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The Relationships Among Medication and Low-Salt Diet Adherence, Beliefs about Medicines, and Psychosocial Variables among Individuals with Heart Failure.

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Heart failure (HF) is a debilitating chronic illness that afflicts millions of Americans and carries a poor prognosis, likely due to insufficient medication and low-salt diet adherence, which exacerbates HF symptoms and leads to frequent rehospitalizations. Specific reasons underlying non-adherence among HF patients are unclear. Studies investigating reasons for adherence among HF patients have shown that correlates of poor adherence include demographic (i.e., age, income), functional (i.e., NYHA), and psychosocial (i.e., social support, depression) variables. Research studies among individuals with chronic diseases suggest that an individual's beliefs about medicines may explain adherence, but this research is limited among HF patients. The purpose of this study was to examine how psychosocial variables and beliefs about medicines are related to self-reported medication and low-salt diet adherence among individuals with HF, while controlling for demographic and physical functioning variables. This study had three aims: 1) To examine the relationships between psychosocial variables (e.g., depression, hostility, social support) and adherence; 2) To examine the relationship between beliefs about medicines and adherence; and 3) To investigate whether beliefs about medicines moderate the relationship between psychosocial variables and adherence. An ethnically-diverse sample of 105 HF patients completed several measures

assessing depressive symptoms, level of hostility, perceived social support, beliefs about medicines, and medication and low-salt diet adherence. Structural equation modeling revealed that higher depression, higher hostility, and a stronger belief that medications are harmful and/or overused by doctors were significantly related to worse medication adherence. Further, participants who believed that medicines are necessary and had few concerns about them were more likely to adhere to a low-salt diet. Age, income, and number of co-morbid illness also were significantly related to low-salt diet adherence beyond contributions of beliefs about medicines scales and psychosocial variables. Thus, overall it appears that different beliefs about medicines differentially influence medication versus low-salt diet adherence, and psychological disposition may not underlie low-salt diet adherence. These results can inform interventions of health care practitioners in addressing adherence issues with HF patients.

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Chapter 1 INTRODUCTION

Heart failure (HF) is a chronic, debilitating condition defined broadly as insufficient circulation of blood throughout the body due to a weakened myocardium. It results from a wide variety of etiologies adversely affecting the myocardium and often causes fluid and sodium homeostasis disruption. Currently in the U.S., approximately 5 million adults are diagnosed with HF with 550,000 new cases diagnosed annually (American Heart Association [AHA], 2005). HF afflicts approximately 10% of elderly individuals (van der Wal et al., 2006), and thus will become an even greater medical and societal burden in the years to come. In fact, inpatient discharges for HF more than doubled from 1979 to 1999 (AHA, 2002) and HF is expected to double in prevalence by the year 2030 (U.S. Department of Health, 1991).

Although medical and surgical management for patients with HF has greatly improved, the prognosis of HF continues to be grim. In fact, despite medical advances, HF deaths in the U.S. increased 145% from 1979 to 1999 (AHA, 2002). Other statistics are equally startling: within one year and five years of diagnosis, one in five afflicted individuals, and 75% of men and 62% of women, respectively, will die (Ho, Anderson, Kannel, Grossman, & Levy, 1993; AHA, 2002).

Medical Regimens for Patients with HF

One reason for such poor outcomes among patients with HF may be the complexity of the medical regimen, which consists of both pharmacological and non-pharmacological therapy. HF patients are prescribed a wide variety of numerous medications. Current guidelines recommend prescribing five or more medications depending on the severity, with many elderly patients taking more than 10 medications

for HF and co-morbid conditions (Hunt et al., 2005a; Masoudi et al., 2005). A few medicines that are standard pharmacotherapy for patients with HF, such as angiotensin-converting enzyme inhibitors, beta-blockers and sprinolactone, are effective in reducing both morbidity and mortality (The SOLVD Investigators, 1991; Packer et al., 1996; Pitt et al., 1999), but, of course, only if patients adhere to the arduous regimen, characterized by taking at least 5 HF-specific medicines each day and strict adherence to a low-salt diet (Hunt et al., 2005a; Hunt et al., 2002). This regimen very likely necessitates a complete overhaul of a HF patient's lifestyle and that of his/her family, adding to the challenge of adhering to this regimen. Adherence to prescribed regimens is less than optimal (to be discussed), and non-adherence is considered a primary reason for the poor prognosis.

Of primary importance regarding non-pharmacological management of HF is adherence to a low-salt diet in order to avoid fluid retention (Hunt et al., 2002); a primary cause of adverse events and subsequent hospitalization. Further, similar to other chronic illnesses, current guidelines for non-pharmacological management of HF include severely restricted daily fluid intake, complete abstinence or restriction of alcohol and nicotine use, weighing oneself every day, and regular influenza and pneumonia vaccination (Krum, 2001). This overwhelming regimen is further complicated by findings suggesting that all patients with HF may not receive adequate information regarding adhering to a low-salt diet. Riegel, Moser, Powell, Rector, & Havranek (2006) found that among clinicians in the Heart Failure Society of America who completed a survey, 88.9% reported motivating their patients to care for themselves, 83.4% said they teach patients how to read food labels, 80% reported teaching patients how to identify low-sodium foods when eating in restaurants, and 81.7% said they taught patients ways to alter their

usual diet to a low-sodium diet. These results suggest that HF patients may receive inconsistent—or very little—information and education related to their medical regimen, thereby creating additional potential barriers to adherence.

The relationship between a patient's knowledge and understanding of a medical regimen and adherence, however, is not yet clear. Research conducted among HF and other cardiac populations found that receiving knowledge pertaining to one's cardiovascular disease and its therapy did not improve adherence (Cline et al., 1999; Ni et al., 1999; Wang et al., 2002). Studies have reflected this finding regarding low-salt diet adherence. For example, Ni et al. (1999) reported that though 90.3% of HF patients stated that they knew they should restrict sodium intake, only 38-40% of those reported always avoiding salty foods. Another study found that though 90.2% of HF patients reporting knowing that they should adhere to a low-salt diet, only 9.8% of them reported having done so (Schweitzer, Head, & Dwyer, 2007). Thus, although knowledge and understanding of the HF treatment regimen may not account for much of adherence behavior, it is important to remember that the medical regimen for HF is very complex and adherence is likely to be influenced by a patient's experience with and reception of medical advice.

Adherence Definitions

The very definition of adherence appears to be up for debate and may frame the way in which adherence is addressed and improved. Some definitions seem to put responsibility for adherence on health care providers: The World Health Organization posits in their Global Report on Innovative Care for Chronic Conditions: Building Blocks for Action (2002), that non-adherence is "fundamentally a failure of the health care

system" (WHO, 2002). Others define adherence as a patient's responsibility given adequate health care advice. For example, Leventhal, Riegel, Carlson, and De Geest (2005) defines adherence as a patient's "informed free choice of behaviors selected from those recommended by the health care provider" and asserts that the patient must acquire skills necessary for regimen implementation and seek advice as needed. Another often-used definition of adherence is that it is "the extent to which a person's behavior coincides with medical or health advice" (Haynes, 1979).

For purposes of this study, since adherence will be assessed by patient self-report, it therefore will be defined from the patient's perspective and interpretation of adherence, but may be considered a reflection of broader medical system phenomena. It is argued that, though patients may appear to be passive recipients of health care information, patients make decisions regarding adherence (or lack thereof) to the medical regimen. Increasingly, it is becoming apparent that patients are very active agents of their medical care, and adherence appears to be influenced by ever-changing personal and situational factors (Lucas et al., 2002; Spire et al., 2002).

Rates of Non-Adherence to both Medications and Low-Salt diet among HF Patients

Rates of medical regimen adherence among HF patients vary widely depending upon how one defines adherence and the measures employed to assess adherence. Studies that have assessed adherence according to the percentage of medications taken as prescribed by each individual (either by self-report or MEMS caps) have reported adherence rates ranging from 50-96% of medications taken as prescribed (Evangelista, Berg, & Dracup, 2001; Gwadry-Sridhar et al., 2005; Wu, Moser, Chung, & Lennie, 2008). Other studies defined patients either as adherent or non-adherent according to

whether the patient adhered to a certain percentage of medications taken as prescribed. Studies defining patients as "adherent" if the patient adhered (either by self-report, pill count, or pharmacy refill records) <75-80% of the time reported that 45-89% of patients were adherent for up to a year's duration (Granger et al., 2005; Rasmussen, Chong, & Alter, 2007; Kramer et al., 2006;; Michalsen, Konig, & Thimme, 1998; Rich, Gray, Beckham, Wittenberg, & Luther, 1996).

Studies that have assessed *full* or *total* compliance with medications for HF found that only about 10% reported *full* compliance (Monane, Bohn, Gurwitz, Glynn, & Avorn, 1994). Quite different is the result from another study that found that 74% of their patients reported taking their medication "exactly" as prescribed (Ni et al., 1999). Even following a life-threatening event such as a myocardial infarction (MI), 52% of patients were adherent (defined as refilling medications >75% of days) at 6 months and 45% were adherent at 12 months after the index MI (Kramer et al., 2006). Studies assessing adherence have been plagued by a paucity of information regarding the minimum level of adherence that would be effective in benefitting the patient. To that end, very recently Wu et al. (2009) found that medication adherence below 88% among HF patients significantly increased the likelihood of emergency room visits for HF exacerbation, rehospitalizations, and all-cause mortality.

As previously discussed, medication adherence is but one aspect of HF therapy; adherence rates to low-salt diet also are less than optimal (Bennett et al., 1998; Tsuyuki et al., 2001; Michalsen et al., 1998; Vinson, Rich, Sperry, Shah, & McNamara, 1990; Happ, Naylor, & Roe-Prior, 1997). One study found that only 38-40% of patients reported

always eating a low-salt diet (Ni et al., 1999); another reported that 64% of HF patients followed a low-salt diet (Schwarz & Elman, 2003).

Consequences of Medication and Diet Non-Adherence Among HF Patients

It is well-established that medication non-adherence causes increased mortality and hospitalization in patients with heart disease (Dunbar-Jacob, Bohachick, Mortimer, Sereika, & Foley, 2003; Vinson et al., 1990; Ghali, Kadakia, Cooper, & Ferlinz, 1988; Opasich et al., 2001; De Geest et al., 2003; Wagdi, Vuilliomenet, Kaufmann, Richter, & Bertel, 1993; Miura et al., 2001; Fonarow, Gawlinski, Moughrabi, & Tillisch, 2001; Gallagher, Viscoli, & Berkman, 1993; Horwitz et al., 1990) and is in fact thought to be one of the most common causes of HF exacerbation and subsequent hospital admission in patients with HF (Chin & Goldman, 1997; Li, Morrow-Howell, & Proctor, 2004; Miura et al., 2001; Hope, Wu, Tu, Young, & Murray, 2004; Vinson et al., 1990; De Geest et al., 2003; Happ et al., 1997; Welsh et al., 2002; Bertel, 1991; Ghali et al., 1998). One study revealed that non-adherent post-MI patients—defined in this study by taking less than 75% of prescribed doses—were 2.6 times more likely to die in one year than those who adhered (Horwitz et al., 1990). A startling 44-82% of individuals are readmitted to the hospital within 90 days to 1 year after an initial discharge for decompensated HF (Krumholz et al., 1997; Rich et al., 1993; Vinson et al., 1990; Krumholz et al., 2002). It has been estimated that fully one-half to two-thirds of hospitalizations for HF are preventable via improved adherence (review by Hauptman, 2008).

In addition to medication non-adherence, low-salt diet non-adherence is a major contributor to morbidity, as some researchers suggest that volume overload—a proximate consequence of low-salt diet non-adherence—is one of the most common causes of HF

hospitalizations (Bennett et al., 1998; Tsuyuki et al., 2001; Michalsen et al., 1998). It is important to emphasize that the great majority of exacerbations and subsequent hospitalizations could be prevented, and an emergency room is not the optimal environment in which to treat patients with a complex, chronic disease (Horowitz, Rein, & Leventhal, 2004). It is imperative to address medication and low-salt diet adherence as early, often, and effectively as possible.

Costs to the Medical System Due to Non-Adherence

In a period of global recession and escalating health care costs, we would be remiss to ignore the impact of behavior—specifically in this case; adherence—on health care costs. The annual expenditure estimate in the U.S. for HF medical care is approximately $27.9 billion (AHA, 2005), approximately 60% to 70% of this cost is for inpatient hospital care (Kannel, 2000; McMurray & Stewart, 2002), and $2.9 billion is spent on drugs to treat HF (Hunt et al., 2005a). Among Medicare recipients, HF is the leading reason for hospital admission, and expenditures for Medicare beneficiaries in 2001 for HF treatment totaled $4.0 billion with an average $5912 spent per HF discharge (Thom et al., 2006). Overall, HF accounts for 43% of Medicare expenditures (Hunt et al., 2005a). These costs are bound to increase drastically as our population ages. The time for interventions aimed at improving adherence is nigh.

Again, since HF and its management are very complex, non-adherence might be attributed to factors such as taking multiple medications and adhering to a challenging diet. While treatment-related factors and other variables, such as an individual's demographics (i.e., income, age) may affect adherence, it is important to understand that adherence (or lack thereof) is not accidental or circumstantial. Individuals make decisions

regarding whether, when, and how to take their medicines. Studies among patients with chronic illnesses have established that patients purposefully experiment with timing and amount of dosages (Donovan & Blake, 1992). Despite advances in medical therapy for HF, prognosis remains poor and costs remain high; both of which largely are attributed to inadequate medication and low-salt diet adherence.

Associations between Demographic Variables and Adherence in Cardiac Samples

Non-modifiable variables.

Overall, the relationships between non-modifiable demographic variables (i.e., age, gender, and ethnicity) and adherence among individuals with HF are unclear. Some studies have found that age is positively related to adherence (Bane, Hughes, & McElnay, 2006; Phatak & Thomas, 2006; Maguire, Hughes, & McElnay, 2008; Khanderia et al., 2008; Morgan et al., 2006); others have found age is negatively related to adherence (Park, Willis, Morrow, Diehl, & Gaines, 1994); and other studies have reported no association between age and adherence (Wu, Moser, & Chung, et al., 2008). Regarding gender, some studies revealed that women are less adherent than men (Irvine et al., 1999; Morgan et al., 2006; Chapman et al., 2005). Most studies examining ethnic differences in adherence find no differences (Reynolds et al., 2004), though one did report that non-adherent patients were less likely to be Caucasian (Morgan et al., 2006). Many studies simply do not report associations (or lack thereof) between these demographic variables and adherence; thus, it is important to continue to explore whether and how these variables are related to adherence.

Socioeconomic status (SES).

SES usually is assessed by education level and income. Wu et al. (2009) found that education level did not differ between non-adherent and adherent HF patients, whereas Bane et al. (2006) reported that number of years of education and non-adherence were significantly positively related.

Since medicines can be costly to individuals, it is important to determine whether a patient's income is related to adherence. Interestingly, few studies among HF patients report significant associations between income and adherence. One study among post-CABG patients (Khanderia et al., 2008) found those who reported an annual income of $50,000 to $100,000 (compared with <$20,000) were less adherent. It may be the case that low-income individuals who receive medications for free are more adherent. Another study among elderly patients found that medication adherence was poor even in a setting in which medications were free of charge for the patient (Simpson, 2006). Thus, the relationship between SES and adherence is not clear and should continue to be examined.

Associations between Functional Variables, Regimen Complexity and Adherence

It seems reasonable to presume that the way an individual feels and functions each day might affect activities, including adherence to medications. Several studies have investigated whether one's overall level of functioning (often represented in HF patients by New York Heart Association [NYHA] functional class I-IV, which represent worsening functioning by increasing Roman numeral) is related to adherence. Some research among HF patients has revealed that a worse NYHA class was related to poorer adherence (Wu, Moser, Chung et al., 2008), while another found that HF patients in NYHA class III or IV were more adherent than those in NYHA I or II (Pamboukin et al.,

2008). Often related to NYHA class and overall function is left ventricular ejection fraction (EF), which is the fraction of blood pumped out of the left ventricle with every ventricular contraction. EF frequently is a diagnostic parameter for HF, as a very low value (i.e., 30-40%) indicates impaired ventricular functioning. In one study, EF was negatively related to adherence to attending phlebotomy appointments during which their international normalized ratio (INR), which reflects adherence to Warfarin, was assessed (Pamboukian et al., 2008). EF, however, was not related to INR values per se in this study.

As previously discussed, HF patients often are plagued with a heavy medication burden and co-morbid diseases, both of which can affect adherence. HF patients are prescribed up to 8.5 medications on average (Masoudi et al., 2005). Studies investigating the relationship between medication burden and adherence are mixed. Some have reported that number of medications and adherence are negatively related (Phatak & Thomas, 2006; Chapman et al., 2005), while others report a positive relationship (Shalansky & Levy, 2002; Orensky & Holdford, 2005; Billups, Malone, & Carter, 2000), while still others report no relationship (Wu, Moser, Chung et al., 2008).

Similarly, reports of the nature of the relationship between co-morbid diseases and adherence are mixed. Some studies have found the presence and number of co-morbid diseases to be negatively related to adherence (Soumerai et al., 2006), while others have found no association between the two (Bane et al., 2006; Wu, Moser, Chung et al., 2008; Maguire et al., 2008; Pamboukian et al., 2008).

Thus, the available evidence on the relationship between an individual's daily functioning and adherence is inconclusive and requires further study.

Associations between Psychosocial Variables and Adherence

Depression.

It is well-established that depression is common among HF patients. Compared to the U.S. average of 9.5%, studies have reported that prevalence of depression or several depressive symptoms among HF patients ranges from 14-60% (review by Delville & McDougall, 2008). Research has shown that depression predicts worse outcomes among HF patients including increased mortality, rehospitalization, and worsening health status (Vaccarino, Kasl, Abramson, & Krumholz, 2001; Jiang et al., 2001; Rumsfeld et al., 2003; Murberg, Bru, Svebak, Tveteras, & Aarsland, 1999). It has been suggested that poor adherence mediates the association between depression and poor outcomes (review by Joynt, Whellan, & O'Connor, 2003). Further, depressed individuals may have poorer outcomes simply because they are more likely than non-depressed individuals to adopt maladaptive lifestyle behaviors such as smoking, overeating, and little physical activity (Bonnet et al., 2005; review by Lysy, Da Costa, & Dasgupta, 2008).

Depression and poor adherence, indeed, appear to be related among cardiac patient populations (i.e., coronary artery disease, post-MI, hypertension) (Gehi, Haas, Pipkin, & Whooley, 2005; Wang et al., 2002; Ziegelstein et al., 2000; Stilley, Sereika, Muldoon, Ryan, & Dunbar-Jacob, 2004; Carney, Freedland, Eisen, Rich, & Jaffe, 1995; Wang et al., 2002), though one study found that depression and adherence were not related among post-MI patients (Taylor, Barber, McIntosh, & Khan, 1998). Studies including only patients diagnosed with HF also have found that depression is negatively related to adherence (van der Wal et al., 2006; Wray, Waters, Radley-Smith, & Sensky, 2006). One very large study of HF patients found that among patients who reported

several depressive symptoms, 43.8% reported great difficulty adhering to medicines, which was significantly greater than the percentage of non-depressed patients who reported no difficulty taking medicines (27.1%) (Morgan et al., 2006). Overall in this study, HF patients who reported having difficulty taking medications versus those who reported having no difficulty were 60% more likely to have significant depressive symptoms. Another study, though, did not find evidence of a significant relationship between depression and adherence among HF patients, as use of antidepressants—defined in this study as a proxy for presence of depression—was not associated with adherence (George & Shalansky, 2007).

