martial status* | *Age, gender, race, education, income* | — |

Those relationships found to be significant in correlational analyses were further examined in multivariate regression analyses controlling for the previously reviewed covariates. Table 2 illustrates the steps planned a priori for regression analyses in accordance with each study aim.

*Table 2. Planned Statistical Analyses by Specific Aim*

| SPECIFIC AIMS | | PLANNED ANALYSES |
|---|---|---|
| I | *To determine the relationship between social support and markers of heart failure severity* | **STEP 1** Demographic, lifestyle, and clinical covariates<br>**STEP 2** Social support *(functional or structural)* |
| II | *To determine the relationship between perceived stress and markers of heart failure severity* | **STEP 1** Demographic, lifestyle, and clinical covariates<br>**STEP 2** Perceived stress |
| III | *To determine the relationship between social support and perceived stress* | **STEP 1** Demographic, lifestyle, and clinical covariates<br>**STEP 2** Social support *(functional or structural)* |
| IV | *To determine whether perceived stress mediates the proposed relationship between social support and markers of heart failure severity* | Interactive Sobel Test Calculation Tool<br>*http://quantpsy.org/sobel/sobel.htm*<br>***(Preacher & Leonardelli, 2012)*** |
| V | *To determine whether social support moderates the proposed relationship between perceived stress and markers of heart failure severity* | **STEP 1** Demographic, lifestyle, and clinical covariates)<br>**STEP 2** Social support *(functional or structural),* Perceived stress<br>**STEP 3** Social support *(functional or structural)* x Perceived stress |

Specific Aim IV was, alternatively, tested using an interactive Sobel test calculator developed by Preacher and Leonardelli (2012). This analytic approach was selected due to the conservative nature of this statistical method that has been widely accepted and highly recommended to test mediation (Kenny, 2012; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). The Sobel test provides an estimate

of the indirect effects of independent and mediator variables by multiplying the "a" path coefficient (i.e., association between the independent variable and mediator) by the "b" path coefficient (i.e., association between the mediator and dependent variable) and dividing by the estimate of the standard error of a*b. The resulting value yields an estimate of a*b in the form of a z-statistic that may be used to test the null hypothesis that a*b is equal to zero in the population. Regression analyses were first performed (i.e., Specific Aims II and III) to obtain unstandardized coefficients and standard errors as directed by Preacher and Leonardelli (2012). These values and standard errors were then entered into the online calculator for resulting z scores and significance.

Additionally, Specific Aim V required the generation of an interaction term to test the moderation of social support on the relationship between perceived stress and heart failure severity markers. Social support and perceived stress variables were first transformed to reduce multicollinearity through centering the scores by subtracting the mean from each observation. An interaction term was then generated between each measure of social support and scores on the PSS by multiplying the centered variables. The resulting interaction term was then entered into regression analyses after demographic and clinical covariates to test the proposed hypotheses.

Given that many statistical analyses were conducted to address the proposed research questions, the possibility of type I error in the study is an important issue. Although the investigation did not statistically correct for multiple comparisons in order to assure adequate statistical power, results were cautiously interpreted and focused on the identification of patterns in the data corresponding to established literature.

***Rationale for the selection and application of covariates***

As previous sections have addressed, heart failure severity can be influenced by a number of demographic and lifestyle factors. Advanced age and male gender, for example, have been consistently associated with a higher risk of heart failure (He et al., 2001; Listerman, et al., 2007). Heart failure also disproportionally affects African Americans who display a 50 to 75% greater rate of heart failure incidence as compared with persons of other races and ethnicities (Lloyd-Jones et al., 2010; McCullough et al., 2002). Similarly, cigarette smoking and obesity have been identified as significant risk factors linked to heart failure in epidemiological investigations (He et al., 2001; Kenchaiah et al., 2002). Low socioeconomic status has been also been linked to a greater relative risk of heart failure as compared with persons of higher socioeconomic means (He et al., 2001; Listerman et al., 2007; Philbin, Dec, Jenkins, & DiSalvo, 2001; Rathore et al., 2006). Accordingly, the variables of age, gender, race, smoking status, body mass index, education, and income were controlled for in all multivariate analyses. Prior myocardial infarction has, likewise, been identified as a potent risk factor for the development of heart failure due to systemic neurohormonal activation and ventricular remodeling (Listerman et al., 2007). Appropriately, prior myocardial infarction was only controlled for in analyses testing BNP due to its direct effects on this marker of heart failure severity.

Previous literature has also largely supported a strong relationship between depression and poorer heart failure outcomes (Kop et al., 2011; MacMahon & Lip, 2002; Rutledge et al., 2006; Sherwood et al., 2007; Williams et al., 2002). As depressive symptoms are common among heart failure patients (Kop et al., 2011; Krishnan et al.,

1998) and have been associated with disease morbidity and mortality (Kop et al., 2011; Rutledge et al., 2006), the present study opted to control for depression in analyses using the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996). The construct of depression, however, was excluded as a covariate in analyses using the KCCQ as its inclusion would have controlled for the variance already intended to be tested with the outcome variable. Also, in order to isolate the constructs of structural and functional social support, martial status was applied as a covariate only in analyses examining functional social support as described in Table 1.

Both variables of time since diagnosis and time since most recent heart failure hospitalization were considered for inclusion as covariates in statistical analyses. A priori exploration of these variables, however, revealed that neither event was significantly related to any independent or dependent measure in this investigation. Although markers of heart failure severity have been shown to fluctuate in the time period following diagnosis and heart failure hospitalization (McMurray & Stewart, 2002; Morita et al., 1993), the lack of a significant association was not surprising in light of prior evidence demonstrating the relative stability of social networks, functional social support, and perceived stress across time for cardiovascular and population samples (Cohen & Janicki-Deverts, 2012; Friedman, 1997; Martire, Schulz, Mittelmark, & Newsom, 1999). Moreover, other studies examining psychosocial variables such as social support and perceived stress rarely include these clinical event variables in planned analytic approaches. Accordingly, the duration of time since diagnosis and time since heart failure hospitalization were not included as covariates in the following analyses.

***Power analyses***

Using G*Power 3.1 (Heinrich-Heine University, 2010), a priori analyses revealed that a medium effect size (0.15) would be obtained with 107 participants given an alpha level of .05 with power set at 0.95 and two tested predictors (e.g., social support and perceived stress) and no more than ten total predictors (e.g., age, gender, race, smoking status, prior myocardial infarction, body mass index, education, income, marital status, and depression). These results are comparable to sample size estimations reported by Green (1991), suggesting 117 participants for obtaining a medium effect size with ten predictors when alpha equals .05 and power set to 0.80. With an N of 147 participants, the present study was, therefore, adequately powered to test the hypothesized relationships.

# Results

## Sample Characteristics

One hundred forty-seven individuals were sampled in the study. Participants were primarily African American (68.7%) males (75.3%) with a mean age of 57.4 (± 11.5) years and generally reported low to middle socioeconomic background (i.e., household income for 60.0% of the sample less than $30,000; highest education for 50.6% of the sample high school graduation or less). Patients predominantly exhibited mild to moderate heart failure severity (i.e., 95.3% of the sample NYHA class II or III) and endorsed many common risk factors associated with heart failure. The sample also reflected a high representation of patients with non-ischemic heart failure (58.7%). Sample characteristics including means and standard deviations are outlined in Table 3. Exact values will be reported for *p*-values in all analyses aside from those levels of significance less than .0004 on analytic output, which will be reported as $p < .001$.

## Psychosocial and Heart Failure Severity Measures

### *Descriptive statistics for study variables and comparisons with other samples*

The present sample of heart failure patients endorsed greater overall functional support on the ISEL (M = 38.3 ± 6.7) than has been previously reported in clinical samples (e.g., respiratory illness, osteoarthritis, subclinical cardiovascular disease, breast cancer; M = 28.8 ± 5.7; Pittsburgh Mind-Body Center, 2008). Additionally, comparable means and standard deviations were found between the three ISEL subscales (Table 4). Structural social support measures revealed that heart failure patients within this sample generally reported having access to social others (M = 16.9 ± 9.9) with origins in diverse networks (M = 5.3 ± 1.9), but remained active in only few social network domains

*Table 3. Sample Characteristics*

| DEMOGRAPHICS | |
|---|---|
| **Sample size** | **147** |
| **Gender** *n (%)* | |
| *Male* | **113 (75.3)** |
| *Female* | **34 (22.7)** |
| *Missing values* | 3 (2.0) |
| **Age** *years (SD)* | **57.4 (11.5)** |
| **Race** *n (%)* | |
| *African American* | **103 (68.7)** |
| *Caucasian* | **42 (28.0)** |
| *North American Indian* | **1 (0.7)** |
| *Missing values* | 4 (2.7) |
| **Highest education** *n (%)* | |
| *High school or less* | **38 (25.3)** |
| *High school graduate* | **38 (25.3)** |
| *Some college* | **37 (24.7)** |
| *College graduate* | **24 (16.0)** |
| *Some graduate school* | **3 (2.0)** |
| *Graduate degree* | **6 (4.0)** |
| *Missing values* | 4 (2.7) |
| **Marital status** *n (%)* | |
| *Married* | **40 (26.7)** |
| *Widowed* | **16 (10.7)** |
| *Single* | **32 (21.3)** |
| *Separated / divorced* | **55 (36.7)** |
| *Separated / divorced & married* | **1 (0.7)** |
| *Widowed & separated / divorced* | **2 (1.3)** |
| *Missing values* | 4 (2.7) |
| **Household income** *n (%)* | |
| *< $15,000* | **51 (34.0)** |
| *$15,000 – $30,000* | **39 (26.0)** |
| *$30,000 – $70,000* | **43 (28.7)** |
| *> $70,000* | **12 (8.0)** |
| *Missing values* | 5 (3.3) |

| HEALTH | |
|---|---|
| **NYHA class** *n (%)* | |
| *II* | **81 (54.0)** |
| *III* | **62 (41.3)** |
| *IV* | **3 (2.0)** |
| *Missing values* | 4 (2.7) |
| **Medical conditions** *(%)* | |
| *Coronary artery disease* | **44.7** |
| *Hypertension* | **76.7** |
| *Non-ischemic cardiomyopathy* | **58.7** |
| **Left ventricular ejection fraction** *M (SD)* | **23.1 (7.5)** |
| **Months since diagnosis** *M (SD)* | **50.9 (52.8)** |
| **Months since hospitalization** *M (SD)* | **38.6 (24.2)** |
| **Health behaviors** | |
| *Current smoker (%)* | **26.7** |
| *Smoking history (%)* | **68.7** |
| *Body mass index M (SD)* | **30.8 (7.6)** |
| **Beck Depression Inventory (BDI)** *n (%)* | |
| *Minimal depression (0-13)* | **95 (63.3)** |
| *Mild depression (14-19)* | **20 (13.4)** |
| *Moderate depression (20-28)* | **11 (7.4)** |
| *Severe depression (29-63)* | **14 (9.3)** |
| *Missing values* | 10 (6.7) |

(M = 2.2 ± 1.4). Measures of perceived stress (M = 13.2 ± 8.3) in this sample were slightly higher than expected for males (M = 12.1 ± 5.9) and persons between age 55 and 64 (M = 11.9 ± 6.9), but lower than the reported norms for African Americans (M = 14.7 ± 7.2; Cohen, 2004).

*Table 4. Descriptive Statistics of the Study Sample*

| PSYCHOSOCIAL MEASURES | | HEART FAILURE SEVERITY MEASURES | |
|---|---|---|---|
| **Interpersonal Support Evaluation List (ISEL)** *M (SD)* | | **β-Natriuretic Peptide (BNP)** | |
| *Tangible subscale* | **12.98 (2.73)** | *BNP pg/ML M (SD)* | **471.99 (653.57)** |
| *Appraisal subscale* | **12.80 (2.55)** | *log BNP M (SD)* | **2.39 (0.53)** |
| *Belonging subscale* | **12.50 (2.68)** | **Six Minute Walk Test (6MWT)** *feet (SD)* | **1066.66 (248.13)** |
| *Total score* | **38.28 (6.65)** | **Kansas City Cardiomyopathy Questionnaire (KCCQ)** *score (SD)* | |
| **Social Network Index (SNI)** *M (SD)* | | *Functional Status score* | **73.62 (23.06)** |
| *Social Network Size* | **16.86 (9.89)** | *Quality of Life domain* | **66.03 (25.79)** |
| *Network Diversity* | **5.26 (1.88)** | | |
| *Embedded Networks* | **2.17 (1.44)** | | |
| **Perceived Stress Score (PSS)** *M (SD)* | **13.17 (8.33)** | | |

***Markers of heart failure severity compared with other samples.*** Regarding measures of heart failure severity, the mean distance walked by patients in this sample on the 6MWT (M = 1066.7 ± 248.1) was lower than the 1315-1410 feet previously observed among unencouraged heart failure patients (Guyatt et al., 1985). For the KCCQ, measures of symptom severity (M = 73.6 ± 23.1) and quality of life (M = 66.0 ± 25.8) were higher than those previously documented for stable heart failure patients with a NYHA classification of II or higher, suggesting that the current sample had less symptom severity and a better overall quality of life than commonly observed among heart failure

patients (Green et al., 2000). Mean levels of BNP (M = 472.0, SD = 653.6) within the sample were greater than the 100 pg per milliliter threshold used clinically for the diagnosis of heart failure (Maisel et al., 2002; Table 4).

***Relationships among psychosocial variables and heart failure severity markers.*** Measures of both functional and structural social support were significantly correlated with all social support instrument subscales (Table 5). Heart failure severity measures were also mildly correlated with one another with the exception of some relationships between objective markers and subjective reports of heart failure severity. Specifically, the 6MWT was significantly correlated with both the physiological biomarker BNP

*Table 5. Univariate Relationships between Psychosocial and Heart Failure Severity Measures*

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Interpersonal Support Evaluation List (ISEL)** | | | | | | | | | | | | |
| **1.** *Tangible subscale* | — | | | | | | | | | | | |
| **2.** *Appraisal subscale* | **.56**** | — | | | | | | | | | | |
| **3.** *Belonging subscale* | **.61**** | **.47**** | — | | | | | | | | | |
| **4.** *Total score* | **.87**** | **.80**** | **.83**** | — | | | | | | | | |
| **Social Network Index (SNI)** | | | | | | | | | | | | |
| **5.** *Social Network Size* | **.26**** | **.25**** | **.30**** | **.33**** | — | | | | | | | |
| **6.** *Network Diversity* | **.32**** | **.21*** | **.29**** | **.33**** | **.77**** | — | | | | | | |
| **7.** *Embedded Networks* | **.24*** | **.21*** | **.26**** | **.29**** | **.93**** | **.70**** | — | | | | | |
| **8. Perceived Stress Scale (PSS)** | **-.21*** | **-.32**** | **-.27**** | **-.32**** | **-.22*** | -.11 | -.16 | — | | | | |
| **9. β-Natriuretic Peptide (BNP)** | -.04 | -.05 | -.03 | -.05 | -.01 | .01 | .02 | -.06 | — | | | |
| **10. Six Minute Walk Test (6MWT)** | .01 | .17 | .04 | .08 | .06 | -.01 | .08 | -.04 | **-.29**** | — | | |
| **Kansas City Cardiomyopathy Questionnaire (KCCQ)** | | | | | | | | | | | | |
| **11.** *Functional Status score* | .07 | **.29**** | .06 | .16 | .00 | .02 | -.05 | **-.35**** | .02 | **.31**** | — | |
| **12.** *Quality of Life domain* | **.20*** | **.35**** | .15 | **.28**** | **.25**** | **.19*** | **.22*** | **-.60**** | .10 | .09 | **.60**** | — |

*Note: * p < .05, ** p < .01, *** p < .001.*

($r$ = -.29, $p$ = .002) and symptom severity as measured by the KCCQ Functional Status score ($r$ = .31, $p$ < .001). The 6MWT was not significantly related to KCCQ Quality of Life ($r$ = .09, $p$ = .295). Heart failure symptom severity, however, was strongly correlated with ratings on the KCCQ Quality of Life domain ($r$ = .60, $p$ < .001). These results suggest that the heart failure severity measures used in this study are somewhat interrelated, but reflect distinct facets of the heart failure syndrome.