Thus, the relationship between depression and adherence seems to be fairly strong and indicative of a worse prognosis and suggests that an assessment of depression should be included in studies examining correlates of adherence. This assertion also begs investigation into other cognitive and psychosocial variables that might affect adherence, as depression is highly related to social support (Finch, Okun, Pool, & Ruehlman, 1999; Schwarzer & Leppin, 1991; Maher, Mora, & Leventhal, 2006) and hostility (Mao, Bardwell, Major, & Dimsdale, 2003; Barefoot et al., 1995).

Social support.

Social support generally is considered a crucial aspect of overall well-being and functioning, and therefore should be considered as possibly affecting medication adherence. Some studies have shown that increased perceived social support is related to greater adherence among cardiac (i.e., hypertension, post-MI) patients (Simpson, Farris, Johnson, & Tsuyuki, 2000; Nelson, Stason, Neutra, & Solomon, 1980; Maguire et al., 2008; Bastone & Kerns, 1995; Doherty, Schrott, Metcalf, & Iasiello-Vailas, 1983; Flury,

1993; Kulik & Mahler, 1993; Earp & Ory, 1979). Also, interestingly, even an objective measure of social support (versus the more subjective *perceived* social support)—the number of pleasurable social activities in which one participates—also is strongly associated with medication adherence (Irvine et al., 1999). In this study including post-MI patients, those who were adherent participated in twice as many social activities as the non-adherent patients. This effect may be due partly to age, as more adherent patients were more likely to be younger (≤ 70 years old) than patients who were less adherent. The effects of social support on adherence actually spans chronic illnesses, as social support explains much of the variance in adherence among HIV patients as well (Reynolds et al., 2004).

Social support has been shown to be strongly related to treatment adherence among HF patients as well. Wu, Moser, and Chung et al. (2008) found that among a relatively large (n=134) sample of HF patients recruited from outpatient clinics, perceived social support was significantly related to both dose-day and dose-count adherence measured by MEMS caps, controlling for ethnicity, barriers to adherence, and financial status. Another study conducted open-ended interviews among a small number of elderly HF patients and found that a common reason for difficulty adhering to medications was lack of supportive others to assist the patients' medication procurement (Happ et al., 1997).

Hostility.

Another emotional trait common among individuals with heart disease is hostility. Hostility has been well-established as an independent risk factor for heart disease and all-cause mortality (Miller, Smith, Turner, Guijarro, & Hallet, 1996). Hostility, a personality

trait, can be described as having a suspicious, mistrustful attitude toward the general environment and relationships with others, which theoretically may lead them to ignore or reject medical advice (Smith, 1992). Further, though studies suggest that high hostility is related to having more negative health behaviors, more chronic disease risk factors, and poor medical regimen adherence (Kawachi, Sparrow, Spio, Vokonas, & Weiss, 1995), very few studies explicitly have investigated the relationship between hostility and adherence among cardiac or chronic illness patient populations.

One study undertook the challenge of investigating whether hostility was related to adherence among renal dialysis patients (Christensen, Weibe, & Lawton, 1997). These researchers used biological markers (serum phosphorus) as a proxy for adherence to a complex dietary and medication regimen. They found that higher hostility was associated with higher serum phosphorus values, indicating that patients who were more hostile were less adherent. This relationship between adherence and hostility existed, however, only among individuals who expressed a certain belief; namely, a low expectancy that their health care providers were trustworthy and would provide effective treatment. Conversely, among patients who reported a high expectancy that their health care providers were trustworthy and would provide effective treatment, hostility was not significantly related to serum phosphorus values; so very unlikely related to adherence.

It appears, then, that beliefs about the effectiveness of one's prescribed health care regimen are powerful factors and are related to hostility. Research also shows that beliefs about health care are related not only to adherence but to other psychosocial constructs such as depression and social support, to be discussed later.

To summarize, the previous sections have discussed the extent to which demographic, functional, and psychosocial variables are related to adherence among patients with chronic diseases and also among patients with HF. Accumulated evidence suggests that relationships between these variables and adherence are mixed; with some studies reporting that many of these variables are related to adherence and others reporting opposite or null associations. Thus, further research is required to continue to determine if and how these variables are related to adherence such that interventions to improve adherence might be designed. Given the alarmingly common incidence and dire consequences of non-adherence among HF patients and the fact that research to date on established correlates of adherence is severely lacking, consideration of other person-related variables that might affect adherence is imperative. It is no secret that changing patient behavior is very difficult, and adherence in particular seems to be a pervasive problem among HF patients despite well-established consequences of non-adherence.

The Current State of Interventions to Improve Adherence

Current intervention approaches to medication adherence generally are not very effective, though improving adherence has been a major public health goal for the past four decades. Despite the well-established individual and societal burden of non-adherence, relatively few randomized, controlled trials have been published that include assessment of long-term (i.e., >6 months) trial efficacy (review by Haynes et al., 2001). Some interventions including simplifying dosage regimens, teaching patients to self-monitor their medication-taking behavior, and providing prompts and reminders to patients, have demonstrated limited efficacy (review by McDonald, Garg, et al., 2002). Those that are most effective generally include assessment of a patient's motivations for

change and a behavioral modification component according to reported motivations (review by Nagasawa, Smith, Barnes, & Fincham, 1990). Such interventions, however, are labor-intensive, require great financial resources, and result in only moderate improvements (Family Heart Study, 1994; ICRF OXCHECK Study Group, 1994; Peterson, Takiya, & Finley, 2003; Rich et al., 1995; Hunt et al., 2002).

It is well-known that health behavior can be extremely difficult to change and its influences are multifactorial. One of the reasons that behavior change interventions have failed thus far is because assessment of behavioral influences and interventions intended to change behavior often focus on factors that largely are non-modifiable, such as demographics and—in some cases—psychosocial variables. The fact that adherence varies considerably among individuals and across illnesses suggests that its influences are varied, and probably can be neither assessed nor remedied by current interventions that consist of implementing minor behavioral strategies (i.e., reminder cues) (review by Leventhal & Cameron, 1987). Rather, scientific advances in the assessment and remediation of maladaptive adherence behavior should be modeled according to theories of what guides behavior change.

The research by Christensen et al. (1997) shed light on the power—and perhaps utility—of beliefs about one's prescribed health care regimen on the relationship between a personality trait and adherence among patients with a chronic illness. Similar research has shown that beliefs are related to other psychosocial variables, including depression and social support, to be discussed later. First, it would be prudent to discuss theories of behavior and how individual beliefs might affect behavior, especially adherence. Theories of the ways in which patients receive medical advice and make decisions, which

may affect the way health care is delivered, are varied and offer unique perspectives. These theories and their models will be briefly discussed in the following section.

Theories of Behavior Change

Biomedical model.

According to the biomedical model, the patient is considered to be a passive, obedient recipient and executer of prescribed medical regimens. The responsibility of adherence necessarily lies with the patient, and non-adherence is considered to result from personality and/or psychological abnormalities of the patient. A patient's understanding of his/her illness and the treatment largely are ignored and considered irrelevant. The biomedical model ignores two key issues, including 1) the psychological or personality traits that might account for adherence; and 2) the effect of the health care provider and health care system on adherence. Studies and interventions that are designed based on this model ignore assessment of several aspects related to adherence, including the patient's appraisal of illness and treatment and examination of aspects of the medical regimen that might impede adherence. Thus, according to limited research on correlates of adherence, this model seems inadequate as an approach to address and alleviate non-adherence (Fabrega, 1975; Davis, 1966; Stimson, 1974).

Operant and social learning behavioral models.

These models explain behavior according to cues that might elicit behavior, rewards that reinforce behavior, and how behavior gradually becomes shaped. Employing these models to attempt to explain or change behavior likely is limited to circumstances in which the target behavior can become a habit. The behavioral approach appears to be somewhat effective in changing some behaviors, such as smoking, alcohol use, and

weight loss in the short-term, but fails to engender long-term change (Leventhal & Cleary, 1980; Hunt & Bespalec, 1974; Craighead, Stunkard, & O'Brien, 1981). These models ignore individual cognitive processes, goals, and motivations that may underlie behavior change. In short, while behavioral approaches do recognize that the patient is an active agent in his/her medical care, they fail to address deeply-rooted cognitions that affect adherence (review by Leventhal & Cameron, 1987).

Communications approach.

This model views the patient as a proactive agent in the prescribed medical regimen who seeks knowledge from the clinician. It is the responsibility of the health care practitioner to convince the patient that the prescribed regimen will be effective (Fishbein & Azjen, 1975). Research employing this model has revealed that adherence is related to a patient's satisfaction with his or her health care provider (Korsch & Negrete, 1972; Hunt & Bespalec, 1974). This model's effectiveness appears to rest not only with the patient's general satisfaction with medical care but also with the strength of a 'threat' to one's health if one does not adhere (Becker, Nathanson, & Drachman, 1977). Though this model does account for the patient's satisfaction with medical care, it ignores the extent of the patient's understanding and knowledge of the prescribed regimen and cognitions related to both the reality of the health 'threat' and effectiveness of the prescribed regimen.

Rational belief theory.

Models that emanated from this theory are based on the assumption that behavior results from objective and logical thoughts presuming that the individual has attained adequate information (i.e., pros and cons related to the target behavior) in order to form

such beliefs. According to this model, then, having inadequate knowledge so as to form beliefs results in non-adherent behavior (review by Leventhal & Cameron, 1987).

The most widely used rational belief theory is the Health Belief Model (HBM), which is considered a social cognition model (Rosenstock, 1966; Becker, 1974; Rosenstock, 1974). The theory specifies that four aspects shape behavior: perceived probability of a threat, perceived severity of a threat, perceived benefits of a behavior, and perceived barriers of a behavior. Together with the HBM, other social cognition models, including the Theory of Reasoned Action (Ajzen & Fishbein, 1980) and the Theory of Planned Behavior (Azjen, 1985) theorize that adherence behavior is shaped by rational decisions made by a patient. Cognitions that are central to these rational decisions (i.e., belief that adverse consequences to which one is susceptible will result from non-adherence) have been borne out by these models and supported in literature as being related to adherence (Kelly, Mamon, & Scott, 1987; Horne & Weinman, 1998).

In addressing one's perceived probability and severity of a threat, these models ignore one's perceived seriousness of a threat, which appears to be a different construct than severity and is much more pertinent in influencing behavior (Weinstein, 1988). Further, one's perceived seriousness of a threat may be influenced by social norms, and these models do not account for the ways in which social norms might influence one's beliefs about the health threat. Also, these models fail to identify the affective factors involved in behavior and how those factors might change as goals are achieved.

Self-regulative systems theory.

According to the Self-Regulatory Model (SRM), an individual actively solves one's problems, and behavior is a reflection of a desire to improve upon current health

status and achieve self-defined goals (Engel, 1977; Carver & Scheier, 1982; Leventhal & Nerenz, 1983). Two regulatory systems function jointly as a parallel system: one system is a cognitive one that forms representations of the illness and associated treatment; the other system regulates emotions aroused by the health threat. Both of these systems incorporate information received from the environment (i.e., family, friends, media) and from the individual (i.e., past experience, current symptoms).

Adaptive behavior follows progression through three stages in which the individual 1) develops cognitive representations of the health threat, 2) copes with the threat and formulates an action plan, and 3) appraises progress and effectiveness of the plan. The cognitive representations of illness are structured around five components: beliefs about the nature/identity of the illness, likely duration of the illness, health consequences of the illness, causes of the illness, and extent to which the individual believes he/she can be cured or can manage the illness. The stage of coping and formulating an action plan can be partially explained by Leventhal's 'common sense' model (Leventhal, Meyer, & Nerenz, 1980), which proposes that one's cognitive representations (beliefs) about illness impact coping responses and subsequent behavior. That is, if an individual believes that taking the medication makes 'common sense' according to their cognitive representations of the illness, adherence is likely (Leventhal, Diefenbach, & Leventhal, 1992). In this way, this theory helps explain how beliefs and behavior are associated, thereby shedding light on the types of beliefs that guide behavior.

Studies suggest that cognitive representations of illnesses do indeed influence a wide variety of health behaviors (Leventhal, Nerenz, & Steele, 1984; Leventhal, Meyer,

et al., 1980). Further, cognitive representations of illnesses appear to influence functional outcomes among individuals who have chronic illnesses, suggesting that—especially compared to mere short-term utility of other theories—the SRM may impact long-term behavior (Petrie, Weinman, Sharpe, & Buckley, 1996; Scharloo et al., 1998; Scharloo, Kaptein, Weinman, Wilems, & Rooijmans, 2000; Hagger & Orbell, 2003).

Thus, theories such as the SRM and HBM provide possible explanations for behavior. Horne, Weinman, and Hankins (1999) developed a questionnaire, called the Beliefs about Medicines Questionnaire (BMQ), based upon these theories in an effort to operationalize ideas posited by the models and begin to determine whether these theories help explain human behavior. It is clear, as already discussed, that current methods of explaining behavior and the way the medical system approaches non-adherence are not adequate in engendering change. Horne (1997) used the following three key questions, which summarize existing literature on lay beliefs about medicines, as a guide to develop the BMQ: 1) What is the nature of beliefs about medicines and can those beliefs be summarized into 'common themes' applicable to a range of illness and cultural groups; 2) What are individual characteristics associated with certain beliefs and how strongly do individuals hold these beliefs; and 3) Do different beliefs about medicines relate to each other and also to adherence behavior.

It is hoped that the BMQ, whose development will be discussed in the following section, can help explain adherence behavior and perhaps guide future interventions to improve adherence. Results from use of the BMQ can have great implications for clinicians, who should not presume that the patient shares similar beliefs about medicines as they do (Horne, Frost, Hankins, & Wright, 2001). Further, compared with correlates

such as age, SES, gender, and even—to some extent—psychosocial variables, beliefs are potentially modifiable and can be addressed during medical appointments (Horne, 2003; Petrie, Cameron, Ellis, Buick, & Weinman, 2002). Patient beliefs about medicines have great implications for the effectiveness of clinical appointments and chronic disease management (Horne et al., 1999).

Beliefs about Medicines Questionnaire Development

Items comprising the BMQ were chosen from many statements reflecting commonly held beliefs about illness and medication (according to the HBM, SRM, and 'common-sense' model) and also from interviews that BMQ developers (Horne et al., 1999) conducted with 35 patients who took medication for a variety of chronic illnesses. Questions during the interviews were open-ended and elicited patients' views related to their prescribed medication regimen and opinions about medicines in general. Together, statements reflecting commonly held beliefs about illness and medication derived from the models and the interview totaled 34 statements. Exploratory Principal Components Analysis (PCA) was employed to determine which of the 34 statements seemed to best represent commonly held beliefs about medication.

PCA revealed that 18 of the 34 statements loaded onto two factors or themes: general beliefs about medicines and specific beliefs about medicines. Further analysis revealed that general beliefs could be separated into two scales such that one assessed beliefs about the nature of medicines (General Harm subscale; 4 items) and the other assessed beliefs about how medicines are used by doctors (General Overuse subscale; 4 items). The specific beliefs scale items nicely divided into two scales as well: one subscale (Specific Necessity; 5 items) assesses beliefs related to the extent to which

medication prevents further health deterioration, and the other subscale (Specific Concerns; 5 items) assesses beliefs related to aspects of both an emotional ("Having to take my medicines worries me") and a cognitive ("My medicines are a mystery to me") nature. In this way, the Specific Concerns subscale addresses both of the cognitive and emotional aspects of the parallel processing system described by the SRM (Leventhal, Meyer, et al., 1980). Thus, the BMQ consists of four subscales: General Harm, General Overuse, Specific Necessity, and Specific Concerns. Often the two subscales of the General and Specific scales are combined in analyses such that studies investigate the relationship between adherence and General medicine beliefs by combining the Harm and Overuse scales and Specific medicine beliefs by creating a Necessity-Concerns differential.

A substantial body of literature supports the use of the BMQ in partially explaining adherence among a variety of individuals with chronic illnesses, though has not been employed often in studies including patients with HF. The next section will discuss how the BMQ has been shown to be related to adherence in studies that included samples of patients diagnosed with general, non-cardiac chronic illnesses, broadly-defined cardiovascular disease, and HF.

Relationships between Beliefs about Medicine and Adherence

Among patients with non-cardiac chronic illnesses.

Horne and Weinman (1999) studied a sample of 324 patients diagnosed with a range of chronic illnesses including asthma, CVD, renal, and cancer. Results revealed that higher scores on the BMQ Specific Necessity subscale were indicative of higher reported adherence, and higher BMQ Specific Concerns were related to lower adherence

across the range of chronic illnesses. Medication beliefs as measured by the BMQ predicted adherence more strongly than clinical or sociodemographic factors. The BMQ Necessity-Concerns differential score and reported adherence were also positively related. Patients who indicated their concerns were greater than need for medications (i.e., Necessity-Concern differential was negative) reported significantly lower adherence than those with a positive differential. The value of the Necessity-Concerns differential is supported by this and previous research that suggests that individuals make decisions by employing an implicit "cost-benefit" analysis that weighs beliefs about the necessity of medication for maintaining health or avoiding illness against concerns about the negative effects of taking it (Horne, 1997).

Another study including patients diagnosed with a variety of chronic illnesses (Phatak & Thomas, 2006) revealed that the BMQ Specific Concerns subscale was very significantly positively related to non-adherence ($p < .0001$) while the BMQ Specific Necessity subscale was marginally positively related to adherence ($p = .08$). Further, the BMQ General Overuse and Harm subscales were each positively related to non-adherence ($p < .0001$). Thus, patients who believed medicines were harmful or overused reported greater non-adherence. Multiple regression showed that the Specific Necessity subscale and Specific Concerns subscales negatively and positively, respectively, predicted non-adherence controlling for general medication beliefs (e.g., BMQ Harm and Overuse), age, co-morbid diseases, and number of prescribed medications. This full model explained 26.5% of the variance in medication adherence. Interestingly, including only age, co-morbid diseases, and number of medications in a model predicting adherence accounted for only 5.2% of adherence, while including only BMQ scales in a

model predicting adherence explained 22.4% of variation in adherence. Thus, this study shows that beliefs about medicines account for a much greater amount of adherence behavior than demographic and functional variables.

Horne, Parham, Driscoll, and Robinson (2009) examined the relationship between patient attitudes toward medicines and adherence among patients diagnosed with irritable bowel disorder. Study participants were placed into one of four attitudinal groups (i.e., accepting, ambivalent, skeptical, indifferent) depending upon their responses on both the BMQ Necessity and BMQ Concerns subscales. The four groups significantly differed in adherence to medication such that patients in the accepting group reported significantly higher adherence than those in the other three attitudinal groups. Regarding the three other groups, the ambivalent group reported higher adherence than did both the skeptical group and the indifferent group. The skeptical and indifferent group did not differ from each other in terms of adherence. The pattern of adherence behavior in the four groups illustrates that patients who believe medicines are necessary and have few concerns about them are more adherent than those who 1) scored high on both Necessity and Concern subscales and 2) scored low on Necessity and high or low on Concern.

Horne, Cooper, Gellaitry, Date, and Fisher (2007) also conducted similar research among patients recruited from an outpatient HIV clinic who were debating whether to accept or decline initiation of HAART [highly active retroviral therapy] pharmacotherapy. Those who declined HAART had low scores on the BMQ Necessity subscale and high scores on the BMQ Concerns subscale. This study was unique in that it was a longitudinal study and patients were contacted at 12 months after baseline. At follow-up, HIV patients who had scored low on the Necessity subscale and high on the

Concern subscale at baseline reported low adherence 12 months later. This study suggested that the BMQ—especially the Necessity and Concern subscales—may have great predictive abilities. Indeed, the BMQ Necessity-Concerns differential was significantly related to adherence also among patients prescribed inhaled corticosteroids for asthma (Menckeberg et al., 2008).

Among patients with CVD.