## Results Organized by Specific Aims

### *Specific Aim I*

The first aim of the investigation was to determine the relationship between social support and markers of heart failure severity, replicating and expanding previous research conducted by this investigator in a smaller sample (Berg, 2011). It was hypothesized that within the realm of functional social support, only the ISEL Appraisal Support subscale would be significantly associated with measures of heart failure severity.

***Univariate relationships.*** As expected, appraisal support as measured by the ISEL Appraisal subscale was significantly correlated with symptom severity as determined by the KCCQ Functional Status score ($r$ = .29, $p$ = .001) and KCCQ Quality of Life domain ($r$ = .35, $p$ < .001). The ISEL Appraisal subscale was not significantly associated with BNP ($r$ = -.05, $p$ = .580) or distance walked on the 6MWT ($r$ = .17, $p$ = .066). The ISEL Tangible subscale was also significantly related to scores on the KCCQ Quality of Life domain ($r$ = .20,$p$ = .029), however, was not significantly correlated with BNP ($r$ = -.04, $p$ = .686), 6MWT ($r$ = .001, $p$ = .994), or the KCCQ Functional Status score ($r$ = .07, $p$ = .435). The ISEL Belonging subscale, was not significantly correlated with any measured marker of heart failure severity including BNP ($r$ = -.03, $p$ = .733), distance

walked on the 6MWT ($r$ = .04, $p$ = .712), KCCQ Functional Status score ($r$ = .06, $p$ = .524), or the KCCQ Quality of Life domain ($r$ = .15, $p$ = .087). Furthermore, overall ISEL support scores were only significantly associated with ratings on the KCCQ Quality of Life domain ($r$ = .28, $p$ = .002). Overall ISEL scores were not significantly associated with BNP ($r$ = -.05, $p$ = .597), distance walked on the 6MWT ($r$ = .08, $p$ = .399), or KCCQ Functional Status score ($r$ = .16, $p$ = .071).

With regard to structural social support and heart failure, it was hypothesized that more structural social support as measured by the Social Network Index would be significantly associated with less severe heart failure. Network Diversity ($r$ = .19, $p$ = .036), Social Network Size ($r$ = .25, $p$ = .005), and the number of Embedded Networks ($r$ = .22, $p$ = .014) as assessed by the SNI were significantly related to KCCQ Quality of Life domain scores. Structural social support scales were not significantly associated with BNP, distance walked on the 6MWT, or KCCQ Functional Status score (Table 5).

***Multivariate relationships.*** Significant associations in the univariate analyses were further explored using multivariate regression analyses controlling for relevant demographic and biomedical variables that might affect outcomes on each measure of heart failure severity. Age, gender, race, smoking status, body mass index, prior myocardial infarction, education, income, marital status, and depression were selected a priori as covariates based reported effects on outcome measures and were applied to the regression analyses in accordance with Table 1. Controlling for these variables, the ISEL Tangible subscale was significantly predictive of KCCQ Quality of Life scores ($\beta$ = .21, $p$ = .026), explaining an additional 4% of the variance beyond recognized predictors

($\Delta R^2 = .04$, $\Delta F\ (1, 115) = 5.10$, $p = .026$; Table 6). With respect to other domains of functional social support, the ISEL Appraisal subscale ($\beta = .33$, $p < .001$) and overall ISEL scores ($\beta = .27$, $p = .003$) were both significantly associated with scores on the KCCQ Quality of Life domain after controlling for demographic and clinical variables, accounting for 10% and 7% of the variance, respectively (ISEL Appraisal subscale, $\Delta R^2 = .10$, $\Delta F\ (1, 115) = 13.86$, $p < .001$; ISEL Overall score, $\Delta R^2 = .07$, $\Delta F\ (1, 115) = 9.08$, $p = .003$). The ISEL Appraisal subscale also significantly predicted reported symptom severity reflected in the KCCQ Functional Status score ($\beta = .27$, $p = .004$) after

*Table 6. Multivariate Relationships between Psychosocial and Heart Failure Severity Measures (Specific Aims I and II)*

| | **Kansas City Cardiomyopathy Questionnaire (KCCQ)** | | | | | |
|---|---|---|---|---|---|---|
| | *Functional Status score* | | | *Quality of Life domain* | | |
| | *B* | *SE B* | β | *B* | *SE B* | β |
| **Interpersonal Support Evaluation List (ISEL)** | | | | | | |
| *Tangible subscale* | — | — | — | **1.99** | **0.88** | **0.21*** |
| *Appraisal subscale* | **2.47** | **0.83** | **0.27**** | **3.38** | **0.91** | **0.33***** |
| *Belonging subscale* | — | — | — | — | — | — |
| *Total score* | — | — | — | **1.07** | **0.35** | **0.27**** |
| **Social Network Index (SNI)** | | | | | | |
| *Social Network Size* | — | — | — | **0.65** | **0.24** | **0.25**** |
| *Network Diversity* | — | — | — | **2.92** | **1.28** | **0.22*** |
| *Embedded Networks* | — | — | — | **3.93** | **1.63** | **0.22*** |
| **Perceived Stress Scale (PSS)** | **-1.00** | **0.23** | **-0.36***** | **-1.90** | **0.22** | **-0.61***** |

*Note:* ***KCCQ Functional Status score:*** *ISEL Appraisal, $R^2 = .10$ for Model 1; $\Delta R^2 = .07$** for Model 2. Perceived Stress Scale, $R^2 = .06$ for Model 1; $\Delta R^2 = .12$*** for Model 2.* ***KCCQ Quality of Life domain:*** *ISEL Tangible, $R^2 = .06$ for Model 1; $\Delta R^2 = .04$* for Model 2. ISEL Appraisal, $R^2 = .06$ for Model 1; $\Delta R^2 = .10$*** for Model 2. ISEL Total, $R^2 = .06$ for Model 1; $\Delta R^2 = .07$** for Model 2. Social Network Size, $R^2 = .07$ for Model 1; $\Delta R^2 = .06$** for Model 2. Network Diversity, $R^2 = .07$ for Model 1; $\Delta R^2 = .04$* for Model 2. Embedded Networks, $R^2 = .07$ for Model 1; $\Delta R^2 = .05$* for Model 2. Perceived Stress Scale, $R^2 = .05$ for Model 1; $\Delta R^2 = .34$*** for Model 2. * $p < .05$, ** $p < .01$, *** $p < .001$. Positive scores on the KCCQ reflect better reported health status.*

controlling for relevant demographic and clinical variables ($\Delta R^2 = .07$, $\Delta F$ (1, 115) = 8.88, $p = .004$; Table 6).

For structural social support, Network Diversity ($\beta = .22$, $p = .025$), Social Network Size ($\beta = .25$, $p = .007$), and the number of Embedded Networks ($\beta = .22$, $p = .018$) on the SNI were significantly associated with KCCQ Quality of Life domain scores, explaining 4%, 6%, and 5% of the variance, respectively (Network Diversity, $\Delta R^2 = .04$, $\Delta F$ (1, 112) = 5.17, $p = .025$; Social Network Size, $\Delta R^2 = .06$, $\Delta F$ (1, 112) = 7.54, $p = .007$; Embedded Networks, $\Delta R^2 = .05$, $\Delta F$ (1, 112) = 5.78, $p = .018$; Table 6).

***Specific Aim II***

The second aim of the investigation was to determine the relationship between perceived stress and markers of heart failure severity. It was hypothesized that higher levels of perceived stress as measured by the Perceived Stress Scale (PSS) would be significantly associated with more severe markers of heart failure.

***Univariate relationships.*** When examining markers of heart failure severity, the PSS was moderately correlated with symptom severity ($r = -.35$, $p < .001$) and quality of life ($r = -.60$, $p < .001$) as assessed by the KCCQ Functional Status score and Quality of Life domain. PSS scores were not significantly related to BNP ($r = -.06$, $p = .494$) or distance walked on the 6MWT ($r = -.04$, $p = .644$; Table 5).

***Multivariate relationships.*** Again, those associations found to be significant in univariate analyses were explored using multivariate regression analyses controlling for selected covariates as outlined in the analytic plan (Table 1). Perceived stress as measured by the PSS was significantly associated with KCCQ Functional Status scores ($\beta = -.36$, $p < .001$), accounting for 12% of the variance after accounting for covariates

($\Delta R^2 = .12$, $\Delta F$ (1, 130) = 18.94, $p < .001$). The PSS was also related to KCCQ Quality of Life domain scores ($\beta = -.61$, $p < .001$), explaining 34% of the variance beyond covariates ($\Delta R^2 = .34$, $\Delta F$ (1, 130) = 73.09, $p < .001$; Table 6).

***Specific Aim III***

The third aim of the investigation was to assess the relationship between social support and perceived stress among heart failure patients. It was hypothesized that more functional and structural social support as endorsed on the ISEL and SNI would be significantly predictive of lower scores on the Perceived Stress Scale.

***Univariate relationships.*** Higher scores on all measures of functional social support were significantly associated with lower ratings on the PSS including higher ratings on the ISEL Tangible ($r = -.21$, $p = .016$), ISEL Appraisal ($r = -.32$, $p < .001$), ISEL Belonging ($r = -.27$, $p = .002$), and overall ISEL scores ($r = -.32$, $p < .001$). More structural social support as determined by greater Social Network Size on the SNI was also significantly related to lower PSS scores ($r = -.22$, $p = .016$); Network Diversity ($r = -.11$, $p = .251$) and the number of Embedded Networks ($r = -.16$, $p = .085$) reported by participants, however, were not significantly correlated with the Perceived Stress Scale (Table 5).

***Multivariate relationships.*** Adjusting for covariates, significant univariate relationships remained significant in multivariate regression analyses. Specifically, higher measures of functional social support including scores on the ISEL Tangible ($\beta = -.24$, $p = .008$), ISEL Appraisal ($\beta = -.33$, $p < .001$), and ISEL Belonging ($\beta = -.24$, $p = .006$) subscales as well as overall ISEL scores ($\beta = -.32$, $p < .001$) were significantly related to lower PSS ratings. Beyond known demographic and medical predictors, the ISEL

Tangible subscale accounted for 5% of the variance in the model ($\Delta R^2 = .05$, $\Delta F$ (1, 118) = 7.31, $p = .008$), while the ISEL Appraisal ($\Delta R^2 = .10$, $\Delta F$ (1, 118) = 14.43, $p < .001$), ISEL Belonging ($\Delta R^2 = .06$, $\Delta F$ (1, 118) = 7.70, $p = .006$), and overall ISEL scores ($\Delta R^2 = .10$, $\Delta F$ (1, 118) = 13.93, $p < .001$) explained 10%, 6%, and 10% of the variance, respectively. Likewise, Social Network Size remained significantly associated with PSS scores ($\beta = -.21$, $p = .021$) after adjusting for recognized predictors, accounting for 4% of the model variance ($\Delta R^2 = .04$, $\Delta F$ (1, 114) = 5.51, $p = .021$; Table 7).

*Table 7. Multivariate Relationships between Social Support and Perceived Stress Measures (Specific Aim III)*

| | Perceived Stress Scale (PSS) | | |
|---|---|---|---|
| | *B* | *SE B* | β |
| **Interpersonal Support Evaluation List (ISEL)** | | | |
| *Tangible subscale* | **-0.71** | **0.26** | **-0.24**** |
| *Appraisal subscale* | **-1.04** | **0.27** | **-0.33***** |
| *Belonging subscale* | **-0.73** | **0.26** | **-0.24**** |
| *Total score* | **-0.39** | **0.10** | **-0.32***** |
| **Social Network Index (SNI)** | | | |
| *Social Network Size* | **-0.17** | **0.07** | **-0.21*** |
| *Network Diversity* | — | — | — |
| *Embedded Networks* | — | — | — |

*Note:* ***Perceived Stress Scale:*** *ISEL Tangible, $R^2 = .08$ for Model 1; $\Delta R^2 = .05^{**}$ for Model 2. ISEL Appraisal, $R^2 = .08$ for Model 1; $\Delta R^2 = .10^{***}$ for Model 2. ISEL Belonging, $R^2 = .08$ for Model 1; $\Delta R^2 = .06^{**}$ for Model 2. ISEL Total, $R^2 = .08$ for Model 1; $\Delta R^2 = .10^{***}$ for Model 2. Social Network Size, $R^2 = .07$ for Model 1; $\Delta R^2 = .04^{*}$ for Model 2. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.*

In summary, aside from belonging support, all measures of functional and structural social support were significantly associated with reported quality of life as reflected in the KCCQ Quality of Life domain. Only appraisal support, as measured by

the ISEL Appraisal subscale, was significantly related to another marker of heart failure severity, namely symptom severity as indicated by the KCCQ Functional Status score. Ratings of perceived stress were significantly correlated with subjective reports of symptom severity and quality of life as captured by the KCCQ Functional Status score and Quality of Life domain. Greater functional social support — including tangible, appraisal, belonging and overall functional support scores — as well as reported social network size were significantly associated with PSS scores among this sample of heart failure patients (see Tables 5, 6, and 7 for summary of univariate and multivariate findings).

***Specific Aim IV***

The fourth aim of the investigation was to determine whether perceived stress as measured by the Perceived Stress Scale mediated the proposed relationship between social support and markers of heart failure severity. It was hypothesized that perceived stress would mediate and thereby explain the relationship linking functional and structural social support with markers of heart failure severity.

Mediational analyses were conducted in accordance with procedures outlined by Sobel (1982) wherein test statistics were calculated using only those relationships displaying significant associations in previous aims. To review, these relationships included the association between ISEL Appraisal and KCCQ Functional Status score (Specific Aim I) as well as the relationships linking ISEL Appraisal, ISEL Tangible, overall ISEL scores, and Social Network Size with the KCCQ Quality of Life domain (Specific Aim I). Perceived stress was not examined as a mediator for the relationships linking Network Diversity and Embedded Networks on the SNI with the KCCQ Quality

of Life domain as neither of these predictors were significant associated with the PSS in prior regression analyses (Specific Aim II).