A study including patients prescribed medication for hypertension found that scores on the BMQ Concerns subscale differed significantly between those patients who were adherent versus non-adherent such that the adherent patients had significantly lower concerns (Maguire et al., 2008). Another study including patients with hypertension, however, did not find evidence that adherence was related to beliefs about medicines (Wang et al., 2002).

Bane et al. (2006) revealed that patients receiving medicine for CVD who were adherent had significantly lower scores on the BMQ Concern subscale than those who were non-adherent. Further, scores on the Concern subscale significantly predicted adherence. Adherent patients also had significantly higher scores on the Necessity-Concerns differential than non-adherent patients. Another study (Byrne, Walsh, & Murphy, 2005) of patients with established coronary artery disease revealed that all four BMQ subscales were correlated with adherence such that the BMQ Necessity scale was negatively associated with adherence and the other three scales were positively associated with adherence. In this study, regression analyses showed that the BMQ Concerns and Necessity scales were significantly associated with adherence controlling for the BMQ Harm and Overuse scales (among other control variables).

A study that included patients after they had coronary bypass surgery found that the BMQ Harm and Overuse subscales were significantly related to adherence such that patients who believed that medicines were harmful and/or overused were less likely to adhere (Khanderia et al., 2008).

Among inpatients discharged with unstable angina or had had an MI, scores on the BMQ Necessity subscale were significantly positively related to medication adherence (Sud et al., 2005). This study also included age, gender, and educational level in the analyses and found that they were not related to adherence. Another study including patients post-MI found that adherence to placebo medicine was significantly associated with a better survival rate two years after the initiation of placebo therapy (Irvine et al., 1999). Similar findings have been reported in other studies (Coronary Drug Project Research Group, 1980; Horwitz et al., 1990), which suggest that simply believing that medicines are effective is related to better outcomes. Clearly, beliefs about medicines are very powerful.

Among patients with HF.

Few studies have examined the relationship between beliefs about medicines and adherence among HF patients, and no studies could be found that reported a relationship between the BMQ and adherence. The only study identified that assessed beliefs using the BMQ among HF patients reported that there was no significant relationship between BMQ subscales and adherence (George & Shalansky, 2007). This study did reveal that another belief—the extent that an individual could overcome a barrier that might inhibit ability to obtain and administer medicines—was related to adherence such that those who had higher beliefs in overcoming the barrier reported higher adherence. This study,

however, administered the BMQ items in person or by telephone as opposed to a written survey—which might have biased the responses due to increased social desirability—and included only the BMQ items in the Necessity and Concern subscales. Further, George and Shalansky (2007) defined adherence as a dichotomous variable; specifically, whether or not an individual was adherent to their medications more or less than 90% of days, thereby limiting variance in adherence. Another study that included HF patients found that adherence was associated with a greater perception that medicines and diet would be beneficial (van der Wal et al., 2006).

To summarize, research has demonstrated that beliefs about medicines are related to adherence among individuals with varied chronic illnesses. Often, beliefs about medicines were more strongly associated with adherence than demographic variables. The findings among HF patients, though limited, suggest that beliefs may be related to adherence and—together with other research on the relationship between beliefs and adherence among individuals with other chronic diseases—support continuing to determine whether beliefs are related to adherence among HF patients.

The Relationships between Beliefs about Medicines and Demographic and Psychosocial Variables

A glaring omission in most of the literature on the relationship between beliefs about medicines and adherence is that many studies have not included demographic or psychosocial variables as correlates of adherence; nor have studies examined the relationship between these variables and beliefs about medicines. It is important to consider the relationships between beliefs and psychosocial variables, as those variables might affect (i.e., mediate or moderate) beliefs and therefore, also affect relationships

between beliefs and adherence. The following studies examined the relationship between beliefs and demographic and/or psychosocial variables.

Demographic variables.

Age, gender, and ethnicity may impact beliefs. One study found that, compared with younger people, older people had more positive and less negative views about medicines (Isacson & Bingefors, 2002); another study did not find any relation between any BMQ subscale and age (Mardby, Akerlind, & Jorgensen, 2007). Regarding gender, men reported more negative beliefs about medicines than did women in one study (Horne et al., 2004), though another study revealed that women also generally tend to view medicines as harmful (Isacson & Bingefors, 2002). Ethnicity or cultural background may also affect beliefs about medicines, as one study reported that individuals of Asian background have more negative beliefs about medicines than do individuals of European descent (Horne et al., 2004). Thus, there are no consistent findings regarding the relationships between such demographic variables and beliefs about medicines and further exploration is needed.

Income and education level may also impact beliefs about medicines. One study found that individuals who have a lower income versus those with a higher income believe medicines are more harmful and more beneficial (Isacson & Bingefors, 2002). Several studies have revealed that level of education is significantly related to beliefs about medicines such that those with more education considered medicines more beneficial and less harmful than those with a lower education level (Isacson & Bingefors, 2002; Jorgensen, Andersson, & Mardby, 2006). Another study showed that type of education was related to beliefs about medicines, as pharmacy students were more likely

than students in other fields of study (i.e., engineering, accounting, humanities) to believe that medicines were beneficial (Horne, Frost, et al., 2001). These results suggest that these demographic variables may be related to beliefs about medicines and should be included in research on beliefs about medicines and adherence.

Depression, social support, and hostility.

Several studies have examined the relationship between depression and beliefs about medicines. Research has demonstrated that severity of depression and the BMQ Concerns subscale are strongly positively related among patients taking antihypertensives (Maguire et al., 2008). Similarly, another study found that depression is positively related to having greater concerns about medicines among patients with CVD (Bane et al., 2006). In another study including head and neck cancer patients, beliefs that the illness would last a long time and amount of self-blame for having cancer predicted high levels of depression after treatment (Llewellyn, McGurk, & Weinman, 2007). Thus, some evidence exists to support a relationship between beliefs about medicines and depression.

There is no evidence that perceived social support per se is related to beliefs about medicines, but some research suggests that one's social experiences likely play a role in shaping beliefs. For example, theory suggests that beliefs potentially are shaped by three sources of information, one of which is information provided by friends, family, and individuals of authority (Leventhal, Meyer, et al., 1980; Leventhal, Nerenz, & Steele, 1984). Research done by Barber, Parsons, Clifford, Darracott, and Horne (2004) supports this theory, as results from his study suggests that patients will recognize problems or concerns associated with medications only once they are taking the medications, at which point they may seek information from friends and relatives, who necessarily shape their

beliefs about the medicine. Other research suggests that an increased social life may impact beliefs according to the extent to which their medical regimen interferes with daily activities and social events (Bentley, De Jong, Moser, & Peden, 2005). It may be, then, that higher perceived social support—reflective of a more active social life—is related to more negative beliefs about medicine.

The role social support may play in influencing beliefs about medicines and subsequent adherence is extremely important, as social support generally is considered to be adaptive among individuals with chronic illnesses. Potentially, one's social support network could be a vital part of adherence interventions.

No research has investigated whether and how hostility is related to beliefs about medicines, but it is likely that individuals high in hostility have negative views of medicines. In fact, scoring high on hostility measures scores is associated with having suspicion of the motives of others and to believe that others' behavior is intentionally provoking (Pope, Smith, & Rhodewalt, 1990).

It is important to note that substantial research has shown that these three psychosocial variables likely are interrelated. Studies have shown that perceived support is a strong predictor of depression (Finch et al., 1999; Schwarzer & Leppin, 1991) and depression is a strong predictor of perceived social support, as one study revealed that higher depressive cognitions predicted perceived social support even two years later (Maher et al., 2006). Hostility and depression appear to be highly positively related in the general population (Mao et al., 2003) and also among HF patients, with correlations between hostility and depression ranging from 0.42 to 0.46 (Barefoot et al., 1995). Expectedly, social support appears to be strongly negatively related to hostility (Barefoot,

Dahlstrom, & Williams, 1983; Houston & Kelley, 1989). Thus, the above and other studies (Barefoot et al., 1995; Williams et al., 1997) have shown that depression, social support, and hostility are interrelated CVD risk factors, but their relationships are not yet completely understood.

Rationale, Aims, and Hypotheses

Among patients with HF, lower reported medication adherence and low-salt diet adherence are strongly associated with increased adverse events and resultant hospitalizations, which are a huge cost to the medical system. Interventions designed to increase adherence rarely are successful, and often are costly and result only in short-term, if any, improved adherence, and thus do not appear to address and resolve the core reasons for non-adherence. It is thought that the reason current interventions fail is because they are not structured according to theories of behavioral change. Behavioral theories such as the Health Belief Model and Self-Regulatory Model suggest that core reasons for adherence do not include the presence of authoritative others (i.e., the biomedical model), positive or negative reinforcement (i.e., operant and social learning model), or increased knowledge pertaining to illness and/or medication (i.e., communication model). The Health Belief and Self-Regulatory Models together posit that a patient is more likely to adhere to a prescribed regimen if it makes "common sense" based on their previous experiences and accounts for one's beliefs about an illness and treatment regimen.

Research among individuals with varied chronic diseases have shown that one's beliefs about medicines (i.e., to what extent one needs medications; to what extent medicines cause harm; to what extent physicians excessively rely on medicines to heal) is

associated with medication adherence. A relatively novel measure—the BMQ—has been developed in an effort to operationalize and assess beliefs about medicine and determine whether beliefs are associated with adherence such that interventions might be better designed to improve adherence. The BMQ has proven its utility as a correlate of adherence in many studies. These studies, however, rarely have included demographic variables or psychological factors such as depression, social support, and hostility, which have been shown to be common among and affect adherence in cardiac and other individuals suffering from chronic diseases.

The overall aim of this study is to examine how affective and cognitive variables, social support, and personality (i.e., hostility) are related to self-reported medication and low-salt diet adherence among individuals with HF controlling for demographic and functioning variables, which have been shown to affect adherence. Of primary interest in this study is the role of cognitive factors—specifically, beliefs about medicines—in predicting adherence and the nature of its relationship with depression, social support, and hostility.

As previously discussed, the BMQ produces two composite scales: the Necessity-Concerns differential and the Overuse + Harm sum. The most ideal way to use the BMQ scales and composite scales as either dependent or independent variables does not seem clear based on existing research, as some researchers have used only composite scales as dependent or independent variables; others have used each of the 4 subscales; while others have included all subscales and both composites as variables. An argument for use of the Necessity-Concerns differential versus its individual subscales, however, does exist and seems quite compelling. That is, a patient's perspective of the extent to which he or

she *needs* the treatment is a major factor in predicting whether that person will seek treatment (Park & Jones, 1997). The Necessity-Concerns differential provides information related to the way individuals assess their need for a particular treatment relative to their concerns about that treatment's effects. This differential is a brief, simple way to conceptualize one's beliefs about adherence and has been demonstrated to be strongly associated with adherence. In addition to the studies discussed herein, others have demonstrated that the Necessity-Concerns differential is related to adherence in a variety of chronic illnesses including renal disease (Horne, Sumner, Jubraj, Weinman,, & Frost, 2001), asthma (Horne & Weinman, 2002; Menckeberg et al., 2008), HIV (Horne, Buick, et al., 2004) and depression (Aikens, Nease, Nau, Klinkman, & Schwenk, 2005; Hunot, Horne, Leese, & Churchill, 2007). Since the Specific BMQ scale will be represented by its composite, it seems appropriate that the General BMQ scale also is represented by its composite; the Overuse + Harm sum.

The most extensive research to date examining correlates of adherence among HF patients pertains to assessing the relationship between demographic, functional/regimen, or psychosocial variables and adherence. As previously discussed, the relationships between demographic variables and adherence are unclear and will be considered in these analyses as control variables. Regarding the relationships between psychosocial variables and adherence, research generally supports a strong relationship between depression and adherence. The relationships between social support and adherence and also between hostility and adherence, however, are less clear. **Thus, the first aim of the study is to examine the relationships between psychosocial variables and adherence.**

An emerging body of research pertaining to the relationship between beliefs about medicines and adherence suggests that beliefs—specifically, relevant to this study; the extent to which an individual believes medicines are necessary despite having concerns about their effects, and the extent to which an individual believes medicines are harmful or overused—indeed are related to adherence. More work is needed, however, to continue to reinforce previous findings and more thoroughly describe the relationships between beliefs and adherence, especially among individuals with HF. **The second aim, then, is to examine the relationship between beliefs about medicines and adherence.**

In addition to beliefs and/or psychosocial variables demonstrating main effects on adherence behavior, it is possible that these two variables interact such that the strength or severity of one affects the relationship of the other with adherence. For example, it is possible that the extent of one's beliefs affects the relationship between a psychosocial variable and a behavior. In fact, previously discussed research showed that beliefs moderated the relationship between hostility and adherence. To test this relationship, the BMQ subscales would need to be analyzed as categorical (rather than continuous) variables, and Horne et al. (2009) very recently demonstrated that categorized BMQ subscales are predictive of adherence. **Thus, the third aim is to investigate whether beliefs about medicines moderate the relationship between psychosocial variables and adherence**.

This aim is quite innovative because depression, adherence, and beliefs likely are interrelated and a mechanism to describe their interrelations has not been investigated. The nature of one's beliefs are likely to influence depressed state, as depression tends to remit once certain beliefs (i.e., irrational beliefs and "black and white," inflexible

thinking patterns) are challenged and subsequently altered (Antonuccio, Danton, & DeNelsky, 1995). A few studies have demonstrated that beliefs do moderate the association between psychosocial variables and certain outcomes. For example, one study explored whether attitudes relating to suicide (i.e., the extent to which an individual believes committing suicide is acceptable given the circumstances) moderated the relationships between suicidal ideation and each of depression and hopelessness among college undergraduates (Gibb, Andover, & Beach, 2006). They revealed that the relationship between each psychosocial factor and suicidal ideation (their outcome variable) was significantly positive only among those who scored high on attitudes relating to suicide. Another study explored whether coping—a construct arguably influenced by beliefs—moderated the relationship between stress and their outcome, negative adjustment, (which was created by combining scores on depression, self-esteem, anxiety, and somatic complaints) among adolescents (Jose & Huntsinger, 2005). They found that coping in fact did moderate the relationship between stress and their outcome variable.

Hypotheses commensurate with the above aims and justification are as follows:

Hypothesis 1: Each of depression, social support, and hostility are significantly associated with adherence such that higher levels of depression and hostility and lower levels of social support are associated with poorer adherence.

Hypothesis 2: Beliefs about medicines—specifically, belief that medicines are necessary despite having concerns about their effects, and belief that medicines are harmful and/or overused—are related to adherence such that patients who believe that

medicines are necessary despite concerns and those who believe the medicines are harmful and/or overused are related to greater adherence.

Hypothesis 3: Beliefs about medicine (both BMQ composites) moderate the relationships between each of the 3 psychosocial variables and adherence measures such that higher depression and hostility and lower social support are more likely to be related to lower adherence among individuals who endorse maladaptive beliefs about medicines (e.g., that medicines are harmful and/or overused and that medicines are not necessary and/or elicit strong concerns).

Chapter 2 METHODS

Participants

Study participants in this sample had already completed participation or were still active participants in a larger parent study investigating the prevalence and impact of depression on physical and mental health functioning among individuals with HF. The parent study began recruitment in 2005 and as such, many of this sample's participants had completed the parent study participation as long as 3 years prior to completing the current battery, while some of this sample's participants had been active in the parent study for as little as a few weeks. Parent study participants were recruited from outpatient clinics at private and county medical systems in the Greater Miami area. Inclusion criteria included primary diagnosis of heart failure by a cardiologist, being older than 18 years of age, and fluent in either Spanish or English. Exclusion criteria included current drug or alcohol abuse, current diagnosis of HIV or other immune disorder, current treatment for cancer, or psychosis, dementia, or another psychiatric or cognitive disorder that would impede ability to complete questionnaires. The current sample included inactive and active participants from the parent study who agreed to complete the questionnaire battery containing the measures described in the current study.

Procedures

Parent study eligible participants were identified by an attending cardiologist and referred to study recruiter. Participants were approached following their outpatient clinic appointment and, if willing, consented to participate. They completed a questionnaire battery either in the clinic waiting room or at their home (in which case they returned the questionnaire via mail) including the Center for Epidemiologic Studies Depression Scale-

Revised (CESD-R), Medical Outcomes Study Social Support scale (MOS SS), the Greenglass Hostility scale, the Medical Outcomes Study General and Specific Adherence scales, and several other measures pertaining to demographics, lifestyle (i.e., smoking history, exercise), expected or unexpected emergency department or physician visits, and cardiac or otherwise adverse events. The questionnaire packet for the current study included the above named measures and the Medication Adherence Scale (MAS), a scale measuring low-salt diet adherence (LSD), and the BMQ, in addition to other psychosocial measures and several items relating to demographics and lifestyle. This questionnaire was available in both IRB-approved Spanish and English languages. For the parent study, participants also provided a blood sample if willing, and the study procedure including the battery and blood sample was repeated at 6-month intervals for up to 1 and a half years. All questionnaire packet items were translated into Spanish by a certified translator, and participants were asked to indicate whether they would prefer a Spanish or English version of the questionnaire. A medical chart review was conducted to obtain the patient's ejection fraction and complete medical history, including co-morbid diseases and current prescribed medications; and the NYHA class number was obtained from the patient's physician. These medical variables were obtained consistent with the patient's enrollment date and 12 months after enrollment, if possible. Given the length of time between initial enrollment and completion of this study's questionnaire for most of the current participants, a chart review was conducted consistent with the date the participant completed this study's questionnaire so as to obtain the medical variables most closely chronically associated with psychosocial and adherence variables measured in this study. Participants in the current study were contacted by phone by study personnel, thanked for

their previous participation, and asked if they were willing to complete an additional study questionnaire for which they would be compensated $20. Upon verbal agreement, the questionnaire was mailed to their home along with a stamped and return-addressed envelope. A limitation of the study's data is its self-report nature, especially regarding adherence measures, as participants may over-report adherence. Due to the inherently high specificity of self-report measures, however—as patient admission of non-adherence likely is the truth—it is possible that self-report data is nearly as reliable as objective measures (Stephenson, Rowe, Haynes, Macharia, & Leon, 1993).

Questionnaire measures.

Demographic information.

Participants were asked to report their birth-date, gender, ethnicity, education level, and income. Ethnicity responses consisted of several choices that will be combined into the following categories: Caucasian non-Hispanic, Hispanic White and Hispanic Black, African American, and Other. Education level categories include less than high school diploma; high school diploma or some college; 4-year college graduate; graduate degree. Income levels include < $16,000; $16,000 to $35,000; and >$35,000.

Functional/medical regimen measures.

Ejection fraction, co-morbid diseases, number of months since HF diagnosis, and current prescribed medications were obtained from the patient's medical chart. NYHA functional class was obtained from the patient's cardiologist.

Adherence measures [see Appendix].

Medication adherence scale (MAS).

The MAS (Morisky, Green, & Levine, 1986) consists of four items that ask participants to indicate on a Likert scale from 1 to 5 (1 = "never;" 5 = "always") how often in the past two weeks they did not take their medication for four reasons including forgetting to take it, being careless about taking it, not taking it because they felt better, and not taking it because they felt worse. This scale has demonstrated good reliability (internal consistency = .61) and good predictive and concurrent validity as demonstrated by its significant relationship with blood pressure control over the course of 42 months (Morisky et al., 1986). Scores are summed to obtain the total scale score; the mean was imputed for missing items.

Medical outcomes study (MOS) specific adherence scale.