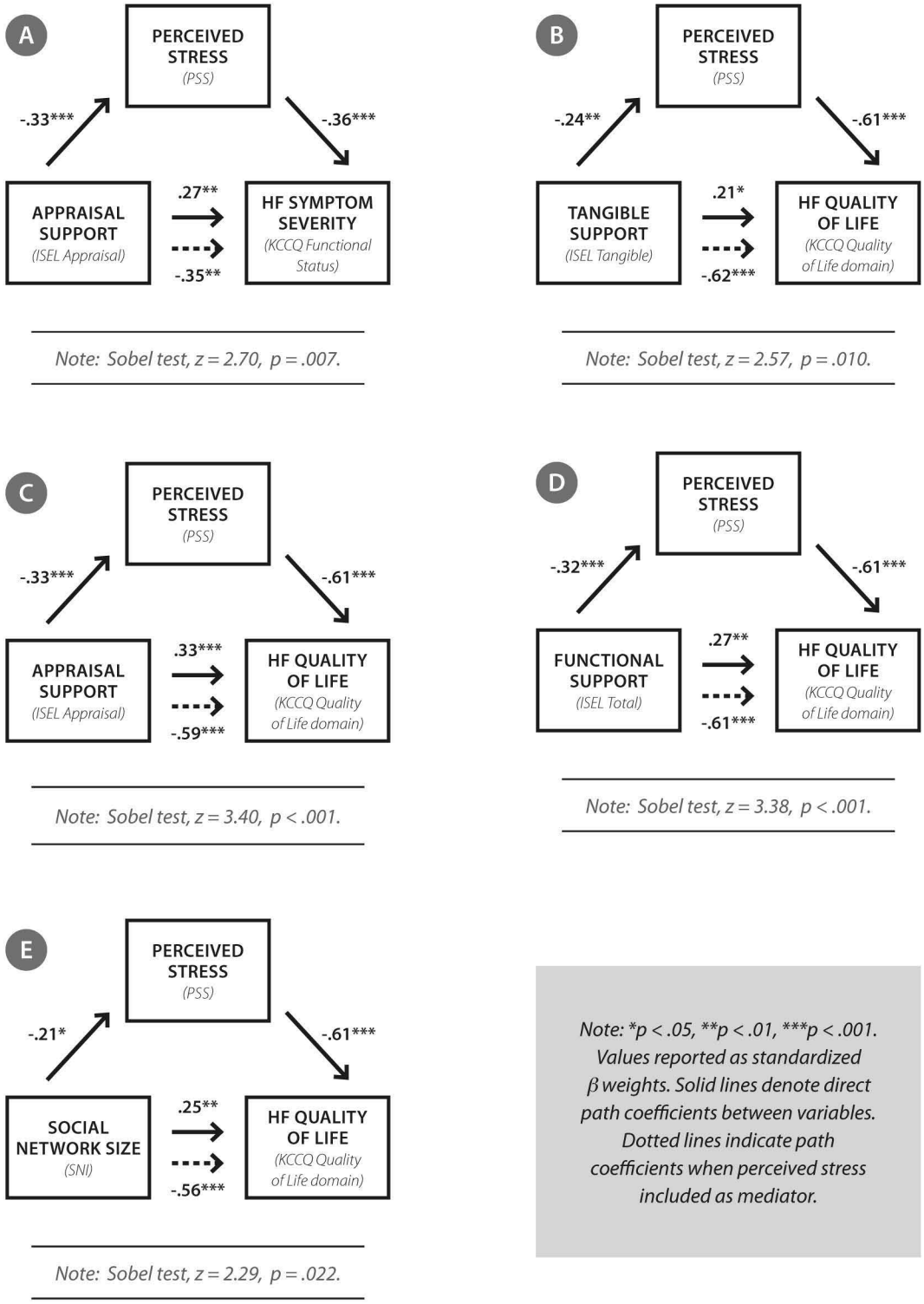
The results of all meditational analyses and the models tested are illustrated in Figure 3. Specifically, using the Sobel test interactive calculation tool developed by Preacher and Leonardelli (2012), PSS scores significantly mediated the relationship between ratings of functional social support on the ISEL Appraisal subscale and KCCQ Functional Status scores ($z = 2.71$, $p = .007$). Similarly, the PSS also significantly mediated the relationships linking the ISEL Tangible subscale ($z = 2.56$, $p = .010$), ISEL Appraisal subscale ($z = 3.41$, $p < .001$), overall ISEL scores ($z = 3.39$, $p < .001$), and reported Social Network Size ($z = 2.24$, $p = .025$) with ratings endorsed on the KCCQ Quality of Life domain.

***Specific Aim V***

The final aim of the study was to determine whether social support moderated the proposed relationship between perceived stress and markers of heart failure severity. In accordance with the stress-buffering hypothesis, it was hypothesized that both measures of functional and structural social support (ISEL and SNI, respectively) would significantly moderate the relationship between perceived stress and markers of heart failure severity.

As described in the analytic plan, the variables under investigation were transformed to reduce multicollinearity through centering the scores by subtracting the mean from each observation. An interaction term was then generated between each measure of social support and scores on the PSS by multiplying the centered variables. To test for moderation, regression analyses were run controlling for demographic and

*Figure 3. Mediation of Perceived Stress in Relationships Linking Social Support and Heart Failure Severity Measures (Specific Aim IV)*



clinical covariates (Step 1) followed by independent psychosocial predictors (Step 2) before the inclusion of each generated interaction term (Step 3). Moderation effects were examined only in those relationships previously determined to show significant associations in Specific Aim II, namely, the associations linking ratings on the PSS with KCCQ Functional Status and KCCQ Quality of Life domain scores.

As reflected in a non-significant interaction term in regression analyses, the relationship between the Perceived Stress Scale and KCCQ Functional Status scores were not moderated by the ISEL Tangible ($\beta = -.02$, $\Delta R^2 = .00$, $\Delta F\ (1, 113) = 0.07$, $p = .797$), ISEL Appraisal ($\beta = -.05$, $\Delta R^2 = .00$, $\Delta F\ (1, 113) = 0.30$, $p = .588$), ISEL Belonging ($\beta = .06$, $\Delta R^2 = .00$, $\Delta F\ (1, 113) = 0.39$, $p = .532$) or overall ISEL scores ($\beta = -.01$, $\Delta R^2 = .00$, $\Delta F\ (1, 113) = 0.01$, $p = .921$). Similarly, the ISEL Tangible ($\beta = .09$, $\Delta R^2 = .01$, $\Delta F\ (1, 113) = 1.44$, $p = .233$), ISEL Appraisal ($\beta = .06$, $\Delta R^2 = .00$, $\Delta F\ (1, 116) = 0.77$, $p = .382$), ISEL Belonging ($\beta = .08$, $\Delta R^2 = .01$, $\Delta F\ (1, 113) = 1.08$, $p = .302$) and overall ISEL scores ($\beta = .09$, $\Delta R^2 = .01$, $\Delta F\ (1, 113) = 1.44$, $p = .233$) did not moderate the relationship between PSS ratings and KCCQ Quality of Life scores. Social Network Size did not moderate the relationship between PSS scores and KCCQ Quality of Life domain ratings ($\beta = .13$, $\Delta R^2 = .02$, $\Delta F\ (1, 110) = 2.91$, $p = .091$). Social Network Size did, however, significantly moderate the relationship between the PSS and reported symptom severity as reflected in KCCQ Functional Status scores ($\beta = .21$, $\Delta R^2 = .04$, $\Delta F\ (1, 110) = 5.92$, $p = .017$; Table 8).

In order to better understand the nature of the interaction of Social Network Size and perceived stress, a series of post hoc analyses were performed. Each independent variable was dichotomized using a median split and participants were then categorized

*Table 8. Multivariate Regression Analyses for Moderation of Social Network Size on the Relationship Linking Perceived Stress and Heart Failure Symptom Severity (Specific Aim V)*

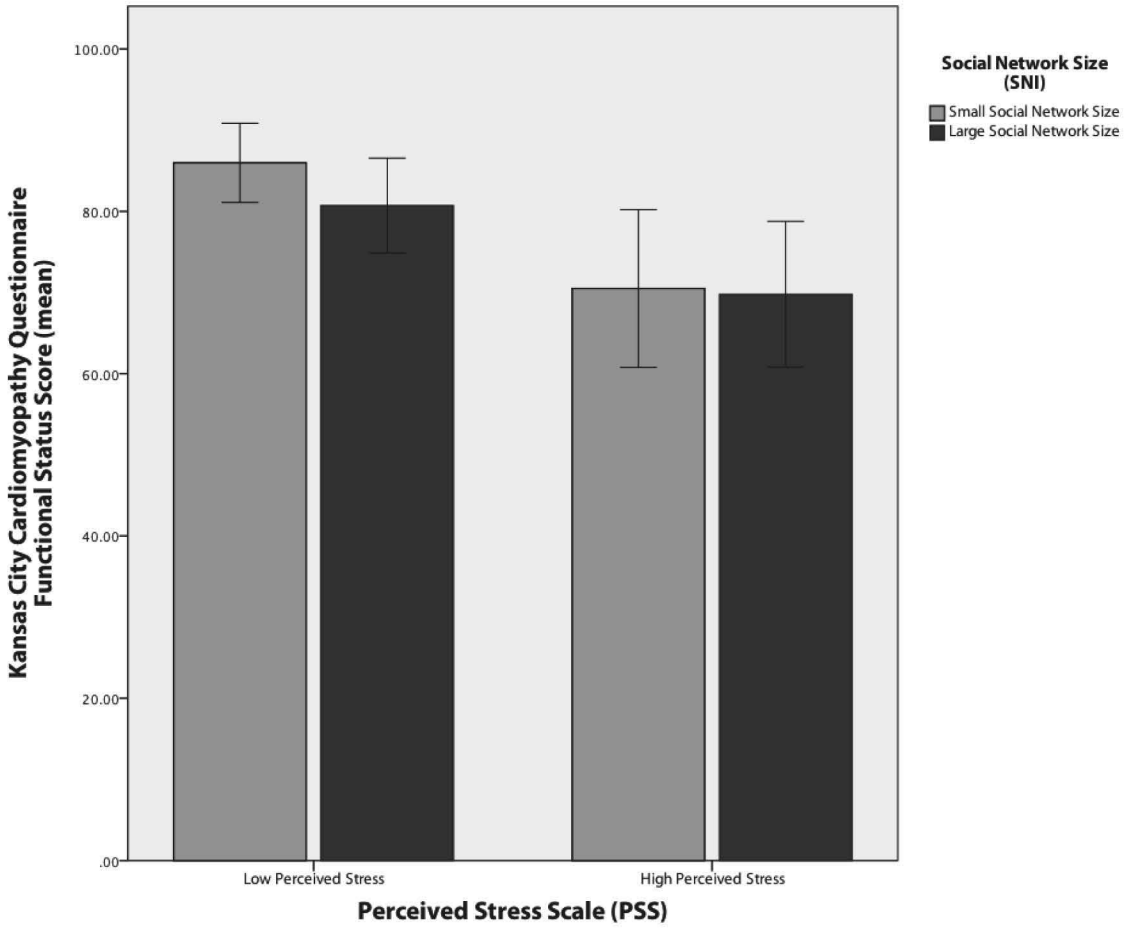
| | **Kansas City Cardiomyopathy Questionnaire (KCCQ)** *Functional Status score* | | |
|---|---|---|---|
| | *B* | *SE B* | β |
| **Model 1** *(Constant)* | **94.63** | **20.82** | |
| *Age* | **-0.17** | **0.20** | **-0.09** |
| *Gender* | **7.04** | **4.91** | **0.14** |
| *Race* | **1.40** | **4.49** | **0.03** |
| *Smoking status* | **5.37** | **5.21** | **0.11** |
| *Body mass index* | **-0.86** | **0.32** | **-0.29**** |
| *Education* | **-4.54** | **1.95** | **-0.25*** |
| *Household income* | **1.95** | **2.52** | **0.21** |
| **Model 2** *(Constant)* | **104.88** | **20.12** | |
| *Age* | **-0.31** | **0.20** | **-0.16** |
| *Gender* | **6.63** | **4.69** | **0.13** |
| *Race* | **0.40** | **4.32** | **0.01** |
| *Smoking status* | **3.64** | **5.00** | **0.07** |
| *Body mass index* | **-0.75** | **0.31** | **-0.25*** |
| *Education* | **-4.19** | **1.87** | **-0.23*** |
| *Household income* | **3.93** | **2.42** | **0.17** |
| *Social Network Size (centered)* | **-0.15** | **0.20** | **-0.07** |
| *Perceived Stress Scale (centered)* | **-0.92** | **0.26** | **-0.33***** |
| **Model 3** *(Constant)* | **103.06** | **19.70** | |
| *Age* | **-0.34** | **0.19** | **-0.17** |
| *Gender* | **7.22** | **4.60** | **0.14** |
| *Race* | **1.90** | **4.27** | **0.04** |
| *Smoking status* | **5.95** | **4.99** | **0.12** |
| *Body mass index* | **-0.88** | **0.31** | **-0.29**** |
| *Education* | **-4.40** | **1.83** | **-0.24*** |
| *Household income* | **4.57** | **2.39** | **0.20** |
| *Social Network Size (centered)* | **-0.16** | **0.20** | **-0.07** |
| *Perceived Stress Scale (centered)* | **-0.92** | **0.25** | **-0.32***** |
| *Social Network Size x Perceived Stress Scale* | **0.06** | **0.03** | **0.21*** |

*Note: $R^2 = .11$ for Model 1; $\Delta R^2 = .09^{**}$ for Model 2; $\Delta R^2 = .04^{*}$ for Model 3. * $p < .05$, ** $p < .01$, *** $p < .001$. Positive scores on the KCCQ reflect better reported health status.*

according to one of four classifications on the social network size / perceived stress interaction variable (small social network, high perceived stress; small social network, low perceived stress; large social network, high perceived stress; large social network, low perceived stress). A univariate analysis of variance (ANOVA) was performed to examine the interaction between the PSS and Social Network Size on KCCQ Functional Status scores. With the small social network / high perceived stress variable designated as the reference group, this analysis revealed a significant effect of the social network size / perceived stress interaction on KCCQ Functional Status scores.

Although the overall model was significant ($F$ (3, 110) = 3.56, $p$ = .017), post hoc comparisons indicated that there were no significant differences between the reference group (i.e., small social network / high perceived stress) and the large social network / high perceived stress cohort ($p$ = .781). The small social network / low perceived stress cohort ($p$ = .005) as well as the large social network / high perceived stress cohort ($p$ = .047) both had significantly more burdensome heart failure symptom severity as reflected in the KCCQ Functional Status scores as compared with the reference group (i.e., small social network / high perceived stress) (Figure 4). These additional analyses suggest that higher levels of perceived stress are related to greater symptom burden regardless of social network size.

*Figure 4. Analysis of Variance Exploring Heart Failure Symptom Severity in Accordance with Social Network Size and Levels of Perceived Stress* (Specific Aim V)




*Note: Error bars indicate 95% confidence intervals. Positive scores on the KCCQ reflect better reported health status.*

# Discussion

## Summary of Findings

The present study examined the relationships among various components of social support, perceived stress, and markers of heart failure severity. Three functions of perceived social support were explored in addition to structural features of social networks. The study also sought to explain whether perceived stress mediated any significant relationships between social support and markers of heart failure severity. To test the stress-buffering hypothesis, the study examined whether social support moderated any significant relationships between perceived stress and heart failure markers.

Results indicated that perceived stress and both functional and structural social support were related to reported symptom severity and health-related quality of life. However, these variables were not associated with physiological and functional status markers of heart failure severity. Interestingly, ratings of perceived stress were observed to mediate the significant relationships between social support and heart failure markers. Social support, however, did not moderate any relationships between perceived stress and markers of heart failure severity in this sample aside from the interaction between social network size and perceived stress on reported symptom severity, presenting limited evidence for the stress-buffering hypothesis.

### *Interrelationships between functional and structural social support*

Although not a specific aim of the present study, the interrelationships between functional and structural social support warrant brief discussion given the conceptual overlap between these psychosocial constructs. Similar to results obtained in the literature (Pittsburgh Mind-Body Center, 2008; Rogers, 2008), this investigation found moderate to

strong relationships between functional and structural social support measures. Specifically, all functional social support measures shared strong positive associations with one another while structural aspects of social networks were also very strongly correlated. Within functional and structural domains, the results indicated that the constructs of tangible, appraisal, and belonging support show modest relationships with social network size, network diversity, and active network domains among heart failure patients. These findings suggest that, although functional and structural social support constructs are interrelated, each support domain likely contributes uniquely to measured heart failure markers. Moreover, results imply that supportive others may furnish resources that satisfy both functional as well as structural support qualities. For example, siblings who would contribute to the size of one's social network and quantity of embedded networks might also supply tangible and belonging support resources such as transportation and a sense of personal belonging.