The MOS-Specific Adherence scale (Sherbourne, Hays, Ordway, DiMatteo, & Kravitz, 1992) included in the parent study consisted of 17 items that address several behaviors to which adherence greatly impacts functioning, adverse events, and overall health. Participants indicate how often they adhered to each behavior on a 6-point Likert scale (1 = "none of the time;" 6 = "all of the time"). A response choice of "N/A: does not apply" was an alternative response if participants wished to indicate that his or her physician had not recommended a particular behavior. Items in this measure are consistent with behaviors frequently recommended to individuals diagnosed with hypertension, diabetes, and/or heart disease. The MOS created separate specific adherence measures for diabetes and heart disease; test-retest reliability over a duration of two years is $r = .68$ and $r = .57$, respectively. For the current study, only two items from

the MOS-Specific Adherence were included in analyses: MOS-med; "Took prescribed medications," which is specific to both diabetes and heart disease scales, and MOS-salt; "Followed a low-salt diet," which is specific only to the diabetes scale.

Low-salt diet (LSD) adherence scale.

In the absence of an established measure to assess extent of adherence to a low-salt diet, we created a measure based on common behaviors and barriers consistent with low-salt diet adherence as often reported by HF patients (Farrell, 2011). A Cronbach's alpha was analyzed for this measure among our sample to determine its reliability, and its face validity was evaluated by practicing cardiologists. The LSD consists of 10 items asking the participant to indicate on a 5-point Likert scale (1 = "never;" 5 = "always") the extent to which they adhere to aspects of a low-salt diet. Sample items include "When shopping for groceries, I avoid buying foods that are salty;" "I do not add more salt to my food;" and "When eating in a restaurant, I am careful to avoid eating salty foods." Item 5 was reverse scored. Scores are summed to obtain the total scale score; the mean was imputed for missing items.

Psychosocial measures [see Appendix].

Center for epidemiologic studies depression scale-revised (CESD-R).

The CESD-R (Eaton, Muntaner, Smith, Tien, & Ybarra, 2004) is a self-report scale created from combining selected items from established depression inventories. This scale includes 20 items that pertain to mood, social interactions, motor functioning, somatic complaints, anhedonia, psychomotor retardation/agitation, and suicidal ideation. Respondents are asked to indicate the extent to which they have felt as the item describes in the last 2 weeks. The response values are 5-point Likert scales ranging 0 to 4 where 0

corresponds to “not at all or less than 1 day” and 4 corresponds to “nearly every day for 2 weeks.” Scores of “4” are collapsed to “3” when scored. Items are summed, and the higher the total score, the greater the depressive severity. The mean was imputed for missing items in order to calculate the total score. The CESD-R has good reliability; the Cronbach’s alpha value ranges from 0.90 to 0.92, and the CESD-R appears to correlate highly with the original CESD, $r = 0.88 - 0.93$ (Eaton et al., 2004). Sample items include “My appetite was poor,” “I could not shake off the blues,” “I felt depressed,” “My sleep was restless,” and “Nothing made me happy.”

Medical outcomes study social support scale.

This social support measure (Sherbourne & Stewart, 1991) contains 19 items that assess how often the respondent perceives receipt of four support domains: emotional/informational, tangible, positive social interaction, and affectionate. Response values are a 5-point Likert scale ranging from 1 to 5, where 1 corresponds to a response of “none of the time” and 5 corresponds to “all of the time.” Sample items for each of the four domains are as follows: emotional/informational, “Someone you can count on to listen to you when you need to talk;” tangible, “Someone to help you if you were confined to bed;” positive social interaction, “Someone to get together with for relaxation;” affectionate, “Someone who shows you love and affection.” Responses are summed to obtain the total score, and a higher score corresponds to higher perceived social support. The mean was imputed for missing items in order to calculate the total score. This scale has demonstrated acceptable reliability over time, as the Cronbach alpha for the overall scale is 0.97 and for each subscale are as follows:

Emotional/Informational=0.96, Tangible=0.92, Affectionate=0.94, and Positive Social Interaction=0.91 (Sherbourne & Stewart, 1991).

Greenglass hostility scale.

The Greenglass hostility scale (Greenglass & Julkunen, 1991) is a reliable and valid abbreviated version of the Cook-Medley hostility scale (Cook & Medley, 1954) and has been established as a specific measure of cynical distrust. This scale contains 9 items assessing the extent to which respondents agree or disagree with statements such as "I think most people would lie to get ahead" and "No one cares much what happens to you." Response values are a 4-point Likert scale ranging 1 to 4 with 1 corresponding to "strongly disagree" and 4 corresponding to "strongly agree." Responses were summed and a higher score indicates higher hostility, and the mean was imputed for missing items in order to calculate the total score.

Beliefs about Medicines Questionnaire (BMQ) [see Appendix].

The theory that influenced development of the BMQ (Horne et al., 1999) has already been discussed. When completing the BMQ, participants are asked to indicate the extent to which they agree with its 18 statements on a Likert scale from 1 to 5 (1 = strongly agree; 5 = strongly disagree). Sample questions for each scale are as follows: General Harm, "Most medicines are addictive;" General Overuse, "Doctors use too many medicines;" Specific Necessity, "My health at present depends on medicines;" Specific Concerns, "Having to take medicines worries me."

Psychometrics that examined reliability and validity were conducted among a large (n = 524) sample of men and women diagnosed with a variety of chronic illnesses; further information about the sample can be found in Horne et al. (1999). Internal

consistency, assessed by Cronbach alpha, is as follows for each subscale: Specific Necessity = .86; Specific Concerns = .65; General Overuse = .60; and General Harm = .51.

Criterion-related validity was assessed by correlating subscales with certain statements not included in the BMQ but that were believed to represent that scale's underlying constructs. The Specific Necessity subscale demonstrated evidence for criterion-related validity in its significant negative correlation with the statement: "I can cope without my medicines" and significant positive correlations with scores on a measure that assess beliefs related to illness duration and symptoms. The Specific Concerns subscale was significantly negatively correlated with responses to the statement "I have been given enough information about my medicines;" this negative association was believed to represent a construct of this subscale that the patient desires more information about medicines. Further, among general medical and cardiac samples, this subscale was significantly positively correlated with the several items from another measure related to beliefs about sensitivity to adverse effects of medication.

Criterion-related validity of the General Harm subscale was demonstrated by its significant positive association with the statement "It is better to do without medicines." Further, responses to the statement "I can cope without my medicines" were significantly negatively related to both the General Harm and General Overuse scales.

The BMQ showed that it was related to adherence by its correlations with a scale assessing extent of medication adherence. Specific Necessity beliefs significantly correlated with higher reported adherence, $\rho = .19$. Correlations between the adherence scale and the other three scales were significant and negative (except for General Harm,

which failed to reach significance) and are as follows: Specific Concerns, ρ = -.28; General Overuse, ρ = -.19; General Harm, ρ = -.06.

To score each composite, each subscale is summed, and missing items were imputed in order to calculate each subscale total. To calculate the Necessity – Concerns differential, the Concerns subscale was subtracted from the Necessity subscale. To calculate the Harm+Overuse sum, the Harm and Overuse subscales were summed.

Data Analysis Procedure

The distribution of all variables was examined for normality and homoscedasticity of residuals. Data used for the analyses described herein are cross-sectional. Variables skewed greater than a value of 3 or have a kurtosis value greater than 10 were transformed using natural log transformation. Descriptive characteristics were analyzed for all demographic, psychosocial, and adherence measures using the Statistical Package for Social Sciences (SPSS) database Version 16.0.

Control variables included in the model were those that were correlated with at least one of the adherence measures at a significance level of $p < .10$, using SPSS database. Potential control variables included age, ethnicity, gender, number of co-morbid diseases, number of medications, NYHA, EF, income, and education level. A path was specified in the model from each control variable to the latent variable Adherence.

The model was evaluated using Structural Equation Modeling (SEM) with the M*plus* statistical program (v6.0, Muthén & Muthén, 2010). The maximum likelihood method was used to estimate path coefficients, loadings, and standard errors for significance tests (two-tailed, α = .05). Several indices recommended by Hu and Bentler

(1999) were followed to evaluate model fit, including ≥ .95 for the comparative fit index (CFI), ≤ .06 for the root-mean-square error of approximation (RMSEA), and ≤ .08 for the Standardized Root Mean Squared Residual (SRMR).

The first step during modeling was to determine fit of the proposed measurement models (Figure 1) including the fit of the indicators (MAS, LSD, MOS-med, MOS-salt) on the latent variable, Adherence, in the model. After establishing an acceptable measurement model, the latent variable was used in the SEM model specification and evaluation.

To test Hypothesis 1, direct paths from each of the three psychosocial variables (depression, social support, hostility) to Adherence were specified and tested for significance.

To test Hypothesis 2, BMQ composites (i.e., Necessity-Concerns differential and Harm+Overuse sum) were added to the model and direct paths specified from both of the BMQ composites to Adherence and examined for significance. These paths were tested for significance controlling for each other and also one at a time.

To test Hypothesis 3, two groups were created for each BMQ composite such that one includes participants scoring above the midpoint on each BMQ composite and the other includes participants scoring below the midpoint. The midpoints of each of the scales were determined by the average of their ranges. As such, the midpoint for the Necessity-Concerns composite is 0 and the midpoint for the Harm+Overuse composite is 24. Two analyses were conducted for each path linking each psychosocial variable to Adherence such that in one analysis for a particular path, the path was constrained, and in the other analysis the path was unconstrained (estimated freely). It was concluded that

beliefs about medicines moderates the relationship specified between that psychosocial variable and Adherence if the model with the path unconstrained demonstrated significantly better fit than the model with the path constrained.

For all analyses, the structural model as specified was assessed for model fit according to the index cut-off values described above. If the structural model did not converge or could not be altered so as to achieve adequate model fit, the hypotheses were analyzed using hierarchical multiple regression.

Chapter 3 RESULTS

Participants

This ethnically-diverse sample included 105 men and women. Of all parent study participants who were contacted by study personnel and invited to participate in the current study, 72 participants declined participation. Since participants demonstrated their intent to decline simply by not returning their completed questionnaire in the mail, specific reasons they may have declined participation are unknown. Regarding differences between responders and refusers, there were no significant ($p < 0.10$) differences in age, gender, income, education level, NYHA class, EF, number of prescribed medications, number of months since HF diagnosis, and number of co-morbid diseases. Ethnicity group, however, did significantly ($p = 0.06$) differ between responders and non-responders. The responder group consisted of a relatively higher proportion of Caucasians and Black (African) Americans to Hispanics compared to the non-responder group. The current study sample remains extremely diverse, though, because Hispanics were oversampled in the parent study.

All questionnaires were tested for Cronbach's alpha and also for differences between English and Spanish versions. The Cronbach alpha for each measure is as follows: MAS = 0.66, LSD = 0.70, Necessity – Concerns differential = 0.83, Harm+Overuse sum = 0.85, CESD-R = 0.95, Hostility = 0.81, Social support = 0.92. Of all measures, the Harm+Overuse sum significantly differed between English and Spanish versions [$F(103) = 4.81$, $p = 0.03$] such that Spanish speakers indicated they had stronger beliefs that medicines were harmful and/or overused, and the MOS-med item differed [$F(96) = 6.89$, $p = 0.01$] such that English speakers were more adherent to medicines.

Table 1 presents descriptive statistics of participant characteristics, including demographic information, medical variables, psychological functioning and attitudes, and adherence. The mean values for all four of the adherence measures suggest that this sample was fairly adherent to both medication and low-salt diet. Determining whether the participants indeed were highly adherent based on some sort of "cut-off" value is nearly impossible to do with these measures. For example, we used a Likert scale as the response set for the MAS in this study, while the response set typically is "yes" or "no" (Morisky et al., 1986). Thus, there are no established cut-off values that would indicate level of adherence for the MAS as measured in this study. Given that the possible range of scores for the MAS in this study is 4 to 20 and our patients reported a mean of 18.04 and standard deviation of 2.24, one could posit that this sample overall was very adherent to medicines. Additional analyses showed that 57% of participants reported on the MAS that they "never" forgot to take their medication, and only 1% of participants reported on the MAS that they "always" forgot to take their medication. Since this was the first study using the LSD, any potential cut-off values are not known. No cut-off values could be found for the MOS items, but one study (Chung et al., 2008) labeled participants as "adherent" only if they answered "all of the time" to the MOS-med and MOS-salt items. By this analysis, 82% of current study participants were "adherent" to medication and 42% to a low-salt diet. Indeed, patients were significantly more adherent to medications than they were to low-salt diet [t (198) = 21.90; p = 0.00].

Regarding medical and psychosocial variables shown in Table 1, participants were prescribed a mean of 8.1 medications, and several medications in particular were very common. In this sample, 91% of participants were prescribed beta-adrenergic or

alpha-beta blockers, 85% were prescribed diuretics, 61% were prescribed statins, and 62% were prescribed angiotensin-converting enzyme inhibitors. Also as shown in Table 1, the mean CESD-R score of 19.00 exceeds the well-established clinical depression cut-off value of 16, suggesting that overall this sample was clinically depressed. Further, 54% of participants scored at least 16 on the CESD-R, providing additional evidence that this sample overall suffered from depression.

Regarding beliefs about medicines in this sample, negative values on the Necessity-Concerns differential indicate a greater belief in necessity about medicines in addition to having fewer concerns about medicines. Lower values on the Harm+Overuse sum indicate a stronger belief that medicines are harmful and/or overused. Thus, the mean values as shown in Table 1 suggest that overall this sample slightly leaned toward believing medicines were necessary and having few concerns about them, and tended not to believe that medicines were harmful and/or overused. Participants can be placed into "high" or "low" categories of beliefs according to whether those scores were above or below the midpoint for each scale; 0 for Necessity – Concerns, 24 for Harm+Overuse. Eighty percent of participants scored below the midpoint on the Necessity – Concerns scale, indicating they tend to believe that medicines are necessary and have few concerns. Scoring at and above the midpoint on the Necessity – Concerns differential were 8.6% and 11.4% of participants, respectively. Twenty-one percent of participants scored below the midpoint on the Harm+Overuse sum, indicating that they tend to believe that medicines are harmful and overused by doctors. Scoring at and above the midpoint on the Harm+Overuse sum were 5.7% and 73.3% of participants, respectively.

Hypothesis 1

The aim of Hypothesis 1 was to test the relationships between psychosocial variables and adherence as defined by the latent variable "adherence," comprised of indicators MAS, LSD, MOS-med item, and MOS-salt item.

The measurement model as proposed, shown in Figure 1, was deemed unsuitable for further analysis. Though the model fit was adequate [$\chi^2(2) = 1.08$, $p = 0.58$, CFI = 1.00, RMSEA = 0.00, and SRMR = 0.03], all four indicators did not load significantly onto the latent variable. As shown in Figure 1, the MAS loading was insignificant, suggesting that the MAS greatly differs from the other three measures in construct validity and/or measurement error. Therefore, this latent variable as an outcome measure of adherence was abandoned and not used in hypothesis testing.

Rather, the MAS was used as the outcome variable of adherence, as it has frequently been used as an adherence measure in other studies whose samples include HF patients and, thus, appears to be the most valid measure of the four adherence measures used in this study. Of all potential control variables, only education level was related to the MAS (F (102) = 2.41, p = .09), and therefore was included as a control variable in all analyses in which the MAS was the dependent variable. Testing of Hypothesis 1 revealed that both depression [$\beta = -0.20$, SE = 0.10, $p = 0.03$] and hostility [$\beta = -0.22$, SE = 0.09, $p = 0.02$] were significantly related to the MAS when social support and education level also were included in the model, though both social support and education level were not significant predictors. Due to non-significance, education level was removed from the model in order to create a more parsimonious model. Figure 2 shows path coefficients

corresponding to the psychosocial predictors of the MAS. The model fit could not be estimated due to model saturation.

In order to release degrees of freedom sufficient to estimate model fit, a couple of statistical techniques were tested. First, the variances of the three psychosocial variables were constrained to be equal to each other. These results showed that model fit could be estimated, but it was extremely poor [$\chi^2(2) = 151.39$, $p > 0.05$, CFI = 0.00, RMSEA = 0.84, and SRMR = 1.93], suggesting that the variances of our psychosocial variables indeed are very dissimilar. The second technique tested to release degrees of freedom was constraining a path to be equal to 0. Since social support was a non-significant predictor of the MAS, its path was constrained to be 0 and results showed that model fit was excellent [$\chi^2(1) = 0.04$, $p = 0.84$, CFI = 1.00, RMSEA = 0.00, and SRMR = 0.01]. Further, depression [$\beta = -0.21$, SE =0.09, $p = 0.03$] and hostility [$\beta = -0.22$, SE = 0.09, p =0 .02] remained significant predictors.

Since the MAS was measured only once in this sample, its reliability over time cannot be established. It can be assumed that adherence is a stable behavior unless influenced by some external force, and any observed variability in a specific measure of adherence across time is a reflection of random measurement error (Arnsten et al., 2001; Haubrich et al., 1999). It is important to provide evidence supporting this assumption that adherence is a stable behavior, and also, including multiple assessments of the same measure helps to reduce the likelihood that the results could be influenced by random measurement error. SEM lends itself to establishing whether measures (and therefore, the behaviors they measure) are reliable over time. Since the MOS medication (MOS-med) and low-salt adherence items (MOS-salt) had been used in the parent study over 4 time

points, latent variables were created that consisted of 5 indicators corresponding to each of the assessment time points for each of the MOS-med and MOS-salt items.

First, analyses of both of these measurement models were conducted by allowing all parameters to be estimated varying freely. The coefficients and standard errors corresponding to the loadings for all time points for both of the MOS items are displayed in Table 2. Nearly all of the loadings for both models were significant, and the model fit for both models was adequate [MOS medication item: $\chi^2(5) = 1.94$, $p = 0.86$, CFI = 1.00, RMSEA = 0.00, and SRMR = 0.04; MOS low salt diet item: $\chi^2(5) = 8.50$, $p = 0.13$, CFI = 0.96, RMSEA = 0.08, and SRMR = 0.06].

Next, the reliability of each measurement model was tested. In SEM, the reliability of a measure can be estimated by fixing all indicator loadings to 1 and constraining the error variances to be equal to each other. Then, the variance components from the measurement model—specifically, the variance of the latent variable and the residual variance of the indicators—can be used to calculate the number of times that particular measure would have to be administered in a sample in order to achieve adequate reliability, which generally is specified as approximately 0.80. The following equation was used to determine how many "n" assessments would be required to achieve adequate reliability: 0.80 = latent variable variance / [latent variable variance + (indicator residual variance/n)]. It was determined that 20 assessments of the MOS-med item would be necessary in order to achieve a reliability of 0.79, but only 5 assessments of the MOS-salt item would be needed to achieve a reliability of 0.78. Thus, it was concluded that the MOS-med item was not very reliable over time in this sample, while the MOS-salt item showed adequate reliability over time. Since five assessments of the MOS were

conducted in this sample in the parent study plus the current study, a measurement model of the MOS-salt items was used as a measure of adherence for hypothesis testing. Model fit indices for both measurement models in which the loadings and variances were constrained are as follows: [MOS-med; $\chi^2(13) = 77.68$, $p = 0.00$, CFI = 0.00, RMSEA = 0.22, and SRMR = 0.89] and [MOS-salt; $\chi^2(13) = 22.20$, $p = 0.05$, CFI = 0.90, RMSEA = 0.08, and SRMR = 0.14]. Not surprisingly, the MOS-med fit was quite poor, while most of the MOS-salt fit indices were acceptable.

Thus, Hypothesis 1 was tested with the MOS low salt diet adherence latent variable as the dependent variable. Regarding control variables, all possible controls were tested for a significant ($p < .10$) relationship by bivariate correlation or one-way ANOVA with all five assessments of the MOS-salt item. Several control variables were related to low salt diet adherence, and these relationships are displayed in Table 3. As such, all variables listed in Table 3 were specified as predictors of the MOS-salt latent variable in SEM, and they were removed from the model one at a time according to strength of association with the latent variable. Income level [$\beta = -0.27$, SE = 0.10, $p = 0.01$], age [$\beta = 0.38$, SE = 0.10, $p = 0.00$], and number of co-morbid diseases [$\beta = -0.27$, SE = 0.10, $p = 0.01$] remained significant predictors of low salt diet adherence and were retained in the model to test Hypothesis 1. Results from Hypothesis 1 testing showed that none of the psychosocial variables significantly predicted low salt diet adherence, but all of the control variables remained significant. Path coefficients and standard errors are shown in Figure 3. Most model fit indices, however, were acceptable [$\chi^2(29) = 43.23$, $p = 0.04$, CFI = 0.88, RMSEA = 0.07, and SRMR = 0.07].