### *Social support and markers of heart failure severity*

***Social support and health-related quality of life.*** Tangible and appraisal support resources were significantly associated with ratings on the KCCQ Quality of Life domain. These findings suggest that having access to tangible resources for aid and persons with whom to confide is related to more positive quality of life impressions among persons with heart failure. Perceiving social resources to resolve practical problems (e.g., monetary aid, transportation, and daily care assistance) or to aid in coping with life events may serve to strengthen positive mental and physical perceptions of health and well being among heart failure patients (Cohen et al., 2000). As such, it is not surprising that health-related quality of life definitions proposed by the Centers for

Disease Control (CDC, 2011) specifically cite "social support" as an influential correlate contributing to health-related quality of life assessments and future morbidity and mortality (Konstam et al., 1996; Moser, 2002). The current findings strengthen the assertion noted by the CDC that social support is an important contributor to health-related quality of life.

Similarly, structural social support measures including Social Network Size, Network Diversity, and the number of Embedded Networks significantly predicted heart failure-specific quality of life. Possessing access to multiple and sizable social networks may increase the opportunity for and access to social resources important to one's health-related quality of life (e.g., familial aid, spiritual support). Results linking both functional and structural social support constructs with better health-related quality of life are supported by previous research conducted with cardiovascular disease patient populations including persons with heart failure (Bennett et al., 2001; Clark et al., 2003; Heo et al., 2010; Lee et al., 2005; Westlake et al., 2002).

***Social support and heart failure symptom severity.*** As hypothesized, only appraisal support was significantly predictive of heart failure symptom severity. These results suggest that perceiving the availability of social resources may influence reported symptom burden among heart failure patients. Structural aspects of social support appear to bear more influence over global evaluations of health-related quality of life rather than self-reported symptom severity among heart failure patients. This evidence implies that persons with heart failure report less favorable symptom severity in the absence of appraisal support above other social support features.

Perceived stress also significantly mediated the relationship between appraisal support and heart failure symptom severity. Likewise, significant relationships found between functional and structural social support measures and health-related quality of life were also mediated by life stress perceptions. Taken together, these results suggest that although social support plays a role in the subjective appraisals of health and well-being, perceived stress maybe more influential in health-related quality of life among heart failure patients. This claim is further supported by the interaction of social network size and perceived stress predicting heart failure symptom severity, which when explored showed a relationship driven by levels of perceived stress.

***Social support and physiological markers of heart failure severity.*** Unlike what was found for self-report measures, no significant relationships emerged linking social support with the biomarker BNP or distance walked on the 6MWT. The absence of a relationship between social support and BNP may appear surprising in light of the strong associations observed between social support and symptom and quality of life markers of heart failure severity in this study. However, the lack of an association is not incomprehensible given the complex and multifaceted biological processes involved in heart failure. Previous research conducted by this investigator (Berg, 2011) found no relationship between functional social support and BNP in a smaller sample of heart failure patients. Researchers considered that a larger sample might detect an effect in light of previous evidence linking psychosocial variables with other heart failure biomarkers (i.e., NT-pro-BNP; van den Broek, deFilippi, Christenson, Seliger, Gottdiener, & Kop, 2011).

Clinically, levels of BNP have been shown to be inconsistent with regard to diagnostic utility, demonstrating inverse relationships with known markers of heart failure severity (e.g., left ventricular ejection fraction) and within-patient variability across time despite stable clinical symptoms and severity (Doust, Pietrzak, Dobson, & Glaszious, 2005; Ginsberg & Topalian, 2007; Hetmanski et al., 2000; Takeda et al., 2009). Thus, the present study design may not have included an optimal biomarker to assess the proposed relationships. For example, previous research has suggested that other heart failure biomarkers (e.g., NT-pro-BNP) not measured in the present study may be more susceptible to psychosocial factors (van den Broek et al., 2011). Broadly, the possibility exists that psychosocial variables such as social support may be unrelated to physiological measures of heart failure disease severity or that physiological indicators of heart failure severity are only loosely associated with self-reported health. According to a consensus panel formed to review the science and technology of BNP (Silver et al., 2004), this physiological biomarker may be unrelated to measures of self-reported health status and quality of life, "since patients adjust their expectations downward as they become more ill" (p. 12), thereby accounting for the disparate findings between physiological and self-reported markers of heart failure severity in this study.

***Social support and functional status markers of heart failure severity.*** More surprising, was the absence of an association between social support measures and functional markers of heart failure severity (e.g., 6MWT). Previous research conducted by this investigator in a smaller sample (Berg, 2011) demonstrated a significant relationship between ratings on the ISEL Appraisal subscale and distance walked during the 6MWT after controlling for recognized demographic and medical predictors. Likely,

early analyses exploring these variables were subject to error, or, perhaps, the subsample previously studied was not representative of the larger heart failure population.
The findings reviewed in this larger sample suggest that psychosocial factors may exert primary influence through subjective evaluations of health as observed in symptom severity and quality of life ratings rather than through physiological pathways of disease severity. Aside from previous research conducted by this investigator, no known existing research has examined the relationships among social support, perceived stress, and walk tests in heart failure patients; therefore, the relationship between these psychosocial variables and functional status as measured by the 6MWT for persons with heart failure remains inconclusive.

Certainly, the possibility exists that associations of social support and stress with self-report and not physiological or functional status markers may be a result of overlapping variance between the various self-report scales. As described earlier, social support and perceived stress may be influential contributors to personal evaluations of symptom burden and health-related quality of life, loading onto these heart failure severity constructs. Spector (2006) further describes that "relationships between variables measured with the same method [can be] inflated due to the action of common method variance (CMV), also referred to as monomethod bias" (p. 221).

***Belonging support and markers of heart failure severity.*** As opposed to tangible and appraisal support, no relationship was observed between belonging support reported on the ISEL Belonging subscale and any measured marker of heart failure severity. These results suggest that perceiving the accessibility of others with whom to engage in social activities may not be sufficient to influence physiological and functional status measures

of heart failure severity or impressions of symptom burden and health-related quality of life. Seemingly, social resources may need to provide functions beyond simply belonging to a group, such as tangible and appraisal resources like monetary aid or practical advice. Alternatively, a lack of association between belonging support and heart failure severity markers might have been observed due to the fact that all sampled participants reported some degree of perceived belonging support (ISEL Belonging subscale range = 5-16). Alternative findings might have resulted if greater variability in belonging support was noted among the sample. For the present study in particular, ratings of belonging support may have been artificially inflated due to the fact that participants were members of a heart failure clinic, resided in relatively urban neighborhoods, and were recipients of routine contact with clinical and research staff via regular medical appointments and bi-monthly telephone interviews. The possibility exists that only the complete absence of belonging support may be influential when related to markers of heart failure severity as has been observed in other studies linking social isolation with poor cardiovascular health (Brummett et al., 2005; Eng, Rimm, Fitzmaurice, & Kawachi, 2002; Everson-Rose & Lewis, 2005; Friedmann et al., 2006).

***Social support and perceived stress***

Regarding relationships among social support and perceived stress, it was hypothesized that more functional and structural social support would be significantly associated with lower levels of perceived stress. As expected, greater social support was significantly related with lower levels of perceived stress for all domains of functional social support and reported Social Network Size. Ratings of Network Diversity and the number of Embedded Networks were unrelated to perceptions of stress. These findings

suggest that heart failure patients endorsing greater functional social support and a larger social network are more likely to endorse lower levels of perceived stress, regardless of the number of social groups with whom they share regular contact or the number of social domains within which they are active. Without the perceived availability of resources to resolve practical problems, supply emotional support, or participate in social activities, persons with heart failure may more readily perceive stressful life circumstances as unpredictable, uncontrollable, or overloading (Cohen & Williamson, 1988). Functional social support, therefore, may protect against negative life stress by diffusing burdensome situations, introducing supportive advice, promoting mood enhancement, or granting problem distraction. Similarly, more ample social networks protect against feelings and cognitions of social isolation, which could reduce the likelihood that persons with heart failure perceive life circumstances as unmanageable since they are not likely to endure stress alone. These findings are supported by previous research showing lower perceived stress to be significantly related to appraisal and overall functional social support, although unrelated to measures of structural social support measures in cardiac patients (Brummett et al., 2004; Leon, Nouwen, Sheffield, Jaumdally, & Lip, 2010).

***Gender differences in social support and perceived stress.*** The presented findings ought to be considered in light of our predominately male sample and the known differences between genders in social support and perceived stress domains. For instance, in a random selection of households representing 214 men and 166 women, Antonucci and Akiyama (1987) found that women reported significantly larger social networks and the receipt of more support resources as compared with men among older adults ages 50

to 95. Subsequent literature reviews, however, cited that men tend to report larger social networks than women, although exhibit less investment and intimacy with social others (Thoits, 1995). Women further display a greater propensity to seek out social support for coping with stressful life events as compared with men who more likely engage in problem solving (Thoits, 1995).

Among persons with cardiovascular conditions, early studies of the gender-specific effects of social support on cardiovascular health suggested a stronger association between social support and coronary heart disease for men (Lett et al., 2005). More recent research efforts, however, demonstrate no gender differences for social support on cardiovascular outcomes or a more robust relationship linking social support with cardiovascular health for female patients (Lett et al., 2005). In the present sample, no gender differences emerged when examining the relationships among independent and dependent measures aside from overall ISEL scores where female patients reported significantly greater overall functional support than the males sampled. Regardless, gender was applied as a covariate in all multivariate analyses in order to account for any anticipated effects of gender differences on measured variables.

Perceived stress has also been differentially expressed across genders. Using the Perceived Stress Scale, Cohen and Janicki-Deverts (2012) found that females reported significantly more perceived stress than males in repeated surveys of the national U. S. population spanning nearly three decades. These findings parallel other studies demonstrating that women report more stressful life events (Kessler, McLeod, & Wethington, 1985) and endorse more negative impact of stress as compared with men (Davis, Matthews, & Twamley, 1999). Again, no gender differences were noted in the

present study except for overall functional social support scores on the ISEL. Accordingly, gender was applied as a covariate throughout all multivariate analyses to minimize the imposition of gender differences on the study results.

***Racial differences in social support and perceived stress.*** Similarly, the results from the current study are based on a predominantly African American sample and, accordingly, racial differences in social support and perceived stress would be wise to be considered. According to Kim and McKenry (1998) who examined cultural variations across nearly 10,000 respondents from multiethnic groups, social networks are an important source of supportive resources within the African American community. For African Americans, neighbors and religious social contacts are highly valued and often perceived as fictive kin, stemming from the evolution of African American ancestry where "extended families were [once] the norm and family was defined in terms of community instead of blood ties" (Kim & McKenry, 1998, p. 313). Prior research has also found informal social networks to be important mediators of stress among African American families (Kim & McKenry, 1998). Despite cultural variations in social networks and support-seeking behaviors, Kim and McKenry (1998) note far more similarities than differences in social support relationships between African American, Asian American, Hispanic, and Caucasian samples once socioeconomic factors are statistically considered.

For perceived stress, factor analytic studies of the PSS in African American adults indicate that self-identified African Americans only significantly differed on two items included on the measure (i.e., "During the past two weeks, how often were you able to control your irritations in your life?" and "During the past two weeks, how often did you

feel difficulties were piling up so high that you could not overcome them?") when compared to Caucasian respondents (Sharp, Kimmel, Kee, Saltoun, & Chang, 2007). Such results suggest similar endorsement of perceived stress between African American and Caucasian adults in addition to the psychometric utility of the PSS for diverse, racial groups. These findings are further supported by evidence noted by Cohen and Janicki-Deverts (2012) who found no significant differences between minority and Caucasian respondents on the PSS once controlling for other demographic variables including education, income, and employment status. Regardless, race was accounted for in all multivariate analyses as a covariate due the possible influence of this demographic factor on independent and dependent variables in the study.

***Perceived stress and markers of heart failure severity***

Based on previous literature demonstrating a relationship between stress perceptions and the severity of cardiovascular conditions (Leon et al., 2010; Macleod et al., 2002; Nielsen et al., 2006; Rosen, Contradam, Gorkin, & Kostos, 1997; Rosengren et al., 1991), we similarly hypothesized that higher perceived stress would be significantly associated with more severe heart failure markers. As expected, greater perceived stress was strongly related to worse self-reported heart failure symptoms and health-related quality of life as indicated by the KCCQ Functional Status score and Quality of Life domain, respectively. Life stress perceptions, however, were not associated with physiological or performance markers of heart failure severity.
In accordance with these results, the degree to which heart failure patients describe their lives as stressful is closely associated with their subjective evaluations of symptom severity and disease-specific quality of life. Thus, heart failure patients who regard their

circumstances as unpredictable, uncontrollable, or overloading may more readily endorse burdensome heart failure symptoms and less favorable overall health perceptions without actually experiencing a worsening of physiological disease markers. These findings are supported by evidence linking psychological distress with perceived health status (Tessler & Mechanic, 1978; Watson & Pennebaker, 1989).

According to Lazarus and Folkman (1984), potentially stressful life events are thought to increase disease risk "when one perceives that the demands these events impose tax or exceed a person's adaptive capacity" (Cohen & Janicki-Deverts, 2012, p. 1320). Stressful circumstances, therefore, are believed to influence the pathogenesis of physical disease via negative affective states that impose direct effects on physiological processes and health behavior patterns (Cohen, Janicki-Deverts, & Miller, 2007). For persons with heart failure, exposure to stressful events may be overwhelming particularly as patients' resources are likely depleted from their burdensome health condition. As such, perceived stress amidst scarce adaptive resources may lead to the generation of negative affect and subsequent endorsement of more severe symptoms and poorer quality of life, despite less severe physiological and functional indicators.

The possibility further exists that findings are explained by personality features not measured in the present study. A growing body of research has explored the role of personality in cardiovascular disorders, particularly the influence of negative affectivity traits such as anger, hostility, depression, and anxiety (Steptoe & Molloy, 2007). Prior evidence has revealed an positive association between persons with personality features of neuroticism — defined as a "broad dimension of individual differences characterized as the tendency to experience negative emotion, including fearfulness, irritability,

low self-esteem, social anxiety, and helplessness" — and perceptions of stress (Ebstrup, Eploy, Pisinger, & Jorgensen, 2011; Murberg, Bru, & Aarsland, 2001, p. 750). In fact, research suggests that persons with greater dispositional neuroticism report more exposure to stress, appraise stressors as more threatening, and employ less productive coping strategies in response to stress (Costa & McCrae, 1985; Mroczek & Almeida, 2004). Among heart failure patients, distressed personality features have also been shown to be independent predictors of mortality (Murberg et al., 2001) and associated with a greater likelihood for reported health impairment when compared with samples of non-distressed patients indicating similar disease severity (Schiffer et al., 2005). As such, findings from the current study (e.g., differences notes between self-reported health and objective markers of heart failure severity) may be influenced by personality features not intentionally examined in the present investigation.

***Main effect and stress buffering models***

Two theoretical perspectives are most readily cited for explaining the relationship between social support and health, namely that social support exerts a direct, beneficial influence (*main effect hypothesis*) or protects against the effects of stress on health (*stress-buffering hypothesis;* Cohen & Wills, 1985). As previously described, a main effect of social support was found in the present study linking appraisal, tangible, and overall functional social support as well as social network size, network diversity, and the number of embedded networks with health-related quality of life ratings. Similarly, greater appraisal support was also shown to be associated with reported heart failure symptom severity, supporting the main effect hypothesis among this sample of heart failure patients.

Results examining the stress-buffering hypothesis in accordance with the final aim of the investigation, however, yielded only a single significant finding. According to analyses, only social network size as assessed by the SNI significantly moderated the relationship between perceived stress and heart failure symptom severity. As hypothesized, heart failure patients endorsing small social networks amidst the highest levels of perceived stress reported the most burdensome heart failure symptom severity. However, patients did not appear to significantly differ on the severity of heart failure symptoms whether reporting relatively small or large social networks sizes. On the one hand, this finding may be due to type I error given the large number of analyses conducted in this study. Should these results be replicated, however, these findings may suggest that, while structural qualities of social networks may be independently important for shaping health-related quality of life perceptions, social network size may not be sufficient to buffer against the influence of perceived stress on reported heart failure symptom severity. Moreover, the relationship between perceived stress and markers of heart failure severity appear unchanged by the levels of any other structural and functional aspects of social support in this sample. The degree of perceived stress experienced by heart failure patients, therefore, may be a more important predictor of heart failure symptom severity and health-related quality of life than characteristics or functions of social resources.

These findings somewhat contradict established theory and research championing the buffering influence of social support on the relationship between stress and health (Cohen & Wills, 1985; Uchino et al., 1996). Specifically, Cohen and Wills (1985) present evidence in their seminal review article for a buffering model when social support

"assesses the perceived availability of interpersonal resources that are responsive to the needs elicited by stressful events" (p. 310). Conversely, social support exhibits direct effects on health when examining the degree of social network integration (Cohen & Wills, 1985). Subsequent reviews and research aiming to tease apart what features of social support influence health and disease continue to reveal mixed results (Callaghan & Morrissey, 1993; Steptoe, 2000; Uchino, 2006; Uchino et al., 1996). Within cardiovascular domains, some evidence indicates that social support does not moderate the effects of stress on cardiovascular health (Gerin et al., 1995; Tennant, 1999), although may buffer against the impact of mortality risk factors such as depression (Frasure-Smith et al., 2000). Structural aspects of social support, including social network size, however, have been previously found to moderate the relationship between stress and cardiovascular reactivity in laboratory investigations (Gerin et al., 1995; Phillips et al., 2005; Roy et al., 1998). While social support has been found to buffer against stress for illness (Cohen et al., 1997), social support may not be sufficient enough to buffer against severe disease states with high mortality rates such as heart failure.

Broadly, the *stress-buffering hypothesis* and its relationship to cardiovascular health is poorly understood in light of inconsistent research findings in this area. This discrepancy may be attributable to the numerous ways in which social support, stress, and cardiovascular outcomes have been measured or the potential that the buffering influence of social support on relationships between stress and health in heart failure patients may be weak or non-existent. The role of social support in cardiovascular health appears to be quite complex with many possible mechanisms through which social

support may impact health that were unable to be feasibly assessed in the present sample (Yates, Skaggs, & Parker, 1994).

**Study Limitations**

The present study is not exempt from limitations. Foremost, as a cross-sectional investigation, this study was not designed or able to address causality. The nature of the study design prevents any prediction of heart failure clinical events that may be useful in understanding how psychosocial variables might impact disease progression. While the present study has the advantage of assessing various measures of stress and social support as well as multiple measures of heart failure outcomes, results are limited by data that can be captured using the selected measures (construct validity). This limitation remains particularly relevant for the concept of functional support as social relationships have the potential for a variety of functions beyond those tangible, appraisal, and belonging resources measured using the abridged version of the ISEL (Cohen & Hoberman, 1983). Likewise, instruments designed to measure individual perceptions of psychosocial constructs are inherently subjective and, therefore, subject to the potential for external influences and recall bias (Greenwood, Muir, Packham, & Madeley, 1996).

The participants sampled were primarily African American males and generally of low socioeconomic status — a risk factor shown to be related to cardiovascular disease outcomes (Philbin et al., 2001; Rathore et al., 2006). Therefore, conclusions from the investigation are limited to the population sampled and may not generalize to a broader range of heart failure patients or persons with alternative health conditions.

The present study also did not account for the potential influence of comorbidities — defined as the coexistence of other conditions or illnesses that might influence

prognosis — on the independent and dependent variables (Hall, 2006). As heart failure represents the end stage of cardiovascular disorders and is associated with many medical risk factors, participants were expected to endorse a number of other conditions (e.g., hypertension, diabetes) that are common for persons with heart failure. Findings from this investigation, therefore, ought to be interpreted in light of this context. Future research might consider the inclusion of a comorbidity index, or research tool that reduces all coexistent illnesses and the severity of those illnesses into a single numeric score, such as the as the Cumulative Illness Rating Scale (CIRS), Kaplan-Feinstein Classification (KFC), Charlson Comorbidity Index (CCI), or Index of Co-Existent Disease (ICED) to assess how results would be influenced by the degree of comorbid health conditions (Hall, 2006).

Given the large number of comparisons made in the study, the possibility further exists that the results could be attributable to type I error. Although statistical corrections were not used to correct for multiple comparisons, the results were cautiously interpreted and focused on the identification of patterns in the data corresponding to established research. In this regard, virtually all of the present findings were consistent with the study hypotheses.

**Study Strengths**

Despite these limitations, the study possessed a number of strengths. First, while previous research has generally focused on a single dimension of social support, the present investigation examined various functions of social support along with several structural aspects of social networks. Second, the study employed a collection of clinically relevant heart failure markers (i.e., symptoms, functional status, and a

biomarker) shown to be predictors of morbidity and mortality (He et al., 2001; Kenchaiah et al., 2002; Kop et al., 2011; Levy et al., 1996; Lightwood et al., 2001; Listerman et al., 2007; Lloyd-Jones et al., 2010). Third, the study endeavored to identify multivariate relationships between social support, perceived stress, and heart failure markers, extending previous literature by examining the main effect and stress-buffering hypotheses in a sample of heart failure patients. Finally, the inclusion of standard risk factors in the analyses provided verification that results were independent of other known heart failure predictors.

**Clinical Implications**

Findings from the present study have a variety of implications for clinical practice. Principally, the identification of psychosocial variables associated with heart failure symptom severity and health-related quality of life may allow for the stratification of patients at greatest risk for perceiving impairment, symptom burden, and poor quality of life due to heart failure. Aside from adverse perceptions of personal health status, these patients may also be more likely to utilize health care resources despite the stability of their conditions (Cohen & Janicki-Deverts, 2012; Miilunpalo, Vuori, Oja, Pasanen, & Urponen, 1997; Strik, Denollet, Lousberg, & Honig, 2003).

Results from the present study may further aid health care professionals in clarifying diagnostic impressions. Having awareness that perceptions of social support and life stress may influence subjective reporting of disease burden and health-related quality of life could help to explain disparate clinical observations between physiological representations of heart failure and patient-reported disease burden. For example, a heart failure patient may present with health complaints including fatigue, shortness of breath,

and chest discomfort, despite any demonstrated elevation in disease severity markers (e.g., ejection fraction, biomarkers). The knowledge that lacking a confidant, perceiving limited access to tangible resources, having insufficient social connections, and endorsing high levels of perceived stress may influence heart failure patient presentations may provide explanation for divergent clinical impressions and inform treatment planning.

Moreover, research findings from the current study lend promise for the formulation of interventions or preventative measures to shape modifiable risk factors such as social support and perceived stress. Unlike many heart failure risk factors that are immutable (e.g., advancing age, genetic vulnerabilities), aspects of social support and perceptions of stress have the potential to be altered either through changes to cognitions or behavior. Conceptually, empirical support for both the *main effect* and *stress-buffering hypotheses* proposed by Cohen and Wills (1985) may imply the utility of psychosocial interventions aimed at augmenting social support. However, the present study suggests an alternative mechanism at play in the relationship between social support and heart failure severity markers, namely perceived stress. These findings indicate that, perhaps, the more potent variable influencing reported symptom severity and health-related quality of life among heart failure patients are individual stress perceptions. Certainly, more research is needed to confirm this mechanism and explore other pathways through which social support may influence heart failure markers. Greater understanding of these mechanisms may inform the development of psychosocial interventions to improve heart failure symptom severity and health-related quality of life.

Results from this study encourage an emphasis on improving stress management rather than focusing on enhancing social support for the future development of

psychosocial interventions in heart failure patients. To date, although some research initiatives have attempted to improve social support with mild success, the considerable heterogeneity of findings have prevented the identification of empirically robust clinical interventions to directly enhance the structural or functional aspects of social support (Hogan, Linden, & Najarian, 2002; Stewart, 1989). Stress management, however, has been more extensively examined and many empirically supported clinical approaches such as relaxation training, cognitive restructuring, and meditation have demonstrated promise (Olivio, Dodson-Lavelle, Wren, Fang, & Oz, 2009; Shapiro, 2011; Willert, Thulstrup, Hertz, & Bonde, 2009), even in cardiovascular samples. For example, a meditation-based stress management pilot intervention revealed significant reductions in depressive symptoms and perceived stress in patients with coronary heart disease (Olivio et al., 2009). Similarly, a controlled pilot study of stress management training in elderly heart failure patients demonstrated significant improvements in perceived stress, emotional distress, functional capacity, and heart rate variability as compared with a wait-listed control group after a 10-week intervention (Luskin, Reitz, Newell, Quinn, & Haskell, 2002). Likewise, a randomized controlled trial of cognitive behavior therapy stress management significantly reduced fatal and non-fatal cardiovascular disease events (e.g., myocardial infarction, death) when compared with usual care for post-myocardial infarction patients (Shapiro, 2011). Although future research is needed to fully explore whether similar interventions directed at reducing stress would improve heart failure severity markers, such practices may be an advantageous treatment component for persons with heart failure as well as relieve excess burden on the health care system through reductions in health care utilization.

**Future Directions**

Future research directions may consider examining social support and perceived stress longitudinally to determine if these variables predict, and are not simply associated with, symptom and quality of life markers of heart failure severity. Prospective examinations might achieve this goal by incorporating repeated measures of social support and perceived stress measures to determine if changes in these variables are related to alterations in heart failure markers across time. In addition, future research initiatives could include other recognized markers of heart failure severity (e.g., C-reactive protein, ejection fraction) in addition to clinically relevant outcomes such as hospital readmission, cardiac events, and disease-specific mortality.

Importantly, additional investigations ought to consider the potential bias imposed by social supportive environments within which the study takes place. For instance, heart failure patients in this sample were enrolled in an active heart failure clinic, resided in an urban setting, and received regular attention from clinical and research staff (e.g., routine medical appointments, bi-monthly telephone interviews), possibly generating an artificial environment of social support. Also, although no differences were noted between genders or ethnicities in this sample, few women and persons other than African Americans were available for study participation. The inclusion of more women and persons of other ethnic backgrounds would be informative in that some evidence has acknowledged a difference in supportive needs and preferences between genders and among varying cultures (Vaux, 1985). Undoubtedly, the explicit examination of social support and stress management interventions through clinical trials are necessary for determining whether such adjunct treatments can improve heart failure severity burden and disease outcomes.

Interventions may further provide supplementary evidence for the role of social support and perceived stress in the management of cardiovascular diseases.

## Conclusion

Taken with existing literature, the present study strengthens the notion that high social support and low perceived stress positively influence symptom burden and health-related quality of life. Although future research is needed to fully understand these relationships and develop empirically based interventions in heart failure, evidence from this dissertation provides support that these factors may be noteworthy targets for modification to improve symptom burden and health-related quality of life for heart failure patients.

BETRHEART STUDY
PATIENT ID: _____

**Social Network Index**

Instructions: This questionnaire is concerned with how many people you see or talk to on a regular basis including family, friends, workmates, neighbors, etc. Please read and answer each question carefully. Answer follow-up questions where appropriate.

1. Which of the following best describes your marital status?
____ (1) currently married & living together, or living with someone in marital-like relationship
____ (2) never married & never lived with someone in a marital-like relationship
____ (3) separated
____ (4) divorced or formerly lived with someone in a marital-like relationship
____ (5) widowed

2. Who do you live with (indicate the person's relationship to you): _____

_____

3. How many children do you have? (If > 0, answer 3a.)
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

3a. How many of your children do you see/talk to (e.g., phone/internet) at least once every 2 weeks?
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

4. How many grandchildren do you have? (If > 0, answer 4a.)
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

4a. How many of your grandchildren do you see/talk to (e.g., phone/internet) at least once every 2 weeks?
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

5. Are either of your parents living? (If yes, answer 5a.)
____ (0) neither ____ (1) mother only
____ (2) father only ____ (3) both

5a. Do you see or talk to (e.g., phone/internet) either of your parents at least once every 2 weeks?
____ (0) neither ____ (1) mother only
____ (2) father only ____ (3) both

6. Are either of your in-laws/partner's parents living? (If yes, answer 6a.)
____ (0) neither ____ (1) mother
____ (2) father ____ (3) both ____ (4) N/A

6a. Do you see or talk to either of your in-laws at least once every 2 weeks?
_____ (0) neither _____ (1) mother only
_____ (2) father only ____ (3) both

7. How many other relatives (other than your spouse, parents, children, and grandchildren) do you feel close to? (If > 0, answer 7a.)
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

7a. How many of these relatives do you see or talk to (e.g., phone/internet) at least once every 2 weeks?
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

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8. How many close friends do you have? (meaning people that you feel at ease with, can talk to about private matters, and can call on for help) (If > 0, answer 8a.)
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

8a. How many of these friends do you see or talk to (e.g.., phone/internet) at least once every 2 weeks?
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

9. Do you belong to a church, temple, or other religious group? (If yes, answer 9a.)
_____ no _____ yes

9a. How many members of your church or religious group do you talk to at least once every 2 weeks? (This includes at group meetings and services.)
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

10. Do you attend any classes (school, university, technical training, or adult education) on a regular basis? (If yes, answer 10a.)
_____ no _____ yes

10a. How many fellow students or teachers do you talk to at least once every 2 weeks? (This includes at class meetings.)
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

11. Are you currently employed either full or part-time? (If yes, answer 11a and 11b.)

____ (0) no
_____ (1) yes, self-employed
_____ (2) yes, employed by others

11a. How many people do you supervise?
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

11b. How many people at work (other than those you supervise) do you talk to at least once every 2 weeks?
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

12. Which best describes the place where you live? (Answer 12a.)
_____ Individually detached house
_____ Townhouse or duplex
_____ Apartment
_____ Assisted living apartment
_____ Nursing home
_____ Other:

12a. How many of your neighbors do you visit or talk to at least once every 2 weeks?
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

13. Are you currently involved in regular volunteer work? (If yes, answer 13a.)
_____ no _____ yes

13a. How many people involved in this volunteer work do you talk to about volunteering-related issues at least once every 2 weeks?
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

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14. Do you have any regular visits with professionals (doctors, nurses, home health aids, cleaning help, etc.) at least once every two weeks? (If yes, answer 12a.)
_____ no _____ yes

14a. How many people do you see or have appointments with on a regular basis at least once every 2 weeks?
____0 ____1 ____2 ____3
____4 ____5 ____6 ____7 or more

15. Do you belong to any groups in which you talk to one or more members of the group about group-related issues at least once every 2 weeks? Examples include social clubs like card playing groups, recreational groups, trade unions, commercial groups, professional organizations, groups concerned with children like the PTA, Boy Scouts, or sports teams, groups concerned with community service, etc. (If yes, answer 15a; if no, end of questionnaire.)

_____ no _____ yes

15a. Consider those groups in which you talk to a fellow group member at least once every 2 weeks. Please provide the following information for each such group: the name or type of group and the total number of members in that group that you talk to at least once every 2 weeks.

| Group that you talk to at least once every 2 weeks | Total number of group members |
|---|---|
| 1. | |
| 2. | |
| 3. | |
| 4. | |

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# ISEL-12

Instructions: This scale is made up of a list of statements each of which may or may not be true about you. For each statement circle "definitely true" if you are sure it is true about you and "probably true" if you think it is true but are not absolutely certain. Similarly, you should circle "definitely false" if you are sure the statement is false and "probably false" if you think it is false but are not absolutely certain.