In summary, depression and hostility are significantly related to medication adherence as measured by the MAS and indicate that those who are more depressed and more hostile are less likely to adhere to their medicines. None of the psychosocial measures was related to low-salt diet as measured by a latent variable of MOS-salt items. Further, no control variables were significantly related to medication adherence, while income, age, and number of co-morbid diseases were significantly related to low salt diet adherence even beyond contributions of psychosocial variables such that lower income, higher age, and fewer co-morbid diseases were related to higher low-salt diet adherence.

Hypothesis 2

The aim of Hypothesis 2 was to test the relationship between beliefs about medicines and adherence. This aim was tested with both the MAS and MOS low-salt diet adherence latent variable as outcomes in different models. With the MAS as the dependent variable, the Harm+Overuse subscale was the only significant predictor [β = 0.31, SE = 0.11, p =0.00] and was related to adherence such that those who believe medicines are harmful and/or overused are less likely to adhere to medicines. Path coefficients for all variables in the model are shown in Figure 4. Model fit could not be estimated due to model saturation. Interestingly, when the Harm+Overuse sum was removed from the model, the Necessity – Concerns differential was significantly related to the MAS [β= -0.22; SE = 0.09; p =0 .02], indicating that individuals who believe medicines are necessary and have few concerns about them are more likely to adhere to their medicines. As expected, the Harm+Overuse sum remained strongly significant when the Necessary – Concerns differential was removed from the model [β= 0.34; SE = 0.09; p = 0.00]. Since model fit could not be estimated, a similar statistical technique was

applied to this model in order to release degrees of freedom. That is, the MAS regression path on social support was constrained to be equal to 0 in order to estimate model fit parameters. Model fit was excellent [$\chi^2(1) = .17$, $p = 0.68$, CFI = 1.00, RMSEA = 0.00, and SRMR = 0.01]. Also, the Harm+Overuse sum remained a significant predictor of the MAS [$\beta = 0.31$, SE = 0.11, p =0 .00].

When Hypothesis 2 was tested with the MOS-salt latent variable as the outcome, the psychosocial variables were not included in the model (due to their non-significant relationship with low salt diet adherence in the previous analysis) in order to test a more parsimonious model. Results showed that the Necessity – Concerns differential was significantly related to low salt diet adherence [$\beta = -0.31$, SE = 0.12, p =0.01], while the Harm+Overuse sum was not significantly related to low salt diet adherence [$\beta = -0.20$, SE = 0.12, p =0.11]. Control variables income level, age, and number of co-morbid diseases remained significant predictors as well, and model fit was excellent [$\chi^2(25) = 30.28$, $p = 0.21$, CFI = 0.96, RMSEA = 0.05, and SRMR = 0.06]. Path coefficients and standard errors for all variables in this model are displayed in Figure 5.

Interestingly, the Necessity-Concerns differential was not significant when the Harm+Overuse sum was removed from the model [Necessity – Concerns path; $\beta = -0.03$; SE = 0.02; $p = 0.06$], suggesting that the Harm+Overuse sum serves as a suppressor variable in this model. A suppressor variable removes error variance (or "noise") in another predictor that does not relate to the dependent variable, thereby increasing the predictive validity of that predictor. Classical suppressor variables are not significantly correlated with the outcome variable; and, in fact, the Harm+Overuse sum is not significantly related to any of the MOS-salt item assessments at $p < 0.05$. Further,

suppressor variables typically are significantly related to the predictor from which they remove error variance; the *r* for the Harm+Overuse sum with Necessity – Concerns differential is very high at $r = -0.55$. These results indicate that the presence of the Harm+Overuse sum in this model removes some of the error variance from the Necessity – Concerns differential, thereby strengthening the relationship between the Necessity – Concerns differential and low salt diet adherence. Exploratory analyses of bivariate correlations revealed that the Harm+Overuse sum was very strongly ($p < 0.00$) related to all items of the BMQ Concerns subscale but not to any items of the BMQ Necessity subscale. Further, the BMQ Concerns subscale was not related at a $p < 0.05$ level to any of the MOS-salt items, while two of the MOS-salt items were significantly ($p < 0.05$) related to the BMQ Necessity scale. These results suggest that the Harm+Overuse sum's strong association with the BMQ Concerns subscale is allowing the Necessity – Concerns differential to be significantly associated with low-salt diet adherence despite the non-significant association between the BMQ Concerns scale and low-salt diet adherence.

In summary, the BMQ Harm+Overuse sum was significantly related to medication adherence measured by the MAS beyond contributions of psychosocial variables and the BMQ Necessity – Concerns differential. Thus, those who believe medicines are harmful and/or overused by doctors are less likely to adhere to medicines. The BMQ Necessity – Concerns differential, however, significantly predicted low-salt diet adherence controlling for the Harm+Overuse sum. Thus, patients who believe medicines are necessary and have low concerns about them are more likely to adhere to a low-salt diet. Further, income, age, and number of co-morbid diseases remained

significant predictors of low-salt diet in this model such that a lower income, higher age, and fewer co-morbid diseases were related to higher low-salt diet adherence.

Hypothesis 3

The aim of this hypothesis was to determine whether either of the BMQ scales moderated the relationship between psychosocial variables and adherence. See Figure 6 for an illustration of the models to be tested in SEM. In order to test whether each of the BMQ scales moderated relationships between psychosocial variables and adherence, the BMQ scales were split into two groups; "high" and "low" (following the method used by Horne et al. (2009), described previously). Participants whose score was exactly the midpoint were not included in these analyses (n = 9 for the Necessity – Concerns differential; n = 6 for the Harm+Overuse sum).

Testing this hypothesis with the MAS as the dependent variable using the method that was proposed could not be completed in SEM, as model fit indices could not be calculated due to model saturation, and, thus, the chi-square values for model fit of the constrained versus unconstrained model could not be compared. Another statistical approach was explored in order to determine whether the BMQ scales moderated the relationship between psychosocial variables and the MAS. Interaction terms were created by multiplying each centered psychosocial variable by each of the BMQ group vectors. Each centered psychosocial variable, group variable, and the corresponding interaction term were entered as predictors of the MAS. Education level was also included in analyses but later removed due to non-significance. Results showed that none of the interaction terms were significantly ($p < 0.05$) related to the MAS.

Next this hypothesis was tested with the MOS-salt adherence model as the outcome. When the Necessity – Concerns differential was tested as a moderator, analyses could not be completed likely due to having a very small sample size (n = 12) in the "above" group. When testing the Harm+Overuse sum as a moderator, analyses could not be completed when testing hostility and social support as predictors, also possibly because the sample size for the "below" group was very small (n = 22). When testing depression as the predictor, however, the analysis terminated normally, but the fit was extremely poor [$\chi^2(52) = 88.39$, $p = 0.00$, CFI = 0.72, RMSEA = 0.12, and SRMR = 0.15] and the regression path of adherence on depression was non-significant ($p > .05$).

Therefore, the procedure described above whereby an interaction term was created and tested in path analysis was also conducted for the MOS-salt latent variable as the outcome. Model fit was acceptable for all models [χ^2 *p*s = 0.06 – 0.13, CFIs = 0.89 – 0.93, RMSEAs = 0.05 - 0.07, and SRMRs = 0.06 - 0.07] other than the model testing the depression x Harm+Overuse sum interaction, for which most model fit indices were poor [$\chi^2(52) = 43.65$, $p = 0.04$, CFI = 0.88, RMSEA = 0.07, and SRMR = 0.07]. The interaction term in all models, however, was non-significant ($p > .05$), indicating that the BMQ subscales do not moderate associations between psychosocial variables and low salt diet adherence.

Chapter 4 DISCUSSION

The purposes of this study were to determine whether and to what extent demographic, medical, and psychosocial variables and beliefs about medicines were related to adherence among HF patients. Another aim was to determine whether high or low beliefs about medicines—specifically, the Necessity – Concerns differential and Harm+Overuse sum—moderated relationships between psychosocial variables and adherence. SEM was used to determine whether demographic, medical, and psychosocial variables and the BMQ Necessity – Concerns differential and Harm+Overuse sum predicted a latent variable consisting of four scales measuring medication and low-salt diet adherence: the MAS, MOS medication adherence item (MOS-med), MOS low-salt diet adherence item (MOS-salt), and a low-salt diet adherence scale (LSD).

In summary, results showed that the proposed measurement model was unusable as an outcome variable to test the hypotheses. Although the model fit was excellent, the loading of the MAS on the latent variable was not significant, while the loadings of the other three indicators were significant. The hypotheses were then tested with the MAS as the outcome variable. These path analyses in SEM revealed that depression and hostility both significantly predicted adherence in an SEM model also including social support, though social support was not a significant predictor. Further, when both BMQ scales (Necessity – Concerns differential and Harm+Overuse sum) and all psychological variables were included in the model, only the Harm+Overuse sum significantly predicted medication adherence.

These results help support the strong validity of the MAS, but because it was measured only once in this sample, its reliability is uncertain. Separate measurement

models for each of medication and low-salt diet adherence that consisted of five indicators corresponding to the four MOS-med and MOS-salt assessment time points in the parent study plus one in the current study were created and tested for MOS-med and MOS-salt item reliability. Results showed that the MOS-med item is not reliable in this sample, whereas the MOS-salt was reliable and its measurement model demonstrated adequate fit. Study hypotheses were then tested using the MOS-salt item latent variable as the outcome variable. These analyses revealed that of all variables, income, age, number of co-morbid diseases, and the BMQ Necessity – Concerns differential were significantly related to low-salt diet adherence.

Proposed Measurement Model

Reasons that the proposed measurement model was unsuitable for further analyses are not certain, but speculations can be made. First, including scales measuring the different behaviors of diet adherence and medication adherence may be problematic, as it appears that influences underlying these two behaviors may greatly differ. For example, both the LSD and MOS-salt item share a great deal of the variance in the latent variable (0.44 and 0.49, respectively) while that shared by the MAS and MOS-med item are 0.01 and 0.07, respectively. There were major differences in the measures even *within* each behavior, as the two low-salt diet measures were moderately strongly related to each other ($r = 0.47$), whereas the medication measures were weakly correlated with each other ($r = 0.13$).

Different behaviors within the same measurement model.

No studies could be found that tested a measurement model containing measures assessing both medication and low-salt (or another type of) diet adherence. Some studies,

however, demonstrated that different behaviors do load significantly onto the same measurement model. For example, Wilson and Widom (2009) showed that four different behaviors/circumstances (i.e., prostitution, homelessness, delinquency/crime, school problems) all loaded significantly on a single latent variable tested separately for men and women. Major differences between this study and the current study are that the samples used to create the measurement models were fairly homogeneous, as they tested genders separately and the age range was much narrower at approximately 20 years (19.0-40.7). Further, the sample sizes (approximately 580 for women; approximately 610 for men) were much larger than those for the current study.

DeYoung, Peterson, Seguin and Tremblay (2008) found that three different externalizing behaviors (i.e., vandalism, drug use, aggression) loaded significantly on a single latent variable among 140 adolescent boys. The participants in this study greatly contrast with those in the current study, as this subject pool consisted of Caucasian adolescent boys living in Montreal, Canada, whose behaviors were assessed at exactly the same age. These participants were chosen for the study sample because they had consistently scored high in aggression at several assessment times since they were young children, further establishing the homogeneity of this particular sample.

Donovan, Jessor, and Costa (1993) demonstrated that each of six different health behaviors (i.e., sleep, safety, diet, exercise, low sedentary behavior, and dental care) loaded significantly onto a single latent variable in second-order factor models among groups of junior high and high school students. Similar to the current study, the participants in Donovan et al. (1993) were an ethnically-diverse group. A striking difference between their study and the current study, however, is that their sample was

much larger than the current study's sample (4280 versus 105 participants, respectively). Another major difference is that the age range of the participants in each second-order factor model of Donovan et al. (1993) was quite narrow, as their participants included adolescents in middle schools (grades 7-8) and high schools (grades 9-12), while the current study included adults of a very large age range. Their study participants were also much younger, and the authors note that their results may be due to a possibility that health-enhancing behavior is less fragmented and more uni-dimensional in adolescence, and that it becomes more fragmented into adulthood as individuals take on multiple and varied role obligations. Further, Donovan et al. (1993) measured all six health behaviors with a single questionnaire, the Health Behavior Questionnaire, and they noted that the significant loadings of all health behaviors may simply reflect the common method by which they were measured.

Thus, the major differences in the above studies compared to the current study are that the sample sizes were much larger, the behaviors were assessed within a single questionnaire, and the samples themselves were more homogeneous with regard to age range, gender, and personality factors (i.e., aggression). Current study participants, conversely, are characterized by great heterogeneity. Further, while it is possible the behaviors measured in the above studies may indeed share a common factor or trait, individual characteristics underlying medication versus low-salt diet adherence may be very different. Possible person-specific characteristics underlying medication versus diet adherence are discussed later.

Nature of the questionnaire items.

Another major difference between the MAS and the other three measures in the current study is that all items in the MAS are questions, whereas all items in the other three measures are statements. Research studies have indicated that responding to questions may require a different cognitive process than that of responding to statements (Graesser, McMahen, & Johnson, 1994; Buttner, 2007). When responding to questions, a respondent is required to undergo two separate processes related to each question: 1) monitor the question for internal consistency and 2) determine whether he possesses relevant knowledge sufficient to answer the question (Reder & Kusbit, 1991). According to these researchers, satisfying the latter requirement takes priority over the satisfying the former requirement. That is, theoretically, when responding to a question, an individual's attention should be focused on the information to be provided to the questioner (Graesser et al., 1994). In contrast, when responding to a statement, an individual simply needs to monitor the statement for internal consistency; in other words, determine whether the statement is true for oneself. Based on these unconscious strategies employed when responding to questions versus statements, one might speculate that an individual must apply more cognitive resources to responding to questions than to statements. If that is indeed the case, it is possible that the items in the MAS—as questions rather than statements—may have elicited more accurate and honest responses related to adherence behavior than did the items—as statements rather than questions—in the LSD and MOS-med and MOS-salt scales.

Content of MAS items versus MOS-med item.

As previously noted, it appears that the medication adherence items included in the latent variable were quite dissimilar ($r = 0.13$), and several concepts related to the MAS support use of the MAS, rather than the MOS-med item, as an outcome variable for hypothesis testing. First, the items in the MAS address possible reasons for non-adherence (i.e., forgetting, being careless, feeling better, feeling worse), while the MOS-med item simply addresses to what extent an individual took prescribed medication. It can be speculated that by proposing specific reasons why an individual may not have adhered to medicine, one's memory more accurately recalls episodes of non-adherence. Further, studies have suggested that a common practice in patients is to stop taking medicines due to feeling better or feeling worse. For example, Siegel et al. (1999) concluded that people alter doses or stop medicines depending on the extent to which the medicines meet their expectations, and then observe how they feel once the medicine is reduced or stopped. That is to say, they may stop or reduce their medicines depending on how they feel. Interestingly, two items in the MAS address stopping one's medications upon feeling better and feeling worse. This appears to be a common practice especially among patients taking antihypertensive medicines (Johnson, Williams, & Marshall, 1999), which are common medicines among HF patients. Dowell and Hudson (1997) note that this behavior is more likely to occur if patients are taking the drugs long-term, which is the case for HF patients. Thus, the MAS may be particularly valid in the way that it measures this particular reason underlying the behavior of adherence.

Hypothesis Testing with the MAS as Outcome

Psychosocial variable associations with medication adherence.

When the MAS was specified as the outcome variable in path analysis, both depression and hostility were significantly negatively associated with the MAS. Social support was also included in this model, but it was not related to adherence. These findings support the work of other studies showing that higher depression (van der Wal et al., 2006; Wray, Waters, Radley-Smith, & Sensky, 2006; Morgan et al., 2006) and greater hostility (Kawachi, Sparrow, Spio, Vokonas, & Weiss, 1995) are related to poorer medication adherence among HF patients; however, these studies did not include both depression and hostility as predictors of adherence in the same model. Notably, then, both depression and hostility were related to the MAS in the same model in the current study. By covarying these variables in the model and demonstrating that they are both significantly related to adherence, we provide evidence that depression and hostility are conceptually different constructs that influence adherence in different ways.

Considering all patient population groups, only one study was found that included depression and hostility in the same model as predictors of adherence (Irvine et al., 1999). The participant sample of this study included post-myocardial infarction patients, and social support also was included in the model with depression and hostility. Regarding social support, these researchers reported that the number of social activities in which the respondent participated was significantly related to medication adherence. Other scales they used to assess social support and social networks were not related to adherence. The current study, however, found that social support was not related to adherence, but it included both depression and hostility in that same model at the outset,

whereas Irvine et al. (1999) determined predictors of adherence by using stepwise multiple regression, a statistical technique for which non-significant variables never enter into the model.

Irvine et al. (1999) also found that neither depression nor hostility was related to adherence, which contradicts our findings. One reason could be that Irvine et al. (1999) defined adherence as a dichotomous, rather than continuous, variable; a patient was defined as "adherent" if ≥ 66% of pills were ingested. Also, they used the Beck Depression Inventory rather than the CESD-R to assess depression, and used the Cook-Medley hostility scale in its entirety, while our measure of hostility is actually the 'cynicism' subscale of the Cook-Medley hostility scale. Irvine et al. (1999) also tested the subscales of the Cook-Medley scale as predictors and found that cynicism was not associated with adherence. A possible reason for the contradictory finding, in addition to their use of a dichotomous dependent variable, is that the mean and standard deviation of the Cook-Medley cynicism scale are much lower in Irvine et al. (1999) than in the current study, and perhaps the variance was simply too small and/or and level of cynicism is not sufficiently high enough so as to be related to adherence.

Even when hostility and depression were removed from the model in the current study, social support remained a non-significant predictor (data not shown), suggesting that its non-significance in the model cannot be due to shared variance with depression and/or hostility, though these three constructs often are highly related (Finch, Okun, Pool, & Ruehlman, 1999; Schwarzer & Leppin, 1991; Maher, Mora, & Leventhal, 2006; Barefoot et al., 1995; Barefoot, Dahlstrom, & Williams, 1983) and also were significantly correlated in the current study.

Other studies among HF patients have shown that social support was related to adherence, but there are some differences between the current study and other studies that may account for the different findings. For example, Wu, Moser, and Chung et al. (2008) used MEMS caps, an objective—rather than self-report—measure of adherence as their outcome and found that perceived social support was significantly related to both dose-day and dose-count adherence, controlling for ethnicity, barriers to adherence, and financial status. Happ et al. (1997) concluded that social support was related to adherence by gathering qualitative, rather than quantitative, information from elderly HF patients.

Sayers, Riegel, Pawlowski, Coyne, and Samaha (2008) found that emotional but not instrumental support was significantly related to self-reported adherence in a HF sample. The authors created the two subscales—emotional and instrumental support—from their social support measure. In addition to this study's use of these different social support subscales, major differences between this sample and our sample are that this sample was comprised of mostly (96%) men who were predominantly either African American or Caucasian. Molloy, Perkins-Porras, Bhattacharyya, Strike, and Steptoe (2008) also included depression in the same model with social support and found that practical social support, but not emotional social support, was significantly related to medication adherence among a cardiac population of 262 men and women. Assessment of both types of social support, however, was relatively crude in this study, as they were each assessed by only one question. It may be important, however, to determine whether different aspects of social support (i.e., emotional versus instrumental) influence behavior differentially, and perhaps social support has a greater influence on adherence among men than among women. Further, nearly half of the current study's sample was of

Hispanic ethnicity, and perhaps social support does not influence behavior as strongly among Hispanics as among African Americans and Caucasians.