1. If I wanted to go on a trip for a day (for example, to the country or mountains), I would have a hard time finding someone to go with me.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

2. I feel that there is no one I can share my most private worries and fears with.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

3. If I were sick, I could easily find someone to help me with my daily chores.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

4. There is someone I can turn to for advice about handling problems with my family.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

5. If I decide one afternoon that I would like to go to a movie that evening, I could easily find someone to go with me.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

6. When I need suggestions on how to deal with a personal problem, I know someone I can turn to.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

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7. I don't often get invited to do things with others.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

8. If I had to go out of town for a few weeks, it would be difficult to find someone who would look after my house or apartment (the plants, pets, garden, etc.).

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

9. If I wanted to have lunch with someone, I could easily find someone to join me.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

10. If I was stranded 10 miles from home, there is someone I could call who could come and get me.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

11. If a family crisis arose, if would be difficult to find someone who could give me good advice about how to handle it.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

12. If I needed some help in moving to a new house or apartment, I would have a hard time finding someone to help me.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely False | Probably False | Probably True | Definitely True |

BETRHEART STUDY
PATIENT ID:_____

## *Perceived Stress Scale*

The questions in this scale ask you about your feelings and thoughts during the past two weeks. In each case, please indicate with a check how often you felt or thought a certain way.

**1. During the past two weeks, how often were you upset because of something that happened unexpectedly?**
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

**2. During the past two weeks, how often did you feel that you were unable to control the important things in your life?**
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

**3. During the past two weeks, how often did you feel nervous and "stressed"?**
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

**4. During the past two weeks, how often did you feel confident about your ability to handle your personal problems?**
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

**5. During the past two weeks, how often did you feel that things were going your way?**
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

**6. During the past two weeks, how often did you find that you could not cope with all the things that you had to do?**
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

**7. During the past two weeks, how often were you able to control irritations in your life?**
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

**8. During the past two weeks, how often did you feel that you were on top of things?**
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

**9. During the past two weeks, how often were you angered because of things that were outside of your control?**
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

**10. During the past two weeks, how often did you feel difficulties were piling up so high that you could not overcome them?**
___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

Initials: _____ Date: _____

BETRHEART STUDY
PATIENT ID:_____

## *The KC Cardiomyopathy Questionnaire*

The following questions refer to your **heart failure** and how it may affect your life. Please read and complete the following questions. There are no right or wrong answers. Please mark the answer that best applies to you.

1. **Heart failure** affects different people in different ways. Some feel shortness of breath while others feel fatigue. Please indicate how much you are limited by **heart failure** (shortness of breath or fatigue) in your ability to do the following activities over the past 2 weeks.

Place an **X** in one box on each line

| Activity | Extremely Limited | Quite a bit Limited | Moderately Limited | Slightly Limited | Not at all Limited | Limited for other reasons or did not do the activity |
|---|---|---|---|---|---|---|
| Dressing yourself | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Showering/Bathing | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Walking 1 block on level ground | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Doing yardwork, housework or carrying groceries | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Climbing a flight of stairs without stopping | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Hurrying or jogging (as if to catch a bus) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

2. Compared with 2 weeks ago, have your symptoms of **heart failure** (shortness of breath, fatigue, or ankle swelling) changed?

My symptoms of **heart failure** have become…

| Much worse | Slightly worse | Not changed | Slightly better | Much better | I've had no symptoms over the last 2 weeks |
|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

BETRHEART STUDY
PATIENT ID:_____

3. Over the past 2 weeks, how many times did you have **swelling** in your feet, ankles or legs when you woke up in the morning?

| Every morning | 3 or more times a week, but not every day | 1-2 times a week | Less than once a week | Never over the past 2 weeks |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

4. Over the past 2 weeks, how much has **swelling** in your feet, ankles or legs bothered you?

It has been ...

| **Extremely** bothersome | **Quite a bit** bothersome | **Moderately** bothersome | **Slightly** bothersome | **Not at all** bothersome | I've had **no swelling** |
|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

5. Over the past 2 weeks, on average, how many times has **fatigue** limited your ability to do what you want?

| All of the time | Several times per day | At least once a day | 3 or more times per week but not every day | 1-2 times per week | Less than once a week | Never over the past 2 weeks |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

6. Over the past 2 weeks, how much has your **fatigue** bothered you?

It has been ...

| **Extremely** bothersome | **Quite a bit** bothersome | **Moderately** bothersome | **Slightly** bothersome | **Not at all** bothersome | I've had **no fatigue** |
|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

7. Over the past 2 weeks, on average, how many times has **shortness of breath** limited your ability to do what you wanted?

| All of the time | Several times per day | At least once a day | 3 or more times per week but not every day | 1-2 times per week | Less than once a week | Never over the past 2 weeks |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

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8. Over the past 2 weeks, how much has your **shortness of breath** bothered you?

It has been ...

| **Extremely** bothersome | **Quite a bit** bothersome | **Moderately** bothersome | **Slightly** bothersome | **Not at all** bothersome | I've had **no shortness of breath** |
|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

9. Over the past 2 weeks, on average, how many times have you been forced to sleep sitting up in a chair or with at least 3 pillows to prop you up because of **shortness of breath**?

| Every night | 3 or more times a week, but not every day | 1-2 times a week | Less than once a week | Never over the past 2 weeks |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

10. **Heart failure** symptoms can worsen for a number of reasons. How sure are you that you know what to do, or whom to call, if your **heart failure** gets worse?

| **Not at all** sure | **Not very** sure | **Somewhat** sure | **Mostly** sure | **Completely** sure |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

11. How well do you understand what things you are able to do to keep your **heart failure** symptoms from getting worse? (for example, weighing yourself, eating a low salt diet etc.)

| Do not understand at all | Do not understand very well | Somewhat understand | Mostly understand | Completely understand |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

12. Over the past 2 weeks, how much has your **heart failure** limited your enjoyment of life?

| It has **extremely** limited my enjoyment of life | It has limited my enjoyment of life **quite a bit** | It has **moderately** limited my enjoyment of life | It has **slightly** limited my enjoyment of life | It has **not limited** my enjoyment of life at all |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

13. If you had to spend the rest of your life with your **heart failure** the way it is right now, how would you feel about this?

| Not at all satisfied | Mostly dissatisfied | Somewhat satisfied | Mostly satisfied | Completely satisfied |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

BETRHEART STUDY
PATIENT ID:_____

14. Over the past 2 weeks, how often have you felt discouraged or down **in** the dumps because of your **heart failure**?

| I felt that way **all of the time** | I felt that way **most of the time** | I **occasionally** felt that way | I **rarely** felt that way | I **never** felt that way |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

15. How much does your **heart failure** affect your lifestyle? Please indicate how your **heart failure** may have limited your participation in the following activities over the past 2 weeks.

Please place an **X** in one box on each line

| **Activity** | **Severely** limited | Limited **quite a bit** | **Moderately** limited | **Slightly** limited | **Did not** limit at all | Does not apply or did not do for other reasons |
|---|---|---|---|---|---|---|
| Hobbies, recreational activities | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Working or doing household chores | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Visiting family or friends out of your home | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Intimate relationships with loved ones | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

## References


American Heart Association (AHA). (2010*). Heart disease and stroke statistics: 2010 update at-a-glance.* Retrieved from http://www.americanheart.org/presenter.jhtml?identifier=3000090

American Institute of Stress (AIS). (2011). *Definition of stress.* Retrieved from http://www.stress.org/Definition_of_stress.htm

American Thoracic Society (ATS). (2002). ATS statement: Guidelines for the Six Minute Walk Test. *American Journal of Respiratory and Critical Care Medicine, 166*, 111-117.

Anthony, J. L., & O'Brien, W. H. (1999). An evaluation of the impact of social support manipulations on cardiovascular reactivity to laboratory stressors. *Behavioral Medicine, 25, 78-87*.

Antonucci, T. C., & Akiyama, H. (1987). An examination of sex differences in social support among older men and women. *Sex Roles, 17,* 737-749.

Apple, F. S., Panteghini, M., Ravkilde, J., Mair, J., Wu, A. H. B., Tate, J. (2005). Quality specifications for B-type natriuretic peptide assays. *Clinical Chemistry, 51*, 486-493.

Avison, W. R., & Gotlib, I. H. (1994). *Stress and mental health*. New York: Plenum Press.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck Depression Inventory-II.* San Antonio, TX: Psychological Corporation.

Bennett, S. J., Baker, S. L., & Huster, G. A. (1998). Quality of life in women with heart failure. *Health Care for Women International, 19*, 217-229.

Bennett, S. J., Perkins, S. M., Lane, K. A., Deer, M., Brater, D. C., & Murray, M. D. (2001). Social support and health-related quality of life in chronic heart failure patients. *Quality of Life Research, 10*, 671-682.

Berg, A. E. (2011). *Perceived social support and markers of heart failure severity.* (Unpublished master's thesis). Uniformed Services University of the Health Sciences, Bethesda, MD.

Berkman, L. F., & Syme, S. L. (1979). Social networks, host resistance, and mortality: A nine-year follow-up study of Alameda County residents. *American Journal of Epidemiology, 109*, 186-204.

Brady, S. S., & Helgeson, V. S. (1999). Social support and adjustment to recurrence of breast cancer. *Journal of Psychosocial Oncology, 17*, 37-55.

Brissette, I., Cohen, S., & Seeman, T. E. (2000). Measuring social integration and social networks. In S. Cohen, L. G. Underwood, & B. H. Gottlieb (Eds.), *Social support measurement and intervention: A guide for health and social scientists* (pp. 53-85). Orlando: Oxford University Press.

Brookings, J. B., & Bolton, B. (1988). Confirmatory factor analysis of the Interpersonal Support Evaluation List. *American Journal of Community Psychology, 16*, 137-147.

Bruhn, J. G. (1965). An epidemiological study of myocardial infarctions in an Italian-American community: A preliminary sociological study. *Journal of Chronic Diseases, 18*, 353-365.

Bruhn, J. G., Chandler, B., Miller, M. C., Wolf, S., & Lynn, T. N. (1966). Social aspects of coronary heart disease in two adjacent, ethnically different communities. *American Journal of Public Health, 56*, 1493-1506.

Brummett, B. H., Babyak, M. A., Mark, D. B., Clapp-Channing, N. E., Siegler, I. C., & Barefoot, J. C. (2004). Prospective study of perceived stress in cardiac patients. *Annals of Behavioral Medicine, 27*, 22-30.

Brummett, B. H., Mark, D. B., Siegler, I. C., Williams, R. B., Babyak, M. A., Clapp-Channing, N. E., & Barefoot, J. C. (2005). Perceived social support as a predictor of mortality in coronary patients: Effects of smoking, sedentary behavior, and depressive symptoms. *Psychosomatic Medicine, 67,* 40-45.

Callaghan, P., & Morrissey, J. (1993). Social support and health: A review. *Journal of Advanced Nursing, 18,* 203-210.

Cannon, W. B. (1932). *The wisdom of the body*. New York: Norton.

Centers for Disease Control (CDC). (2010). *Heart failure fact sheet.* Retrieved from http://www.cdc.gov/dhdsp/data_statistics/fact_sheets/fs_heart_failure.htm

Centers for Disease Control (CDC). (2011). *Health-related quality of life concepts.* Retrieved from http://www.cdc.gov/hrqol/concept.htm

Chambers, W. N., & Reiser, M. F. (1953). Emotional stress in the precipitation of congestive heart failure. *Psychosomatic Medicine, 15*, 38-60.

Chatterjee, N. A., & Fifer, M. A. (2010). Heart failure. In L. S. Lily (Ed.), *Pathophysiology of heart disease: A collaborative project of medical students and faculty* (pp. 216-243). Philadelphia: Lippincott Williams & Wilkins.

Chin, M. H., & Goldman, L. (1997). Correlates of early hospital readmission or death in patients with congestive heart failure. *American Journal of Cardiology, 79*, 1640-1644.

Christakis, N. A., & Fowler, J. H. (2007). The spread of obesity in a large social network over 32 years. *New England Journal of Medicine, 357*, 370-379.

Christian, L. M., & Stoney, C. M. (2006). Social support versus social evaluation: Unique effects on vascular and myocardial response patterns. *Psychosomatic Medicine, 68*, 914-921.

Chung, M. L., Lennie, T. A., Dekker, R. L., Wu, J., & Moser, D. (2011). Depressive symptoms and poor social support have a synergistic effect on event-free survival in patients with heart failure. *Heart and Lung.* Retrieved from http://www.sciencedirect.com.lrc1.usuhs.edu/science/article/pii/S0147956310003560

Clark, D. O., Tu, W., Weiner, M., & Murray, M. D. (2003). Correlates of health-related quality of life among lower-income, urban adults with congestive heart failure. *Heart and Lung, 32*, 391-401.

Cohen, S. (1991). Social supports and physical health: Symptoms, health behaviors, and infectious diseases. In A. L. Greene, E. M. Cummings & K. H. Karraker (Eds.), *Life-span developmental psychology: Perspectives on stress and coping* (pp. 213-234). Hillsdale, NJ: Eribaum.

Cohen, S. (2004). Social relationships and health. *American Psychologist, 59,* 676-684.

Cohen, S., Doyle, W. J., Skoner, D. P., Rabin, B. S., & Gwaltney, J. M. (1997). Social ties and susceptibility to the common cold. *Journal of the American Medical Association, 277*, 1940-1944.

Cohen, S., & Hoberman, H. M. (1983). Positive events and social supports as buffers of life change stress. *Journal of Applied Social Psychology, 13*, 99-125.

Cohen, S., & Janicki-Deverts, D. (2012). Who's stressed? Distributions of psychological stress in the United States in probability samples from 1983, 2006, and 2009. *Journal of Applied Social Psychology, 42,* 1320-1334.

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *Journal of the American Medical Association, 298,* 1685-1687.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24*, 385-396.

Cohen, S., Kessler, R. C., & Gordon, L. U. (1995). Strategies for measuring stress in studies of psychiatric and physical disorders. In S. Cohen, Kessler, R. C., & Gordon, L. U. (Ed.), *Measuring Stress: A Guide for Health and Social Scientists* (pp. 3-26). New York: Oxford University Press.

Cohen, S., Mermelstein, R., Kamarck, T., & Hoberman, H. M. (1985). Measuring the functional components of social support. In I. G. Sarason & B. R. Sarason (Eds.), *Social support: Theory, research, and applications* (pp. 73-94). New York: Springer.

Cohen, S., & Syme, S. L. (1985). *Social support and health*. Orlando: Academic Press, Inc.

Cohen, S., Tyrrell, D. A. J., & Smith, A. P. (1993). Negative life events, perceived stress, negative affect, and susceptibility to the common cold. *Journal of Personality and Social Psychology, 64*, 131-140.

Cohen, S., Underwood, L. G., & Gottlieb, B. H. (2000). *Social support measurement and intervention: A guide health and social scientists*. New York: Oxford University Press.

Cohen, S., & Williamson, G. M. (1988). Perceived stress in a probability sample of the United States. In S. Spacapan & S. Oskamp (Eds.), *The social psychology of health* (pp. 31-67). Newbury Park, CA: Sage.

Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin, 98*, 310-357.

Costa, Jr., P. T. & McCrae, R. R. (1985). Neuroticism, somatic complaints, and disease: Is the bark worse than the bite? *Journal of Personality, 55,* 299-316.

Cyranowski, J. M., Hofkens, T. L., Swartz, H. A., & Gianaros, P. J. (2011). Thinking about a close relationship differentially impacts cardiovascular stress responses among depressed and nondepressed women. *Health Psychology, 30*, 276-284.

Dao, Q., Krishnaswamy, P., Kazanegra, R., Harrison, A., Amirnovin, R., Lenert, L. (2001). Utility of B-type natriuretic peptide in the diagnosis of congestive heart failure in an urgent-care setting. *Journal of the American College of Cardiology, 37*, 379-385.