One study indicated that social support may indeed influence behavior differently depending upon ethnicity among patients with HF (Hedemalm, Schaufelberger, & Ekman, 2010). These researchers found that Swedish immigrants from Nordic, other European, and non-European countries were more likely to adhere to medication than those who were native to Sweden. Interestingly, fewer immigrants than Swedish natives endorsed having social support in the form of a supportive other in whom to confide when they needed to share their concerns with another person. Taken together, these results suggest that social support may not be related to medication adherence. The study authors reason that these results are partly a function of support availability differences between the natives and immigrants. That is, given that this particular form of social support addresses *how often* support is available rather than the *quality* of support, the immigrant group may not have access to supportive others who speak their own language as often as they would if they lived in their native country. Further, the authors note that many non-Western cultures are more collectivistic than individualistic, meaning that individuals of non-Western countries are more likely to obey authorities rather than make their own decisions (Oettingen, 1995), and as such are more likely to adhere to medication. The current study had a similarly very diverse sample, and social support might influence behavior differently among different cultures. Future studies may wish to test ethnic group as a moderator variable and examine whether social support affects adherence differently in different cultures.

This is the first study to our knowledge to show that both depression and hostility were related specifically to the MAS. Only a couple of studies reported testing the relationship between the MAS and depression, whereas none have shown that hostility is related to the MAS. Berry et al. (2010) found that among those who were severely depressed, a significantly greater percentage endorsed low adherence than high adherence on the MAS. In this study, participants were defined as "low adherers" if they answered "yes" to any of the four questions of the MAS and "high adherers" if they answers "no" to all of the four questions. The 438 participants in this study were on average 52 years old and comprised of roughly half men and half women, who had all had been taking prescribed antihypertensive medications for at least one month prior to study entry. Hashmi et al. (2007) similarly found that when depression scores and MAS scores were both analyzed as dichotomous rather than continuous variables, a significantly greater proportion of patients with low (≤ 2) scores on the MAS were depressed than among the adherent group, who scored > 2 on the MAS). Multivariate regression analyses, however, using a continuous MAS score (range 0 – 4) as the dependent variable revealed that depression was not associated with adherence.

These studies greatly differ from the current study, as the participants in Berry et al. (2010) were severely depressed, whereas the current study sample reported a wide range of depressive symptomatology. Both studies used the MAS scores in a dichotomous fashion, while our MAS as outcome remained a continuous variable. In fact, when Hashmi et al. (2007) used a continuous MAS score as the outcome, they found that depression was not related to adherence. Based on this comparison, future studies using

the MAS to assess medication adherence may benefit from testing it both as a continuous and dichotomous variable in order to determine which way is most valid.

In summary, the current study's results support previous research regarding the relationships of depression and hostility with medication adherence, though this is the first study to demonstrate that both depression and hostility are related to adherence controlling for each other. In this way, these results show that depression and hostility greatly differ conceptually from one another with regard to explaining adherence behavior. These results differ from other studies, however, with regard to the relationship between social support and adherence, though studies that found a relationship between social support and adherence often considered different types of social support, rather than a global social support measure.

Beliefs about medicines related to medication adherence.

The MAS was also significantly related to the BMQ Harm+Overuse sum but not to the Necessity – Concerns differential when both of these BMQ scales were included in the model. No other study to date has shown that BMQ scales are related to adherence among HF patients. George and Shalansky (2007) did test whether the BMQ scales were related to adherence in a HF sample, and they reported that there was no significant association, but they tested only the Necessity – Concerns differential, not the Harm+Overuse sum. More recently, another study included patients with cardiac disease in their sample—along with patients with other chronic illnesses such as depression, asthma, and diabetes—and found that patients who reported being "accepting" of medicines—defined as high on the Necessity scale and low on the Concerns scale—had the highest adherence out of four possible attitudinal groups; while those in the

"skeptical" group—defined as low on the Necessity scale and high on the Concerns scale—had the lowest adherence (Tibaldi et al., 2009). Tibaldi et al. (2009), however, did not report whether there were differences within individual illness groups in the relationship between beliefs and adherence.

In the current study, the Necessity – Concerns differential was significantly related to the MAS when the Harm+Overuse sum wasn't in the model; similarly, other studies with several different patient groups have shown that beliefs that medicines are necessary and/or having concerns about medicines are related to adherence, and specifically that the Necessity – Concerns differential is related to adherence (Horne & Weinman, 1999; Menckeberg et al., 2008; Bane et al., 2006). Few studies report associations of the BMQ Harm and Overuse subscales with adherence (Phatak & Thomas, 2006; Khanderia et al., 2008). Khanderia et al. (2008) found that each of the Harm and Overuse subscales were related to adherence but did not control for the Necessity and Concerns scales. Phatak and Thomas (2006) reported that all four BMQ subscales were significantly related to adherence when tested as a predictor one at a time, but when they included all four BMQ subscales together in the model, only the Concerns and Necessity subscales were significantly related to adherence. Their patient sample differed from the current sample, however, in that their patient sample consisted of individuals diagnosed with a variety of illnesses. Similarly, another study reported that the BMQ Concerns and Necessity scales were each significantly related to adherence in multiple regression controlling for the Harm and Overuse subscales (Byrne, Walsh, & Murphy, 2005).

This is the first study to our knowledge to demonstrate that patients' beliefs that medicines are harmful and/or overused are more strongly related to adherence than patients' beliefs in the necessity of or concerns about medicines. Further, this is the first study to our knowledge to show that beliefs about medicines as measured by the BMQ are related to adherence among HF patients.

Underlying personality characteristics related to adherence.

It is interesting that both of the Harm+Overuse sum and hostility scales were significantly related to medication adherence, albeit in different models, as these measures may share underlying personality traits. Scores on the BMQ Harm and Overuse scales appear on the surface to reflect a hostile attitude or, more specifically, cynical distrust. In fact, several items on the BMQ Harm and Overuse scales reflect lack of trust in medicines and doctors (i.e., "Medicines do more harm than good;" "Doctors use too many medicines"). No research studies to date have examined the relationship between beliefs about medicines and hostility or cynical distrust. In the current sample, the BMQ Harm+Overuse sum was strongly correlated with the hostility measure (r = -0.31), suggesting that those who tend to be cynical and untrusting of others also are likely to believe that medicines are harmful and overused. Interestingly, hostility was not as strongly related to the Necessity – Concerns differential (r = 0.12), and the Harm+Overuse sum was not as strongly related to the other significant psychological predictor of medication adherence in our model, depression (r = -0.22), as it was to hostility. Though depression and the Necessity – Concerns differential were significantly related to medication adherence when the Harm+Overuse sum was not in the model, these correlations suggest that hostility/cynicism, but not depressed affect, may underlie

the relationship between beliefs about medicines and adherence in this sample. Especially since the current study's hostility measure actually is the "cynical distrust" subscale of the Cook-Medley hostility scale, cynicism, then, may be an underlying personality trait contributing to the development of one's belief system and subsequent adherence.

Other person-related characteristics might also explain our finding that the Harm+Overuse sum, but not the Necessity – Concerns differential, was related to medication adherence. Researchers have suggested that it may be challenging or impossible to appreciate potential benefits of medicines when plagued with distressing and debilitating symptoms, as has been noted among individuals with HIV/AIDS who are taking antiretroviral therapy (McDonald, Bartos, & Rosenthal, 2000). Similarly, given that HF is a debilitating condition, it is possible that HF patients find it difficult to appreciate the benefits or necessity of medicines, and therefore, perceived harm of medications overrode the contribution of perceived necessity in the model.

Another reason why the Harm+Overuse sum may be strongly related to medication adherence in this particular sample is because many of these HF patients are taking medications for which there are few or no symptoms. For example, many have hypertension, and because hypertension has no symptoms, it is very difficult to know whether antihypertensives actually affect one's health, and therefore, whether they truly are necessary. Hypertensive patients in several studies reported this very sentiment (Morgan, 1996, Svensson, Kjellgren, Ahlner, &Saljo, 2000, Johnson et al. 1999, Van Wissen, Litchfield, & Maling, 1998). Similarly, dyslipidemia and diabetes are asymptomatic, given no complications such as diabetic neuropathy, and also are very common in HF patients. Thus, HF patients may not strongly believe that their medicines

are necessary because many of the medications they are prescribed target disorders such as hypertension, diabetes, and dyslipidemia, which are not typically characterized by bothersome symptoms an individual would wish to alleviate on a daily basis.

Regarding demographic and medical regimen covariates, the MAS was significantly correlated with education level, and as such this variable was entered into the SEM model. Once included in the model, however, it was non-significant, so was removed. Overall, the current study's results demonstrate that demographic and/or medical regimen variables are not associated with medication adherence, consistent with what other researchers have suggested in the literature. Thus, it is becoming clearer that one's emotions (i.e., depression), personality characteristics (i.e., hostility/distrust), and beliefs about medicines are strongly associated with medication adherence, while demographic and/or medical variables may play a very small role in one's behavior regarding adherence.

MOS-Med and MOS-Salt Adherence Measurement Models

One possibility the proposed measurement model (Figure 1) was inadequate to use as an outcome variable of adherence is due to uncertain reliability of the measures. Of the four indicators in the proposed measurement model, both the MAS and LSD were measured only once in this sample, whereas the MOS items were measured multiple times. The LSD was created by study authors and as such, its test-retest reliability cannot yet be ascertained. The MAS has been used widely by other researchers, though none has reported test-retest reliability; rather, these researchers used Cronbach's alpha to describe the MAS reliability. In fact, even the MAS creator stated that he has measured reliability

of the MAS only by calculating Cronbach's alpha (D. Morisky, personal communication, February 10, 2010).

It can be assumed that adherence is a stable behavior in the absence of an intervention; thus, the same measure of adherence should be reliable over time. Using SEM, the current study showed that low salt diet adherence, but not medication adherence, was reliable over time in this sample. Latent variables consisting of multiple assessments of the same adherence measure are very rare in the literature, suggesting that it is very difficult to create a latent variable from adherence measures.

One study, though, found that each of four assessments of the Adherence to Combination Therapy Guide (ACTG) and three assessments of the MEMS significantly loaded onto latent variables to create measurement models for each of the ACTG and MEMS (Gonzalez et al., 2007). This sample was similar to the current study sample in that both genders were included, it was quite ethnically-diverse, and the sample most predominantly reported a low education and income level. Further, the length of time between assessment times for the ACTG was similar to that of the current study (baseline, 3 months, 9 months, and 15 months). The MEMS, on the other hand, was measured every 90 days over 9 months. It had previously been determined in a prior study with this sample and these measures that this exact frequency and timing of assessments was sufficient for adequate reliability of medication adherence over time (Llabre et al., 2006). Gonzalez et al.'s (2007) sample differed from the current study sample, however, in that it was larger at 325 men and women, and the average age was a bit younger at 40.9 years; age was a significant correlate of low salt diet adherence in the current study. Further, the number of HIV pills taken daily at baseline was much lower at

2.3 compared with the current study's average of 8.1 medications, which could be one reason why their medication adherence was much more reliable over time. Further, Gonzalez et al. (2007) did not report frequency of co-morbid diseases in their sample, which was another significant correlate of adherence in the present study.

Stability of medication versus low-salt diet adherence.

The current study's results indicate that among individuals with HF, adherence to a low-salt diet is a much more stable behavior than adherence to medicines. Indeed, aforementioned research shows that, despite certain guidelines, there is a great deal of variety and inconsistency in the way that health care providers instruct patients to adhere to low-sodium diets. Thus, since it would have been expected that medication adherence would be more stable than low-salt diet adherence, it can probably be concluded that the practice of standard of care had little bearing on behavior in this particular sample. It is worth noting that though the low-salt diet adherence variable was more reliable over time in this sample, the mean of low-salt diet adherence was significantly lower than the mean of medication adherence. This finding is quite puzzling, and speculations are made below regarding why low-salt diet adherence might be a more reliable behavior than medication adherence.

The reliability of medication adherence has not been compared to that of low-salt (or any other type of) diet adherence in the literature. Some studies, however, did suggest that eating styles are somewhat stable over time. For example, one study recorded food habits in a detailed diet interview with nearly 34,000 healthy women in Sweden at two time points; once in 1987 and a second time in 1997 (Newby, Weismayer, Akesson, Tucker, & Wolk, 2006). Using factor analysis, the authors determined that there were

four major diet styles, which they labeled as Healthy, Western/Swedish, Alcohol, and Sweets. These styles were moderately stable over the nearly 10-year time span, as the correlations between 1987 and 1997 ranged from $r = 0.27$ (Western/Swedish) to $r = 0.54$ (Alcohol). The correlation between 1987 and 1997 for the Healthy pattern was $r = 0.37$, and that of the Sweets style was $r = 0.44$. This provides some evidence that eating habits are moderately stable over time.

Another study looked at the magnitude of change for five health-enhancing behaviors 6 months after first acute myocardial infarction (Salamonson, Everett, Davidson, & Andrew, 2007). Of the five behaviors, 42% of participants reported practicing two health-enhancing behaviors 6 months after the acute myocardial infarction, 25% reported practicing three behaviors, while only 17% reported practicing four behaviors. These findings suggest that individuals tend not to adopt several health-enhancing behaviors at once, and when faced with seemingly overwhelming lifestyle change recommendations, they may devote their energies to changing and maintaining only one behavior at a time. One of the health-enhancing behaviors addressed in Salamonson et al. (2007) was smoking, and most (90%) of the patients reported being tobacco-free at the 6-month follow-up assessment. Similarly, it may be the case that in the current study since nearly half (45.7%) of our patients reported being former smokers, they may be choosing to focus on maintaining a low-salt diet (in addition to remaining tobacco-free) in lieu of stable medication adherence.

Locus of Control May Underlie Adherence

Though in the current study patients had greater adherence rates to medication than to low-salt diet, medication adherence may have varied more than low-salt diet

adherence for certain reasons that are often beyond one's control, such as the availability of personal resources and means necessary to procure medication. On the other hand, individuals may have greater control over the efforts necessary to maintain a steady, albeit lower, adherence to low-salt diet.

Thus, another personality characteristic that might explain the relative reliability of low-salt diet adherence versus medication adherence and that different beliefs differentially predicted medication versus low-salt diet adherence is one's locus of control. First, it is reasonable to presume that the nature of behaviors required to adhere to a certain diet are much more varied and flexible than the behaviors required to adhere to a medication regimen. The behaviors corresponding to lifestyle changes, such as adhering to a low-salt diet, offer a broader spectrum of behaviors that an individual can choose to adopt compared to the spectrum of behaviors associated with adhering to medication. This broader spectrum may appeal to one's internal locus of control. For example, in deciding whether to adhere to a low-salt diet, an individual can select from many different foods that are low in sodium; from fruits and vegetables to lean meats and fish. Further, an individual can choose from a variety of cooking techniques that lend themselves to maintaining a low-salt diet, such as grilling and broiling. Also, many food companies now offer delectable low-sodium options, increasing the number of choices an individual has when choosing foods at the grocery store. Conversely, the behavior of taking medication consists of simply ingesting a pill or other designated form, such as a syrup or sublingual wafer. An individual has very little control over the behavior associated with taking medication.

Recall that the current study's interesting finding that the BMQ Necessity – Concerns differential, but not the Harm+Overuse sum, was significantly related to low-salt diet adherence. Assuming for purposes of simplicity that beliefs about medicines generalize to other aspects of a medical regimen (discussed later), this indicates that individuals with heart failure may not believe that adhering to a low-salt diet is harmful, nor do they believe that doctors recommend a low-salt diet too frequently. Further, individuals with heart failure may believe that adhering to a low-salt diet is necessary and have few concerns about how a low-salt diet might adversely affect their health. Conversely, the Harm+Overuse sum was related to the MAS beyond contributions of the Necessity – Concerns differential, suggesting that a belief that medicines are harmful and/or prescribed too frequently by doctors influences medication adherence beyond any contributions of belief in the necessity and/or level of concern about adverse effects of medicines. As previously mentioned, it seems that a cynical attitude may be a broad underlying personality characteristic influencing medication adherence, while the hostility measure was unrelated to low-salt diet adherence in our results.

Interestingly, hostility and external locus of control appear to be very strongly related, thereby supporting the assertion that locus of control may underlie behavior associated with adhering to medication but not necessarily low-salt diet adherence, as neither hostility nor the Harm+Overuse sum was related to low-salt diet adherence. The relationship between hostility and locus of control is demonstrated in a study that conducted a promax factor analysis in which several scales loaded significantly on the same factor: Rotter's external locus of control scale, the powerlessness subscales of Maddi's Alienation Test/Hardiness scale, all three subscales of the Cook-Medley scale,

and three subscales from the Boss-Durkee Hostility Inventory. The loadings for each scale were as follows: Cook-Medley Cynicism = 0.49; Cook-Medley Paranoia = 0.46; Cook-Medley Hostility = 0.32; Rotter external locus of control = 0.35; Maddi's Powerlessness = 0.79; Boss-Durkee Hostility Inventory physical assault = 0.31; suspiciousness = 0.38; negativism = 0.36. Most notably, the cynicism subscale from the Cook-Medley scale, which is the current study's hostility measure, and both external locus of control scales—the Powerlessness and External locus of control—loaded significantly on the same latent variable and thus can be considered very strongly related (Friedman, Tucker, & Reise, 1995).

The current study is the first to provide some evidence—albeit speculative—that locus of control might underlie medication but not low-salt diet adherence among HF patients. No studies could be found that tested the following relationships: locus of control with medication versus low-salt diet adherence; locus of control with low-salt diet adherence; or locus of control with diet adherence among patients with heart disease. Only one study could be found that examined the relationship between locus of control and medication adherence among patients with heart disease. George and Shalansky (2007) included in their study 350 men and women whose medical records indicated that they currently were prescribed any type of HF medication. They found that health locus of control did not differ significantly between those patients whose refill adherence rates were < 90% compared with those whose rates were ≥ 90%. The participant sample was fairly similar to the current sample in that the mean age was 61.2 years, 69.4% of the sample was men, the vast majority of patients were NYHA class I or II, 46.3% had a high school education or less, and the average number of medications taken per day was 8.0.

The authors, however, did not report the ethnic or racial make-up of the group other than to note that all participants spoke English. Further, their method of assessing adherence differed from ours, in that they assessed adherence via prescription refill rate while the current study used a self-report measure. Based on this difference between studies, it could be speculated that locus of control might affect one's self-report of adherence rather than the actual behavior per se.

Locus of control appears to be related to medication adherence in other patient populations. For example, Davis, Jandrisevits, Iles, Weber, and Gallo (in press) found that those who were non-adherent tended to have an external locus of control, controlling for several variables (i.e., type of disease, gender, age, ethnicity, marital status, housing status, level of education, employment status, income, and drug and alcohol use) among 472 men and women who presented to an emergency department and had a history of one of three chronic illnesses—hypertension, diabetes, or seizure disorder—for which they were taking regular medication. In another study including 588 patients at a Veterans Affairs hospital, higher internal locus of control was significantly related to better self-reported adherence with hypertensive medicine (Hong, Oddone, Dudley, & Bosworth, 2006). Another study of 189 patients with HIV (Lynam et al., 2009), conversely, revealed that locus of control was not related to medication adherence as measured by MEMS. Molassiotis et al. (2002) found that a higher internal locus of control was characteristic of those who were more adherent to combination antiretroviral therapy taken at least three times per day among 136 individuals. Apparently, locus of control as a correlate of adherence has been of interest for quite some time, as Kirscht and Rosenstock (1977) found that among 132 middle-aged patients taking antihypertensive medication, those

who reported feeling more self-reliant were more likely to adhere to their medication regimen compared with patients who attributed their health outcomes to chance. Overall, the above studies provide some evidence that locus of control may influence adherence to medication. Thus, future studies including cardiac samples may wish to include locus of control scales in studies predicting adherence.

Very few studies have examined the relationship between locus of control and adherence to components of a diet. Collins, Bradley, O'Sullivan, and Perry (2009) conducted a qualitative study interviewing 17 men and women with types 1 and 2 diabetes in which they discussed compliance with their diabetes regimen behaviors, attitudes related to how highly they value self-care, level of personal responsibility for their care, and use of specific behavioral strategies toward managing diabetes (i.e., assessing their blood glucose records for patterns, planning and adjusting diet and exercise regimens, and testing and recording blood sugars regularly). Based on patient attitudes and behaviors, the researchers discovered that there were three types of patients: proactive managers, passive followers, and nonconformists. The proactive managers were more likely than the other two types to adopt a healthy lifestyle and engage in self-care behaviors related to managing their diabetes. Proactive managers also accepted a great deal of the responsibility to properly manage their diabetes rather than depend on others (i.e., family members, doctors) for management.

Locus of control also might influence adherence in a way unrelated to hostility/cynicism. Specifically, many patients want to feel that they play a role in their health and are doing something advantageous for themselves. In one study, patients

reported that altering doses of drugs or choosing whether or not to take them represented ways of regaining some control over illness (Donovan & Blake, 1992).

In summary, internal locus of control may affect medication adherence in that the behavior of medication adherence, relative to diet adherence, does not appeal to one's internal locus of control. That is, given that there are very few behavioral options an individual can adopt in order to maintain adherence to medicine, individuals may be loathe to do so. Locus of control is related to hostility/cynical distrust—especially regarding doctors' use of medicines—which are other personality characteristics that the current study demonstrated to be related to medication adherence as well.

Depression Related to Medication but Not Diet Adherence

Another interesting finding from the current study was that depression was related to medication adherence but not to low-salt diet adherence. No other studies have reported that, within the same sample, depression was related to medication but not diet adherence. Other studies, however, have shown that depression is related to both medication and diet adherence or other lifestyle behaviors. Fisher, Glasgow, and Stryker (2010) found that among 463 patients with type 2 diabetes, clinical depression was related to medication and diet adherence. Lin et al. (2004) assessed depression and a variety of self-reported self-care behaviors in over 4000 patients with diabetes for whom pharmacy refill data revealed a nonadherence rate of nearly 20% or more to hypoglycemic medicines in the prior year. Major depression was associated with unhealthy diet, lower physical activity, and lower adherence to oral hypoglycemic, antihypertensive, lipid-lowering medicines.

Gonzalez et al. (2008) assessed depression and a variety of self-reported self-care behaviors among 208 patients with type 2 diabetes in a longitudinal study. They found that high levels of depression at baseline were significantly related to lower adherence to the following self-care behaviors at the follow-up assessment, which was on average 9 months after baseline: general diet recommendations; specific diet recommendations related to eating fruits, vegetables, and carbohydrates; less physical activity; and worse foot care. Studies among the general population have suggested that depressed individuals are more likely than non-depressed individuals to adopt maladaptive lifestyle behaviors such as smoking, overeating, and little physical activity (Bonnet et al., 2005; Lysy et al., 2008).

The above studies differ from the current study in many ways. First, the patient population in the above studies consists of patients with diabetes, and perhaps maintaining a diabetic diet—reducing carbohydrates and fats, which are regarded as "comfort foods"—is more challenging to a depressed individual than reducing sodium intake. Also, the sample sizes were larger, thereby increasing the chance of obtaining statistically significant results. Further, the above studies assessed patients' diet adherence with only a single assessment, and contrasted with the current study's statistical rigor, the reliability of that measure over time within their sample cannot be established.

Demographic and Medical Variables Related to Low Salt Diet Adherence

The current study showed that age, number of co-morbid diseases, and income level each were significantly related to low-salt diet adherence even beyond contributions of psychosocial variables and the BMQ scales. Other studies have shown that higher age

(Bane, Hughes, & McElnay, 2006; Phatak & Thomas, 2006; Maguire, Hughes, & McElnay, 2008; Khanderia et al., 2008; Morgan et al., 2006) and lower number of co-morbid diseases (Soumerai et al., 2006) are related to higher medication adherence, so it is not surprising that these variables were similarly related to low-salt diet adherence in the current sample.

Our finding that income was *negatively* related to low-salt diet adherence is surprising, as one might expect that those who are more affluent are more likely to seek out and afford healthier foods, and thus would be more adherent to a low-salt diet. No studies have shown that income and adherence to a low-salt diet are negatively related, though a couple of studies have suggested that income is negatively related to or does not influence medication adherence (Khanderia et al., 2008; Simpson, 2006).

Regarding income and low-salt diet adherence, one study found that sodium intake was greater among those with lower income, and another found no difference in sodium intake between income groups. Specifically, a study including 574 patients with HF assessed diet by 24-hour recall and found that sodium intake was related to income such that those patients whose income was $25,000 per year or less consumed significantly more sodium per day than those whose income was equal to or greater than $55,000 (Lemon et al., 2010). Ndumele, Shaykevich, Williams, and Hicks (2010) found that there was no difference in low-salt diet adherence between income groups ($\leq$ $46,000 versus > $46,000) among 141 African-American and non-Hispanic white individuals with hypertension.

One possible explanation for this relationship between income and low-salt diet adherence in the current study is that individuals who have a higher income may be more

likely to eat in restaurants, which tend to serve meals that are extremely high in sodium. One study reported that in a very ethnically-diverse sample of children and adolescents, those in the highest of three household income groups (>350% of poverty level) were significantly more likely to eat fast food than those in the lower two income groups (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004). Another study including 891 women, however, showed that within the lower income group, which was defined as ≤$25,000, women were significantly more likely to eat at fast food restaurants more frequently (average of 3.3 times per week) than infrequently (1 time per week or less) (French, Harnack, & Jeffery, 2000). This study did not test whether a similar trend existed in other income groups. Other studies have shown that more fast food eating has been related to higher income level (Paeratakul, Ferdinand, Champagne, Ryan, & Bray, 2003).

Regardless of the relationship between income and fast food eating, comparison of the publicly-available nutrition information for a fast food restaurant with a relatively upscale restaurant revealed that a fast food meal, surprisingly, is not necessarily less healthy in terms of sodium content. For example, the Grilled Chicken sandwich at McDonald's contains 1190 mg sodium and 420 calories, while the Blackened Chicken sandwich at the Cheesecake Factory contains a whopping 2440 mg sodium (1340 calories). Even the seemingly healthy Weight Management Grilled Chicken sandwich at the Cheesecake Factory has 1920 mg sodium (580 calories). Similarly, ordering the Southwest Salad with Grilled Chicken at McDonald's (960 mg sodium; 320 calories) would be a healthier choice than the Weight Management Asian Chicken Salad at Cheesecake Factory (2600 mg sodium; 570 calories). According to the calorie content of

these dishes, one might suspect that portions are much larger at the Cheesecake Factory, explaining the huge difference in sodium content. The portions might indeed be much larger at the Cheesecake Factory, but that alone cannot explain the much higher sodium content, especially since the sodium-to-calorie ratio is much larger for items at the Cheesecake Factory than for comparable items at McDonald's. The fast food champion, the Big Mac, seems rather harmless by comparison at 1040 mg sodium and 540 calories.

Another possible explanation of our findings is that those with higher income levels also likely are more educated, and those who are more educated are more likely to understand which foods are higher in salt. Our low-salt diet adherence measure simply asks the participant the extent to which she or he adheres to a low-salt diet, and it is uncertain whether the participant actually knows whether his/her diet is in fact low in salt. This measure may lack face validity; during an informal discussion with several cardiologists regarding the LSD measure items, they expressed a concern that their patients often do not understand what constitutes a low-salt diet and therefore, their responses to any such adherence measure may not accurately reflect their behavior. Future studies should include a measure assessing one's knowledge and understanding of what constitutes a low-salt diet. To this end, a very interesting study included 102 HF patients and also used the MOS-med and MOS-salt items to determine adherence to both medication and low-salt diet (Chung et al., 2008). In addition, they obtained objective adherence measures, including MEMS to test medication adherence over three months' duration and 24 hour sodium excretion in urine to objectively assess adherence to a low-salt diet. Patients who reported on the MOS items that they were adherent "all of the time" were identified as "adherent," while any other response placed a participant in the

"non-adherent" category for each of medication and low-salt diet. Regarding medication adherence, the self-reported "adherent" group had significantly higher rates of adherence according to MEMS than did the self-reported "non-adherent" group. Urinary sodium levels, however, did not differ between self-reported "adherent" and "non-adherent" groups. These results indicate that these patients accurately reported medication but not low-salt diet adherence. Study authors speculate that the patients may be more knowledgeable about what constitutes medication versus low-salt diet adherence.

Results from other studies, however, suggest that knowledge about one's regimen and health in general are not related to adherence. Heo, Lennie, Moser, and Okoli (2009) conducted a qualitative study including 14 men and 6 women with HF and found that 85% of them reported receipt of information about adopting a low-salt and low-fat diet, but still only 60% reported consistent adherence to either diet recommendation. Interestingly, though the patients generally understood that foods affect one's health, sodium was identified as significantly affecting one's health by only about half of the patients. In fact, more patients reported adhering to a low-fat diet than to a low-salt diet. Another very recent study including 275 mostly indigent, black women who endorsed low income and education levels found that health literacy—a measure of one's knowledge about general medical care—was not a significant predictor of self-reported adherence (Gatti, Jacobson, Gazmararian, Schmotzer, & Kripilani, 2009).

In summary, the finding that income level is negatively related to low-salt diet adherence is counterintuitive, but several factors might explain these results. Most notably, it is likely that individuals at a lower income level also have less education and knowledge about food choices consistent with adopting a low-salt diet. A major

limitation of this study is failing to include a health literacy or similar measure assessing knowledge about one's medical regimen. Though some studies have suggested that knowledge of one's prescribed regimen does not necessarily affect adherence, further examination of the relationship between one's understanding of what constitutes a low-salt diet and low-salt diet adherence is warranted.

BMQ scales did Not Moderate Relations of Psychosocial Variables with Adherence

Testing Hypothesis 3 using the method that was originally proposed with largely was unsuccessful due to model saturation and very unbalanced groups and low sample size. When interaction terms were tested as predictors, none were significant, indicating that neither the BMQ Necessity – Concerns differential nor the Harm+Overuse sum moderated the relationship of psychosocial variables with medication or low-salt diet adherence. The BMQ has not been tested formally as a moderator, though it has been argued that, theoretically, beliefs may influence these relationships (Antonuccio, Danton, & DeNelsky, 1995) and one study did show that beliefs moderated the associations between hostility and adherence to a medical regimen among patients undergoing renal dialysis (Christensen, Weibe, & Lawton, 1997). Researchers wishing to test the BMQ scales as moderators should test this hypothesis with much larger samples.

BMQ Generalizes to Predict Low Salt Diet Adherence

The current study's finding that the BMQ, a measure specifically designed to assess beliefs about *medicines* and predict *medication* adherence, generalizes to predict low-salt diet adherence—a lifestyle behavior—is also very intriguing. In fact, every BMQ item contains the word "medicines" and, therefore, clearly was designed to reflect one's beliefs about taking medication. Based on this study's results, then, it appears that a

measure designed specifically to assess beliefs about *medication* actually broadly reflects a general attitude toward adherence to other aspects of a medical regimen; in this case, low salt diet adherence. Similarly, some other researchers have reported that beliefs about medicines are related to adherence to other aspects of a medical regimen.

A study including 156 patients with diabetes reported that adherence to a diabetic diet was strongly associated with a belief conventional medicine is very useful (Garay-Sevilla, Malacara, Gonzalez-Parada, Jordan-Gines, 1998). In this study, belief in conventional medicine was assessed by questions that addressed several behaviors: frequency of seeking medical care when patients became ill, extent of confidence in their physicians' proficiency, perception of the amount of time medical care demanded from the patient, perception of cost of medical care, use of medical attention for prevention, and perception of the effectiveness of herbs and vegetables to cure diabetes. Another study including diabetic patients used the BMQ to assess beliefs about medicines among Tongan versus European individuals (Barnes, Moss-Morris, & Kaufusi, 2004). They found that the Tongan patients viewed medications as less necessary than did the Europeans and had significantly poorer control over their diabetes according to the HbA1c level, which arguably is influenced by many lifestyle practices, such as diet, in addition to medication adherence. This study further found that Tongan patients reported significantly worse diabetic diet adherence than did the European patients. These results imply that those who view medicines as unnecessary are less likely to adhere to a diabetic diet and other self-care behaviors that influence HbA1c level.

Interventions to Improve Medication Adherence among HF Patients

The results of the current study provide some evidence that health care providers should initiate a conversation with HF patients around their beliefs about medicines; specifically, whether they believe medicines are harmful or overused. Respondents in qualitative studies on patient-reported reasons for non-adherence have reported that their doctors simply scolded them if they reported having altered their medication regimen, and rather than disclose reasons for altering their regimen to their doctors, patients reported that they simply began seeing a different doctor (Roberson, 1992). Thus, unless doctors and other health care providers specifically address patient beliefs about medicines and reasons underlying their decisions, patients may never disclose reasons not only for stopping taking their medications but also for choosing to see another health care provider.

These results might inform future interventions that aim to improve adherence to medicines. Most interventions aimed at improving adherence tend to focus on demographic and/or medical regimen variables, such as providing special pill packaging to simplify the regimen, educational information related to the medicines themselves, and/or telephone calls to serve as reminders to take one's medicines. Rigorous, multidisciplinary nurse-conducted interventions characterized by an inpatient educational component prior to hospital discharge are successful in improving medication adherence rates and decreasing readmission rates among cardiac patients (Phillips, Singa, Rubin, & Jaarsma, 2005; Anderson, Deepak, Amoateng-Adjepong, & Zarich, 2005; Roccaforte, Demers, Baldassarre, Teo, & Yusuf, 2005). Such interventions, however, are fairly labor-intensive, and the less labor-intensive approaches (i.e., providing reminder cards/cues,

telephone calls, more frequent clinic visits) need to be sustained in order to effectively improve adherence (Phillips et al., 2005). In a review paper, 18 of 36 interventions reported in 30 different trials successfully improved adherence, though the effects were not large, and the interventions used in the successful trials did not reveal a particular type of intervention that would be most effective (McDonald, Garg, et al., 2002).

One can speculate that non-intervention factors, such as participant and/or medical regimen characteristics, may have played a role in the significant findings. Thus, though some interventions did result in moderate improvements in adherence, it is unclear which types or aspects of interventions might be most effective. Further, successful interventions generally are complex, laborious, and expensive, which may be unsustainable and/or impossible for some medical practices (Naylor et al., 1994; Rich et al., 1995; Fonarow et al., 1997; Hunt et al., 2002).

Interventions to improve adherence specifically among HF patients show mixed results. One study testing an intensive support and education intervention did not result in increased knowledge of one's regimen, improved decision-making abilities, or increased adherence to self-care behaviors (Jaarsma, Abu-Saad, Dracup, & Halfens, 2000). An educational intervention that consisted of pharmacist provision of written instructions to HF patients demonstrated success in that it resulted in improved adherence to medications and reduced healthcare cost and use, but these improvements dissipated when the intervention ended (Murray et al., 2007). A review on interventions among HF patients concluded that educational programs alone do not positively affect adherence to self-care behaviors (Evangelista & Shinnick, 2008); this has been concluded by other researchers as well (Cline et al., 1999; Ni et al., 1999; Wang et al., 2002; Schweitzer,

Head, & Dwyer, 2007). One reason educational programs especially at the outset of initiating a HF medical regimen may not be effective in improving adherence is because problems with and concerns about medications often arise over time as the patient gains experience taking the medication (Pound et al. 2005).

In summary, we do not yet know which or even whether specific aspects of interventions among HF patients are effective, and the literature on patients with hypertension also does not reveal specific intervention strategies that are consistently effective in improving adherence in a cost-effective, enduring manner. Though further research is needed, the current study and other studies have demonstrated that identifying patients' beliefs about medication and self-care regimens may be an important aspect of counseling patients about their HF regimen (Ekman et al., 2006). Authors of a review paper on the current state of adherence assert that failings of doctors, patients, or the medical systems are not necessarily to blame; rather, patients make decisions about their adherence due to concerns about the medicines (Pound et al., 2005). The current study's results provide additional evidence that discussion of patients' beliefs about medicine and low-salt diet adherence might improve adherence.

Standard of Care for HF

Standard of care for the HF patient demands that the health-care provider emphasize and explain several self-care behaviors such as medication and fluid management (monitoring of weight and symptoms of volume overload), diet, exercise, assessing signs of deteriorating functioning, reduction of sodium intake, limiting daily activities that cause HF symptoms, and following-up with healthcare providers (Albert, 2008; Hunt et al., 2005b). Unfortunately, health care providers may forget to emphasize

the importance of these self-care behaviors. By the very nature of self-care, however, it is considered to be the responsibility of the patient rather than the health care provider. In fact, self-care is defined as "…specific behaviors that individuals initiate and perform on their own behalf, with the intention of improving health, preventing disease, or maintaining their well-being" (Orem, 2001). Thus, many discussions around the execution or lack of self-care behaviors may never enter into the clinical appointment.

Creating interventions for promotion of self-care behaviors in HF is very challenging because it is unclear specifically which aspects of interventions or standard care aimed at improving self-care are *the* aspects that result in improved clinical outcomes. One reason for this great challenge is partially because HF management involves a very complicated regimen (Albert, 2008). Another reason for the uncertainty of how aspects of interventions affect self-care behaviors and subsequent clinical outcomes is due to a dearth of valid measures assessing self-care behaviors following doctors' promotion of these behaviors (ACC/AHA, 2005; Albert, 2008). Such outcome measures that do exist tend to focus on the quality of provision of HF education by health care practitioners and neglect to address patient-specific factors, such as understanding and knowledge of one's regimen, possibly underlying self-care behaviors (ACC/AHA, 2005).

Provider compliance regarding how frequently health care providers explain and emphasize self-care behaviors appears to be low, which complicates studies examining patient adherence to self-care behaviors (Fonarow et al., 2007). Further, it appears that perhaps low-salt diet recommendations actually *should not* be exactly the same for every HF patient, and providers may be confused as to what exact amount of daily sodium

should be ingested per patient. For example, recent studies have revealed that low-salt diet recommendations may depend upon whether the patient is taking certain medications, such as loop diuretics (Albert, 2008). Further, a study including compensated HF patients revealed that those patients who followed a normal sodium diet had significantly *reduced* hospital readmissions, while those who followed a low-sodium diet had significantly increased aldosterone and plasma renin levels 6 months after being randomized to these diets, which suggests that renal and neurohormonal systems were adversely affected by sodium depletion (Paterna, Parrinello, Fasullo, Sarullo, & Di Pasquale, 2008). Other evidence that further confuses diet recommendations is that NYHA class may moderate the association between sodium intake and clinical outcomes. In one study, among patients in NYHA classes III and IV, clinical outcomes (i.e., event-free survival) were more favorable in the group following a 3-gram sodium diet versus a higher-sodium diet. Among those in NYHA classes I or II, however, clinical outcomes did not differ between the group following the 3-gram sodium diet and the group following the higher-sodium diet (Lennie, Chung, Heo, Dekker, & Moser, 2007).