Das, S., & O'Keefe, J. H. (2006). Behavioral cardiology: Recognizing and addressing the profound impact of psychosocial stress on cardiovascular health. *Current Atherosclerosis Reports, 8*, 111-118.

Davis, M. C., Matthews, K. A., & Twamley, E. W. (1999). Is life more difficult on Mars or Venus? A meta-analytic review of sex differences in major and minor life events. *Annals of Behavioral Medicine, 21,* 83-97.

DiMatteo, M. R. (2004). Social support and patient adherence to medical treatment. *Health Psychology, 23*, 207-218.

Doust, J. A., Pietrzak, E., Dobson, A., & Glasziou, P. P. (2005). How well does B-type natriuretic peptide predict death and cardiac events in patients with heart failure: Systematic review. *British Medical Journal, 330,* 1-9.

Ebstrup, J. E., Eploy, L. E., Pisinger, C., Jorgensen, T. (2011). Association between the Five Factor personality traits and perceived stress: Is the effect mediated by general self-efficacy? *Anxiety, Stress, and Coping, 24,* 407-419.

Egolf, B., Lasker, J., Wolf, S., & Potvin, L. (1992). The Roseto effect: A 50-year comparison of mortality rates. *American Journal of Public Health, 82*, 1089-1092.

Eng, P. M., Rimm, E. B., Fitzmaurice, G., & Kawachi, I. (2002). Social ties and change in social ties in relation to subsequent total and cause-specific mortality and coronary heart disease incidence in men. *American Journal of Epidemiology, 155,* 700-709.

Eriksen, W. (1994). The role of social support in the pathogenesis of coronary heart disease: A literature review. *Family Practice, 11*(201-209).

Everson-Rose, S. A., & Lewis, T. L. (2005). Psychosocial factors and cardiovascular diseases. *Annual Review of Public Health, 26*, 469-500.

Frasure-Smith, N., Lesperance, F., Gravel, G., Masson, A., Juneau, M., Talajic, M. (2000). Social support, depression, and mortality during the first year after myocardial infarction. *Circulation, 101*, 1919-1924.

Friedman, M. M. (1997). Social support sources among older women with heart failure: continuity versus loss over time. *Research in Nursing & Health, 20,* 319-327.

Friedmann, E., Thomas, S. A., Liu, F., Morton, P. G., Chapa, D., & Gottlieb, S. S. (2006). Relationship of depression, anxiety, and social isolation to chronic heart failure outpatient mortality. *American Heart Journal, 152*, 940.e941-940.e948.

Gerin, W., Milner, D., Chawla, S., & Pickering, T. G. (1995). Social support as a moderator of cardiovascular reactivity in women: A test of the direct effects and buffering hypotheses. *Psychosomatic Medicine, 57*, 16-22.

Ginsberg, F., & Topalian, S. (2007). Natriuretic peptides: Biomarkers not predictive in the intensive care unit. *Critical Care Medicine, 35,* 1194-1195.

Green, C. P., Porter, C. B., Bresnahan, D. R., & Spertus, J. A. (2000). Development and evaluation of the Kansas City Cardiomyopathy Questionnaire: A new health status measure for heart failure. *Journal of the American College of Cardiology, 35*, 1245-1255.

Green, S. B. (1991). How many subjects does it take to do a regression analysis? *Multivariate Behavioral Research, 26*, 499-510.

Greenwood, D. C., Muir, K. R., Packham, C. J., & Madeley, R. J. (1996). Coronary heart disease: A review of the role of psychological stress and social support. *Journal of Public Health Medicine, 18,* 221-231.

Guyatt, G. H., Sullivan, M. J., Thompson, P. J., Fallen, E. L., Pugsley, S. O., Taylor, D. W. (1985). The 6-minute walk: A new measure of exercise capacity in patients with chronic heart failure. *Canadian Medical Association Journal, 132*, 919-923.

Hall, S. F. (2006). A user's guide to selecting a comorbidity index for clinical research. *Journal of Clinical Epidemiology, 59,* 849-855.

He, J., Ogden, L. G., Bazzano, L. A., Vupputuri, S., Loria, C., & Whelton, P. K. (2001). Risk factors for congestive heart failure in U.S. men and women: NHANES I epidemiologic follow-up study. *Archives of Internal Medicine, 161*, 996-1002.

Heart Failure Association of the European Society of Cardiology (HFA of the ESC). (2007). *Heart failure animations.* Retrieved from http://www.heartfailurematters.org/EN/single/Pages/Animations.aspx

Heinrich-Heine University. (2010). G*Power (Version 3.1.2). Retrieved from http://www.psycho.uni-duesseldorf.de/abteilungen/aap/gpower3/download-and-register

Heo, S., Moser, D. K., Chung, M. L., & Lennie, T. A. (2010). Social status, health-related quality of life, and event-free survival in patients with heart failure. *European Journal of Cardiovascular Nursing*. Retrieved from http://www.sciencedirect.com.lrc1.usuhs.edu/science/article/pii/S1474515110001428

Hetmanski, D. J., Sparrow, N. J., Curtis, S., & Cowley, A. J. (2000). Failure of plasma brain natriuretic peptide to identify left ventricular systolic dysfunction in the community. *Heart, 84*, 440-441.

Hogan, B. E., Linden, W., & Najarian, B. (2002). Social support interventions: Do they work? *Clinical Psychology Review, 22,* 381-440.

Holmes, T. H., & Rahe, R. H. (1967). The social readjustment rating scale. *Journal of Psychosomatic Research, 11*, 213-218.

Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLos Medicine, 7*.

House, J. S., & Kahn, R. L. (1985). Measures and concepts of social support. In S. Cohen & S. L. Syme (Eds.), *Social support and health* (pp. 83-108). Orlando: Academic Press, Inc.

House, J. S., Landis, K. R., & Umberson, D. (1988). Social relationships and health. *Science, 241*, 540-545.

Hunt, S. A., Abraham, W. T., Chin, M. H., Feldman, A. M., Francis, G. S., Ganiats, T. G. (2005). ACC / AHA 2005 guideline update for the diagnosis and management of chronic heart failure in the adult: A report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *Circulation, 112*, e154-e235.

Jiang, W., Alexander, J., Christopher, E., Kuchibhatla, M., Gaulden, L. H., ... (2001). Relationship of depression to increased risk of mortality and rehospitalization in patients with congestive heart failure. *Archives of Internal Medicine, 161*, 1849-1856.

Johnson, C. L. (1999). *The Roseto effect.* Retrieved from http://www.uic.edu/classes/osci/osci590/14_2%20The%20Roseto%20Effect.htm

Jones, G. N., & Brantley, P. J. (1989). *The Weekly Stress Inventory*. Unpublished manual.

Kamphuis, M., Ottenkamp, J., Vliegen, H. W., Vogels, T., Zwinderman, K. H., Kamphuis, R. P. (2002). Health related quality of life and health status in adult survivors with previously operated complex congenital heart disease. *Heart, 87*, 356-362.

Kenchaiah, S., Evans, J. C., Levy, D., Wilson, P., Benjamin, E. J., Larson, M. G. (2002). Obesity and the risk of heart failure. *New England Journal of Medicine, 347*, 305-313.

Kenny, D. A. (2012). *Mediation.* Retrieved from http://davidakenny.net/cm/mediate.htm

Kessler, R. C., McLeod, J. D., & Wethington, E. (1985). The costs of caring: A new perspective on sex differences in psychological distress. In I. R. Sarason & B. S. Sarason (Eds.), *Social support: Theory, research, and applications* (pp. 491-507). The Hague: Martinus Nijhof.

Kim, H. K., & McKenry, P. C. (1998). Social networks and support: A comparison of African Americans, Asian Americans, Caucasians, & Hispanics. *Journal of Comparative Family Studies, 29.2,* 313.

Koizumi, M., Kaneko, Y., Tosa, S., Watanabe, H., Kosaka, T., Hasegawa, H. (2009). Association between perceived stress and plasma B-type natriuretic peptide concentrations. *Circulation Journal, 73*, 1055-1061.

Konstam, V., Salem, D., Pouleur, H., Kostis, J., Gorkin, L., Shumaker, S., Mottard, I., Woods, P, Konstam, M. A., & Yusuf, S. (1996). Baseline quality of life as a predictor of mortality and hospitalization in 5,025 patients with congestive heart failure. *American Journal of Cardiology, 78,* 890-895.

Kop, W. J., Synowski, S. J., & Gottlieb, S. S. (2011). Depression in heart failure: Biobehavioral mechanisms. *Heart Failure Clinics, 7*, 23-38.

Krantz, D. S., & Falconer, J. L. (1995). Measurement of cardiovascular responses. In S. Cohen, R. C. Kessler & L. U. Gordon (Eds.), *Measuring stress: A guide for health and social scientists* (pp. 193-212). New York: Oxford University Press.

Krishnan, K. R., George, L. K., Pieper, C. F., Jiang, W., Arias, R., Look, A., & O'Connor, C. (1998). Depression and social support in elderly patients with cardiac disease. *American Heart Journal, 136,* 491-495.

Krumholz, H. M., Butler, J., Miller, J., Vaccarino, V., Williams, C. S., de Leon, C. F. (1997). Prognostic importance of emotional support for elderly patients hospitalized with heart failure. *Circulation, 97*, 958-964.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer Publishing Company, Inc.

Lee, Y. S. C., Suchday, S., & Wylie-Rosett, J. (2011). *Perceived social support, coping styles, and Chinese immigrants' cardiovascular responses to stress*. International Journal of Behavioral Medicine. Retrieved from http://www.springerlink.com/content/b751574447358222/fulltext.pdf

Lee, D. T. F., Yu, D. S. F., Woo, J., & Thompson, D. R. (2005). Health-related quality of life in patients with congestive heart failure. *The European Journal of Heart Failure, 7,* 419-422.

Leon, T. C., Nouwen, A., Sheffield, D., Jaumdally, R., & Lip, G. Y. H. (2010). Anger rumination, social support, and cardiac symptoms in patients undergoing angiography. *British Journal of Health Psychology, 15,* 841-857.

Lett, H. S., Blumenthal, J. A., Babyak, M. A., Strauman, T. J., Robins, C., & Sherwood, A. (2005). Social support and coronary heart disease: Epidemiologic evidence and implications for treatment. *Psychosomatic Medicine, 67*, 869-878.

Levy, D., Larson, M. G., Vasan, R. S., Kannel, W. B., & Ho, K. L. (1996). The progression from hypertension to congestive heart failure. *Journal of the American Medical Association, 275*(1557-1562).

Lightwood, J., Fleischmann, K. E., & Glantz, S. A. (2001). Smoking cessation in heart failure: It is never too late. *Journal of the American College of Cardiology, 37*, 1683-1684.

Lin, N. (1986). Conceptualizing social support. In N. Lin, A. Dean & W. M. Ensel (Eds.), *Social support, life events, and depression* (pp. 17-30). Orlando: Academic Press, Inc.

Listerman, J., Huang, R. L., Geisberg, C., & Butler, J. (2007). Risk factors for development of heart failure. *Current Cardiology Reviews, 3*, 1-9.

Lloyd-Jones, D., Adams, R. J., Brown, T. M., Carnethon, M., Dai, S., De Simone, G. (2010). Heart disease and stroke statistics 2010 update: A report from the American Heart Association. *Circulation, 121*, e46-e215.

Luskin, F., Reitz, M., Newell, K., Quinn, T. G., & Haskell, W. (2002). A controlled pilot study of stress management training of elderly patients with congestive heart failure. *Preventive Cardiology, 5,* 168-172.

Lyon, B. L. (2000). Stress, coping, and health: A conceptual overview. In V. H. Rice (Ed.), *Handbook of stress, coping, and health: Implications for nursing, research, theory, and practice*. London: Sage Publications, Inc.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test the significance of the mediated effect. *Psychological Methods, 7,* 83-104.

Macleod, J., Smith, G. D., Heslop, P., Metcalfe, C., Carroll, D., & Hart, C. (2002). Psychological stress and cardiovascular disease: Empirical demonstration of bias in a prospective observational study of Scottish men. *British Journal of Medicine, 324,* 1-7.

Macleod, J., Smith, G. D., Metcalfe, C., Carroll, D., & Hart, C. (2001). Are the effects of psychosocial exposures attributable to confounding? Evidence from a prospective observational study on psychological stress and mortality. *Journal of Epidemiological Community Health, 55*, 878-884.

MacMahon, K. A., & Lip, G. Y. (2002). Psychological factors in heart failure: A review of the literature. *Archives of Internal Medicine, 162*(509-516).

Maisel, A. S., Krishnaswamy, P., Nowak, R. M., McCord, J., Hollander, J. E., Duc, P. (2002). Rapid measurement of B-type natriuretic peptide in the emergency diagnosis of heart failure. *New England Journal of Medicine, 347*, 161-167.

Matire, L. M., Schulz, R., Mittelmark, M. B., & Newsom, J. T. (1999). Stability and change in older adults' social contact and social support: The Cardiovascular Health Study. *Journal of Gerontology: Series B-Psychological Sciences & Social Sciences, 54,* S302-S3011.

McCauley, K. M. (1995). Assessing social support in patients with cardiac disease. *Journal of Cardiovascular Nursing, 10*, 73-80.

McCullough, P. A., Philbin, E. F., Spertus, J. A., Kaatz, S., Sandberg, K. R., & Weaver, W. D. (2002). Confirmation of a heart failure epidemic: Findings from the Resource Utilization Among Congestive Heart Failure (REACH) study. *Journal of the American College of Cardiology, 39,* 60-69.

McMurray, J. J. V., & Stewart, S. (2002). The burden of heart failure. *European Heart Journal Supplements, 4,* D50-D58.

Meyer, A. (1951). *The collected papers of Adolf Meyer*. Baltimore: Johns Hopkins Press.

Mezuk, B., Roux, A. V. D., & Seeman, T. (2010). Evaluating the buffering versus direct effects hypotheses of emotional social support on inflammatory markers: The Multi-Ethnic Study of Atherosclerosis. *Brain, Behavior, and Immunity, 24*, 1294-1300.

Miller, V. M., Redfield, M. M., & McConnell, J. P. (2007). Use of BNP and CRP as biomarkers in assessing cardiovascular disease: Diagnosis versus risk. *Current Vascular Pharmacology, 5*, 15-25.

Miilunpalo, S., Vuori, I., Oja, P., Pasanen, M., & Urponen, H. (1997). Self-rated health status as a health measure: The predictive value of self-reported health status on the use of physician services and on mortality in the working-age population. *Journal of Clinical Epidemiology, 50,* 517-528.

Monroe, S. M., & Kelley, J. M. (1995). Measurement of stress appraisal. In S. Cohen, R. C. Kessler & L. U. Gordon (Eds.), *Measuring stress: A guide for health and social scientists* (pp. 122-147). New York: Oxford University Press.

Mookadam, F., & Arthur, H. M. (2004). Social support and its relationship to morbidity and mortality after acute myocardial infarction. *Archives of Internal Medicine, 164*, 1514-1518.

Morita, E., Yasue, H., Yoshimura, M., Ogawa H., Jougasaki, M., Matsumura, T. Mukoyama, M., & Nakao, K. (1993). Increased plasma levels of brain natriuretic peptide in patients with acute myocardial infarction. *Circulation, 88,* 82-91.

Moser, D. (2002). Psychosocial factors and their association with clinical outcomes in patients with heart failure: Why clinicians do not seem to care. *European Journal of Cardiovascular Nursing, 1*, 183-188.

Moser, D., & Worster, P. L. (2000). Effect of psychosocial factors on physiologic outcomes in patients with heart failure. *Journal of Cardiovascular Nursing, 14*, 106-115.

Mroczek, D. K. & Almeida, D. M. (2004). The effect of daily stress, personality, and age on daily negative affect. *Journal of Personality and Social Psychology, 72,* 355-378.

Murberg, T. A., & Bru, E. (2001). Social relationships and mortality in patients with congestive heart failure. *Journal of Psychosomatic Research, 51*, 521-527.

Murberg, T. A., Bru, E., & Aarsland, T. (2001). Personality as predictor of mortality among patients with congestive heart failure: A two-year follow-up study. *Personality and Individual Differences, 30,* 749-757.

New York Heart Association (NYHA). (1994). *Nomenclature and criteria for the diagnosis of diseases of the heart and great vessels.* (9th ed., pp. 253-256). Boston.

Nichols, G. A., Gullion, C. M., Koro, C. E., Ephross, S. A., & Brown, J. B. (2004). The incidence of congestive heart failure in type 2 diabetes. *Diabetes Care, 27*, 1879-1884.

Nielsen, N. R., Kristensen, T. S., Prescott, E., Larsen, K. S., Schnohr, P., & Gronbaek, M. (2006). Perceived stress and risk of ischemic heart disease. *Epidemiology, 17,* 391-397.

Nielsen, N. R., Kristensen, T. S., Schnohr, P., & Gronbaek, M. (2008). Perceived stress and cause-specific mortality among men and women: Results from a prospective cohort study. *American Journal of Epidemiology, 168*, 481-491.

Olivio, E. L., Dodson-Lavelle, B., Wren, A., Fang, Y., & Oz, M. C. (2009). Feasibility and effectiveness of a brief meditation-based stress management intervention for patients diagnosed with or at risk for coronary heart disease: A pilot study. *Psychology, Health, & Medicine, 14*, 513-523.

Oxman, T., & Berkman, L. F. (1990). Assessment of social relationships in elderly patients. *International Journal of Psychiatry Medicine, 20*, 65-84.

Paukert, A. L., LeMaire, A., & Cully, J. A. (2009). Predictors of depressive symptoms in older veterans with heart failure. *Aging and Mental Health, 13*, 601-610.

Pbert, L., Doerfler, L. A., & DeCosimo, D. (1992). An evaluation of the Perceived Stress Scale in two clinical populations. *Journal of Psychopathology and Behavioral Assessment, 14*, 363-375.

Peacock, W. F. (2005, January). The evolving role of BNP in the diagnosis and treatment of CHF: A summary of the BNP consensus panel report. *Emergency Medicine Cardiac Research and Education Group.* Retrieved from http://www.emcreg.org/pdf/monographs/BNP05n.pdf

Pelle, A. J., Gidron, Y. Y., Szabo, B. M., & Denollet, J. (2008). Psychological predictors of prognosis in chronic heart failure. *Journal of Cardiac Failure, 14*, 341-350.

Perlman, L. V., Ferguson, S., Bergum, K., Isenberg, E. L., & Hammarsten, J. F. (1971). Precipitation of congestive heart failure: Social and emotional factors. *Annals of Internal Medicine, 75*, 1-7.

Philbin, E. F., Dec, W., Jenkins, P. L., & DiSalvo, T. G. (2001). Socioeconomic status as an independent risk factor for hospital readmission for heart failure. *American Journal of Cardiology, 87*, 1367-1371.

Phillips, A. C., Carroll, D., Ring, C., Sweeting, H., & West, P. (2005). Life events and acute cardiovascular reactions to mental stress: A cohort study. *Psychosomatic Medicine, 67*, 384-392.

Pittsburgh Mind-Body Center. (2008, May 12). *Basic psychometrics for the ISEL 12 item scale.* Retrieved from http://www.psy.cmu.edu/~scohen/scales.html

Preacher, K. J., & Leonardelli, G. J. (2012). *Calculation for the Sobel test: An interactive calculation tool for mediation tests.* Retrieved from http://quantpsy.org/sobel/sobel.htm

Rathore, S. S., Masoudi, F. A., Wang, Y., Curtis, J. P., Foody, J. M., Havranek, E. P. (2006). Socioeconomic status, treatment, and outcomes among elderly patients hospitalized with heart failure: Findings from the National Heart Failure Project. *American Heart Journal, 152*, 371-378.

Roberti, J. W., Harrington, L. N., & Storch, E. A. (2006). Further psychometric support for the 10-item version of the Perceived Stress Scale. *Journal of College Counseling, 9*, 135-147.

Rod, N. H., Andersen, I., & Prescott, E. (2011). Psychosocial risk factors and heart failure hospitalization: A prospective cohort study. *American Journal of Epidemiology, 174*, 672-680.

Rodriguez-Artalejo, F., Castillon, P. G., Herrera, M. C., Otero, C. M., Chiva, M. O., Ochoa, C. C. (2006). Social network as a predictor of hospital readmission and mortality among older patients with heart failure. *Journal of Cardiac Failure, 12*, 621-627.

Rogers, H. (2008). *Social support, heart failure, and acute coronary syndromes: The role of inflammatory markers*. (Unpublished doctoral dissertation). Uniformed Services University of the Health Sciences. Bethesda, MD.

Rosen, R. C., Contrada, R. J., Gorkin, L., & Kostis, J. B. (1997). Determinants of perceived health in patients with left ventricular dysfunction: A structural modeling analysis. *Psychosomatic Medicine, 59,* 193-200.

Rosengren, A., Hawken, S., Ounpuu, S., Sliwa, K., Zubaid, M., Almahmeed, W. A. (2004). Association of psychosocial risk factors with risk of acute myocardial infarction in 11,119 cases and 13,648 controls from 52 countries (the INTERHEART study): Case-control study. *Lancet, 364*, 953-962.

Rosengren, A., Tibblin, G., & Wihelmsen, L. (1991). Self-perceived psychological stress and incidence of coronary artery disease in middle-aged men. *American Journal of Cardiology, 68*, 1171-1175.

Roy, M. P., Steptoe, A., & Kirschbaum, C. (1998). Life events and social support as moderators of individual differences in cardiovascular reactivity. *Journal of Personality and Social Psychology, 75*, 1273-1281.

Rozanski, A., Blumenthal, J. A., & Kaplan, J. (1999). Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. *Circulation, 99*, 2192-2217.

Rutledge, T., Reis, V. A., Linke, S. E., Greenberg, B. H., & Mills, P. J. (2006). Depression in heart failure: A meta-analytic review of prevalence, intervention effects, and associations with clinical outcomes. *Journal of the American College of Cardiology, 48*, 1527-1537.

Schiffer, A. A., Pederson, S. S., Widdershoven, J. W., Hendriks, E. H., Winter, J. B., & Denollet, J. (2005). The distressed (type D) personality is independently associated with impaired health status and increased depressive symptoms in chronic heart failure. *European Journal of Cardiovascular Prevention and Rehabilitation, 12,* 341-346.

Selye, H. (1950). Stress and the general adaption syndrome. *British Medical Journal*, 1383-1392.

Selye, H. (1951). The general adaptation syndrome. *Annual Review of Medicine, 2*, 327-342.

Selye, H. (1993). History of the stress concept. In L. Goldberger & S. Breznitz (Eds.), *Handbook of Stress: Theoretical and Clinical Aspects* (2nd ed., pp. 2-17). New York: The Free Press.

Shapiro, P. A. (2011). CBT stress management reduces recurrent CAD events after myocardial infarction. *Evidence-Based Medicine, 16,* 147-148.

Sharp, L. K., Kimmel, L. G., Kee, R., Saltoun, C., & Chang, C. (2007). Assessing the Perceived Stress Scale for African Americans adults with asthma and low literacy. *Journal of Asthma, 44,* 311-316.

Shen, B., Eisenberg, S. A., Maeda, U., Farrell, K. A., Schwarz, E. R., Penedo, F. J. (2011). Depression and anxiety predict decline in physical health functioning in patients with heart failure. *Annals of Behavioral Medicine, 41*, 373-382.

Sherwood, A., Blumenthal, J. A., Trivedi, R., Johnson, K. S., O'Connor, C. M., Adams, K. F. (2007). Relationship of depression to death or hospitalization in patients with heart failure. *Archives of Internal Medicine, 167*, 367-373.

Silver, M. A., Maisel, A., Yancy, C. W., McCullough, P. A., Burnett, J. C., Francis, G. S., . . . Hollander, J. (2004). BNP Consensus Panel 2004: A clinical approach for the diagnostic, prognostic, screening, treatment monitoring, and therapeutic roles of natriuretic peptides in cardiovascular diseases. *Congestive Heart Failure, 10,* 1-30.

Smith, G. T., McCarthy, D. M., & Anderson, K. G. (2000). On the sins of short-form development. *Psychological Assessment, 12*, 102-111.

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. In S. Leinhardt (Ed.), *Sociological Methodology 1982* (pp. 290-312). Washington, D.C.: American Sociological Association.

Solway, S., Brooks, D., Lacasse, Y., & Thomas, S. (2001). A qualitative systematic overview of the measurement properties of functional walk tests used in the cardiorespiratory domain. *Chest, 119*, 256-270.

Spector, P. E. (2006). Method variance in organizational research: Truth or urban legend? *Organizational Research Methods, 9,* 221-232.

Spertus, J. A., Peterson, E., Conrad, M. W., Heidenreich, P. A., Krumholz, H. M., Jones, P. (2005). Monitoring clinical changes in patients with heart failure: A comparison of methods. *American Heart Journal, 150*, 707-715.

Steptoe, A. (2000). Stress, social support, and cardiovascular activity over the working day. *International Journal of Psychophysiology, 37*, 299-308.

Steptoe, A., & Molloy, G. J. (2007). Personality and heart disease. *Heart, 93,* 783-784.

Stewart, M. J. (1989). Social support intervention studies: A review and prospectus of nursing contributions. *International Journal of Nursing Studies, 26,* 93-114.

Strik, J., Denollet, J., Lousberg, R., & Honig, A. (2003). Comparing symptoms of depression and anxiety as predictors of cardiac events and increased health care consumption after myocardial infarction. *Journal of American College of Cardiology, 42,* 1801-1807.

Strike, P. C., & Steptoe, A. (2004). Psychosocial factors in the development of coronary artery disease. *Progress in Cardiovascular Diseases, 46*, 337-347.

Takeda, Y., Takeda, Y., Suzuki, S., & Kimura, G. (2009). Within-person variation of the plasma concentration of B-type natriuretic peptide: Safety range in stable patients with heart failure. *American Heart Journal, 157*, 97-101.

Tennant, C. (1999). Life stress, social support, and coronary heart disease. *Australian and New Zealand Journal of Psychiatry, 33,* 636-641.

Tessler, R., & Mechanic, D. (1978). Psychological distress and perceived health status. *Journal of Health and Social Behavior, 19,* 254-262.

Theorell, T., Blomkvist, V., Jonsson, H., Schulman, S., Berntorp, E., & Stigendal, L. (1995). Social support and the development of immune function in human immunodeficiency virus infection. *Psychosomatic Medicine, 57*, 32-36.

Thoits, P. A. (1995). Stress, coping, and social support processes: Where are we? What next? *Journal of Health and Social Behavior, Extra Issue,* 53-79.

Trivedi, R. B., Blumenthal, J. A., O'Conner, C., Adams, K., Hinderliter, A., Dupree, C. (2009). Coping style in heart failure patients with depressive symptoms. *Journal of Psychosomatic Research, 67*, 339-346.

Tsuchihashi-Makaya, M., Kato, N., Chishaki, A., Takeshita, A., & Tsutsui, H. (2009). Anxiety and poor social support are independently associated with adverse outcomes in patients with mild heart failure. *Circulation Journal, 73*, 280-287.

Uchino, B. N. (2004). *Social support and physical health: Understanding the health consequences of relationships*. New Haven: Yale University Press.

Uchino, B. N. (2006). Social support and health: A review of physiological processes potentially underlying links to disease outcomes. *Journal of Behavioral Medicine, 29*, 377-387.

Uchino, B. N., Cacioppo, J. T., & Kiecolt-Glaser, J. K. (1996). The relationship between social support and physiological processes: A review with emphasis on underlying mechanisms and implications for health. *Psychological Bulletin, 119*, 488-531.

Vaccarino, V., Kasl, S. V., Abramson, J., & Krumholz, H. M. (2011). Depressive symptoms and risk of functional decline and death in patients with heart failure. *Journal of the American College of Cardiology, 38*, 199-205.

van den Broek, K. C., deFilippi, C. R., Christenson, R. H., Seliger, S. L., Gottdiener, J. S., & Kop, W. J. (2011). Predictive value of depressive symptoms and B-type natriuretic peptide for new-onset heart failure and mortality. *American Journal of Cardiology, 107,* 723-729.

van Melle, J. P., Bot, M., de Jonge, P., de Boer, R. A., van Veldhuisen, D. J., & Whooley, M. A. (2010). Diabetes, glycemic control, and new-onset heart failure in patients with stable coronary artery disease: Data from the Heart and Soul Study. *Diabetes Care, 33*, 2084-2089.

Vaux, A. (1985). Variations in social support associated with gender, ethnicity, and age. *Journal of Social Issues, 41,* 89-110.

Watson, D., & Pennebaker, J. W. (1989). Health complaints, stress, and distress: Exploring the central role of negative affectivity. *Psychological Review, 96,* 234-254.

Wawrzyniak, A. J., Harris, K. M., Bekkouche, N. S., Whittaker, K. S., Godoy, S. M., Kop, W. J. (2011). *Perceived social support and markers of heart failure severity*. Paper presented at the American Psychosomatic Society, San Antonio, Texas.

Westlake, C., Dracup, K., Creaser, J., Livingston, N., Heywood, J. T., Huiskes, B. L. (2002). Correlates of health-related quality of life in patients with heart failure. *Heart and Lung, 2002*, 85-93.

Willert, M. V., Thulstrup, A. M., Hertz, J., & Bonde, J. P. (2009). Changes in stress and coping from a randomized controlled trial of a three-month stress management intervention. *Scandinavian Journal of Work, Environment, & Health, 35,* 145-152.

White, J. M., & Porth, C. M. (2000). Physiological measurement of the stress response. In V. H. Rice (Ed.), *Handbook of stress, coping, and health: Implications for nursing research, theory, and practice* (pp. 69-94). London: Sage Publications, Inc.

Williams, S. A., Kasl, S. V., Heiat, A., Abramson, J. L., Krumholz, H. M., & Vaccarino, V. (2002). Depression and risk of heart failure among the elderly: A prospective community-based study. *Psychosomatic Medicine, 64,* 6-12.

Wills, T. A., & Shinar, O. (2000). Measuring perceived and received social support. In S. Cohen, L. G. Underwood & B. H. Gottlieb (Eds.), *Social support measurement and intervention: A guide for health and social scientists* (pp. 86-135). Orlando: Oxford University Press.

Yamamoto, K., Burnett, J. C., Jougasaki, M., Nishimura, R., Bailey, K. R., Saito, Y. (1996). Superiority of brain natriuretic peptide as a hormonal marker of ventricular systolic and diastolic dysfunction and ventricular hypertrophy. *Hypertension, 28*, 988-994.

Yates, B. C., Skaggs, B. G., & Parker, J. D. (1994). Theoretical perspectives on the nature of social support in cardiovascular illness. *Journal of Cardiovascular Nursing, 9,* 1-15.

Yu, D. S. F., Lee, D. T. F., Woo, J., & Thompson, D. R. (2004). Correlates of psychological distress in elderly patients with congestive heart failure. *Journal of Psychosomatic Research, 57*, 573-581.

Zautra, A. J., Guarnaccia, C. A., & Dohrenwend, B. P. (1986). Measuring small life events. *American Journal of Community Psychology, 14*, 629-655.