Similarly, though it may appear relatively simple, medication prescription may not be so straightforward either. For example, though diuretic therapy is recommended to promote volume loss in HF (HSFA, 2006; Hunt et al., 2005b, Arnold et al., 2006; Nieminen et al., 2005), its dosing has never been standardized for HF patients who are acutely decompensated (Ezekowitz et al., 2009). In the course of a HF patient's lifetime of managing this complicated condition, the patient likely will be hospitalized several times, and multiple hospitalizations alone imply that the patient will consult many different health care providers. In addition, a HF patient is likely to see different doctors

in various health care clinics such as primary care, emergency departments, and/or cardiology specialty clinics. Given the lack of consistent guidelines and clinical outcomes related to the HF regimen, and inconsistent recommendations by doctors by the above and other studies (Riegel, Moser, Powell, Rector, & Havranek, 2006), it would not be surprising if HF patients, on the whole, receive inconsistent instructions about their medical regimen throughout their lifetime. Such inconsistency and confusion very likely would contribute to inconsistent and lower-than-ideal adherence to both medication and low-salt diet. Future researchers investigating factors that relate to adherence among HF samples may wish to incorporate in their assessment battery a measure of the consistency of medical regimen recommendations received by the patient.

Strengths of the Current Study

This study is characterized by its great participant diversity; thus, these results can be generalized across socioeconomic and ethnic groups and both genders. Also, compared to other HF samples, these participants were fairly young in age and spanned a wide range of ages; thus, report of their behavior and overall well-being is unlikely to be influenced by non-HF conditions common among elderly individuals such as impaired cognitive function and relative psychomotor retardation and fatigue.

This study used well-established psychosocial and self-report adherence measures and included numerous demographic and medical control variables that frequently are not included as controls in other studies investigating correlates of adherence. Including many and varied controls helps to ensure that the results were not confounded by other variables affecting adherence. Including the BMQ—an innovative, well-established measure reflective of Leventhal's theories on underlying influences of human behavior—

as a predictor of adherence was also a strength. No studies to date among HF samples have shown that beliefs about medicine as measured by the BMQ are related to adherence to medicines or to other aspects of the HF medical regimen. Many studies examining predictors of adherence in other patient samples, such as HIV/AIDS, have demonstrated the predictive utility of the BMQ. The current study adds to this literature by elucidating one of many possible strong influences of adherence among individuals with chronic illnesses.

Another strength of this study is its statistical strategy; specifically, use of SEM. SEM requires that reliable and valid measures be used to create latent variables, especially when those latent variables are designated as dependent variables in the model. Further, SEM requires that all indicators loading onto a certain latent variable share a great deal of variance to explain the underlying construct; in this case, adherence. The current study's use of measurement models to create a single latent variable of both medication and low-salt diet adherence is a much more sophisticated statistical technique than that used by other researchers, whose measures of adherence generally are administered only once in the participant sample. This technique helps to ensure that the outcome measures are reliable over time and also reflect a single construct.

Another strength of using SEM is that analyses can be completed including all participants even if data is missing, while other statistical methods, such as multiple regression, require that researchers solve missing data problems by using techniques such as listwise deletion that typically result in biased parameter estimates (Tomarken & Waller, 2005). Since a great deal of data was missing in the current study, very likely due to attrition in the parent study, full information maximum likelihood (FIML) was used

when conducting analyses, which allows for parameter estimation from an incomplete data set. It is clear that missing data is due to attrition through the first four assessments in the parent study, as the proportion of complete data decreased from baseline through time 4 for the MOS-salt item (1.00, 0.88, 0.74, and 0.40, respectively) and the MOS-med item (0.99, 0.85, 0.73, 0.39, respectively).

Most notably, there was a nearly 60% response rate in the follow-up study from parent study participants, which is greater than that of the 4th time point in the parent study. Apparently, then, many participants from the parent study chose to complete the current study assessment battery but chose not to complete the battery at other time points, especially the 3rd and 4th assessments in the parent study. Reasons for this are uncertain, but financial incentive alone would not have motivated current study participants to complete the current battery, as the reimbursement for the current battery was identical to that of each assessment in the parent study. It is possible that passage of time influenced participation in the current study, as the parent study assessments took place in 6-month increments, while the current battery was completed up to three years after completion of parent study participation. Perhaps participants are more willing to complete repeat-measure assessments after a greater amount of time has passed since the last assessment.

Limitations and Suggestions for Future Studies

Though a strength in terms of external generalizability, the heterogeneity of this sample may not have been advantageous with regard to utility of the proposed latent variable. Based on the work of other researchers who loaded different behaviors onto a single latent variable, future studies aiming to create such latent variables might benefit

from inclusion of more homogeneous samples and/or samples with a large number of participants. Researchers who do have ethnically-diverse samples may wish to test whether ethnicity moderates relationships between person-specific characteristics and adherence, as it is possible that the different belief systems of different cultures differentially influence behaviors. The very small current study sample size is a very likely reason why the moderation analyses as proposed could not be completed, as the groups for each BMQ scale were extremely unbalanced and one of the groups necessarily consisted of a very small number of participants. Another limitation is that our data are cross-sectional, thus limiting ability to establish causality of adherence by psychosocial and personality measures. Future studies would benefit from testing psychosocial and BMQ scale predictors of adherence in a longitudinal fashion.

In general, a major limitation of the study is that the measures were all self-report, which can be especially problematic when studying adherence. Future studies should include objective measures, such as MEMS, as well as self-report measures. Compared with objective measures, overestimating adherence is much more likely when it is self-reported (Cramer, Mattson, Pervey, Scheyer, & Oulette, 1989), and self-report measures also are influenced by social desirability (Holtgraves, 2004; Stafford, Jackson, & Berk, 2008). One study, however, reported that there was no relationship between social desirability and self-reported adherence (Pearson, Simoni, Hoff, Kurth, & Martin, 2007). Further, it is possible that self-report measures are nearly as reliable as objective measures due to their inherently high specificity, as patient admission of non-adherence likely is the truth (Stephenson et al., 1993). Another consideration regarding the influences of social desirability is that such influences likely are most salient when face-

to-face interviews are conducted with research participants; whereas in our study, participants completed the questionnaires themselves without an interviewer present.

This study did not find a relationship between social support and adherence, contradicting several other studies, possibly because the social support measure used in this study was a single measure of global social support. Future studies might test whether different types of social support (i.e., tangible, emotional) are differentially related to adherence. Another measure that might benefit future studies is a measure of health knowledge or literacy, as it is quite possible that, especially regarding adherence to a low-salt diet, patients may not understand which foods are low in salt and erroneously believe that they are indeed adhering to a low-salt diet when that really is not true. Though studies are not yet conclusive regarding the influence of knowledge and/or education level on adherence, future studies might include a measure assessing one's knowledge and understanding of what constitutes a low-sodium diet. Finally, results from the current study and other studies suggest that locus of control may underlie adherence, and studies testing predictors of adherence among HF patients also may wish to examine whether locus of control is related to medication and/or low-salt diet adherence.

The finding that the Necessity – Concerns differential was significantly related to adherence only when the Harm+Overuse sum was included in the model might be viewed as a limitation. Exploratory analyses suggested that the Harm+Overuse sum effectively removes the "noise" in the BMQ Concerns subscale, which results in a significant relationship between the Necessity – Concerns differential and low-salt diet adherence. Future studies examining predictors of adherence to diet or another behavior might prefer

to ignore the influence of the BMQ Concerns scale, and instead include simply the BMQ Necessity subscale as a predictor.

Clinical Implications

Clinicians might use these findings to inform their clinical practice as they assess whether their patients are adherent to medication and/or a low-salt diet. As research suggests, clinicians should be encouraged to address patient concerns related to aspects of a medical regimen; often, patients may be harboring concerns about their medical regimen yet hesitate to raise these concerns during the clinical appointment. These results also provide evidence that adherence to different aspects of a medical regimen are likely not due to a single underlying factor, whether that be demographic, medical, psychosocial, or belief system. Rather, it appears based on the current study's findings that psychological (i.e., depression) and personality traits (i.e., hostility/cynicism) may help explain adherence to medicines, but not to diet. Further, adherence to medicine may be influenced by one's beliefs regarding perceived harm of medicines and/or perceived overuse of medicines by providers, while adherence to diet appears to be related to one's perceived need for a healthy diet. Also, these findings suggest that locus of control may help explain adherence to medicine, but not necessarily to diet.

Thus, if confronted with a HF patient who is not adhering to medicines, a clinician might use the current study's findings by reviewing symptoms of depression with the patient and initiating a conversation about the patient's beliefs related to medicines. Similarly, if a patient seems to have difficulty adhering to a low-salt diet, a clinician might initiate a conversation around the extent to which the patient believes a low-salt diet is necessary for HF management and overall health. Thus, results suggest

that very different factors help explain adherence to different aspects of a HF medical regimen and provide clinical insight for addressing adherence issues with HF patients.

Summary

The current study aimed to determine which of several demographic, medical, psychosocial, and beliefs about medicines variables were related to a single latent variable of "adherence;" comprised of four different measures assessing both medication and low-salt diet adherence. Using SEM, a very sophisticated statistical technique, the study failed to create an acceptable latent variable "adherence." Instead, a widely-used measure of medication adherence, the MAS, was used as the outcome variable to test whether certain demographic, medical and psychosocial variables, and beliefs about medicines predicted medication adherence. Results showed that depression, hostility, and having a tendency to believe that medicines are harmful and/or overused were significantly related to lower medication adherence.

Next, using SEM, it was revealed that low-salt diet adherence, but not medication adherence, was a fairly stable behavior in this HF sample, and a latent variable comprised of five low-salt diet assessments was created and deemed adequate as an outcome variable. Hypothesis testing revealed that not any of the three psychosocial measures were related to low-salt diet adherence, but higher age, lower income level, and lower number of co-morbid diseases were all significantly related to better low-salt diet adherence. Further, a belief that medicines were necessary despite having concerns about them was related to better adherence to a low-salt diet. Despite study limitations, these results can inform clinicians as they address reasons underlying adherence issues to a HF

regimen and provide ideas for future research on predictors of adherence and potential interventions aiming to improve adherence among HF patients.

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Table 1

Means, standard deviations, and percentages of participant demographics, medical characteristics, and psychosocial variables

Study variable	Mean (SD); [scale range]/percentage
Age	57.38 (10.75)
Ethnicity	
Caucasian	25%
Black	28%
Hispanic	43%
Other	4%
Gender	
Male	62%
Female	38%
Income	
<$16K	43%
$16K-$35K	23%
>$35K	34%
Education level	
High school or less	51%
Some college	30%
College degree	19%
NYHA	
I	22%
II	45%
III	32%
IV	1%
Ejection Fraction	28.70 (13.95)
Number of medications	8.10 (2.85)
Number of co-morbid diseases	1.92 (1.67)
Months since diagnosed with CHF	87.56 (63.17)
Depression	19.00 (15.09); [0 – 60]
Social Support	69.82 (21.44); [19 – 95]
Hostility	20.54 (5.70); [9 – 36]
Necessity-Concerns differential	-6.43 (6.04); [-20 – 20]
Harm+Overuse sum	28.43 (6.42); [8 – 40]
MAS (Morisky Adherence Scale)	18.04 (2.24); [4 – 20]
LSD (Low-salt diet) scale	37.36 (6.32); [10 – 50]
MOS medication adherence item	5.56 (1.17); [0 – 6]
MOS low salt diet adherence item	4.64 (1.58) [0 – 6]

Table 2

Measurement Models for the MOS Medication adherence item and MOS low salt diet item

MOS item and time points of assessments	β (SE)
MOS Medication adherence item	
Baseline parent study	.72 (.20)***
6-month parent study	.45 (.15)**
12-month parent study	.37 (.16)*
18-month parent study	.11 (.21)
Current study	.29 (.15)*
MOS low salt diet adherence item	
Baseline parent study	.47 (.10)***
6-month parent study	.77 (.08)***
12-month parent study	.70 (.08)***
18-month parent study	.84 (.08)***
Current study	.56 (.10)***

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

Table 3

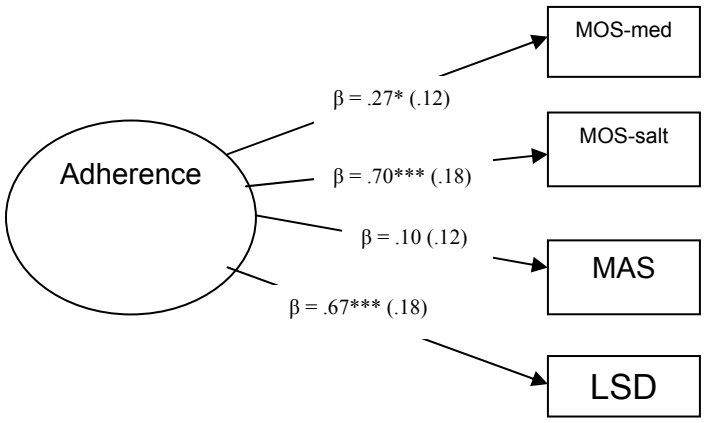
Bivariate correlations and one-way ANOVAs of the relationships between each MOS-salt item assessment and control variables

Control variables	MOS-salt baseline parent study	MOS-salt 6-month parent study	MOS-salt 12-month parent study	MOS-salt 18-month parent study	MOS-salt current study
Age	r = .19**	r = .32***	r = .32***	r = .42***	-
Income	F (92) = 3.13**	F (82) = 9.49***	F (69) = 3.58**	F (38) = 3.39*	F (89) = 2.54*
Education level	F (102) = 2.63*	-	-	-	-
Ethnicity	-	F (88) = 3.05**	-	F (38) = 6.24***	-
Questionnaire language	-	F (90) = 8.35***	-	F (40) = 4.80**	-
EF	-	r = -.18*	-	r = -.28*	-
Number of medications	-	-	r = .19*	-	-
Number of co-morbid diseases	r = -.20**	r = -.18*	-	-	-

*$p \leq .10$; **$p \leq .05$; ***$p \leq .005$

Figure 1

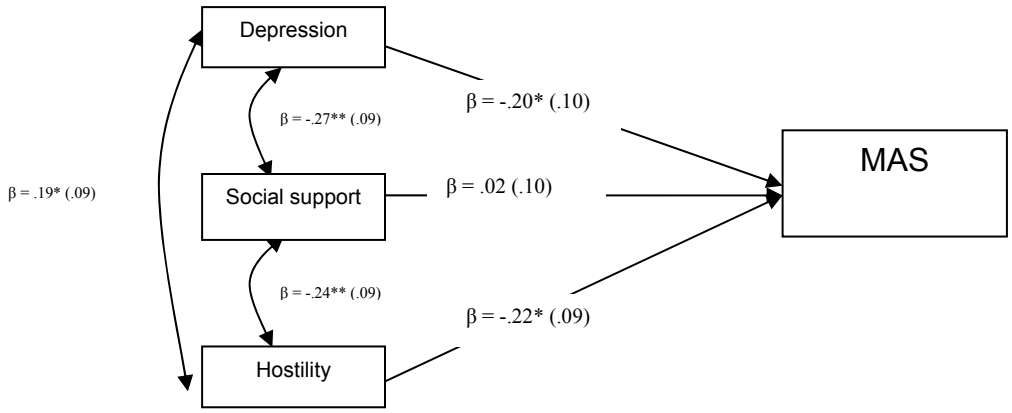
Standardized coefficients (and standard errors) of all loadings of the proposed measurement model of Adherence



***$p \leq .001$, **$p \leq .01$, *$p \leq .05$

Figure 2

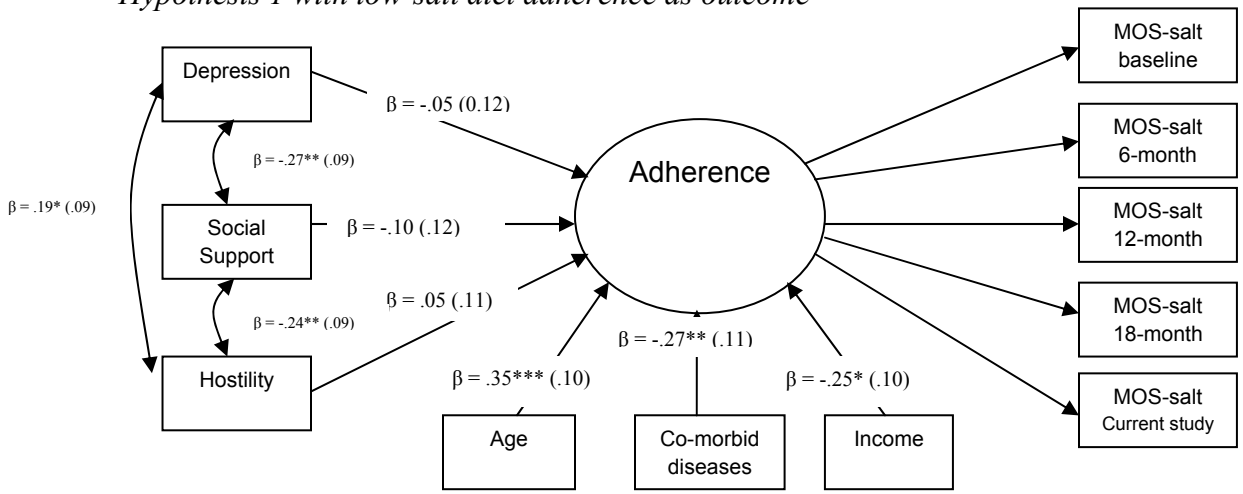
Standardized coefficients (and standard errors) of all paths and covariances for testing Hypothesis 1 with the MAS as outcome



***$p \leq .001$, **$p \leq .01$, *$p \leq .05$

Figure 3

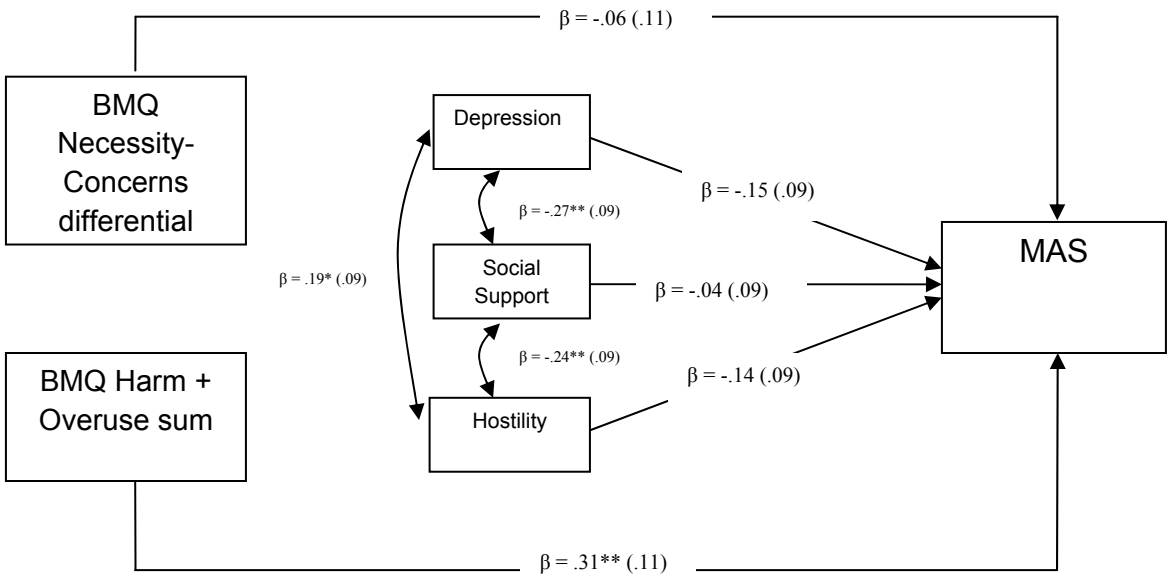
Standardized coefficients and standard errors of all paths and covariances for testing Hypothesis 1 with low-salt diet adherence as outcome



***$p \leq .001$, **$p \leq .01$, *$p \leq .05$

Figure 4

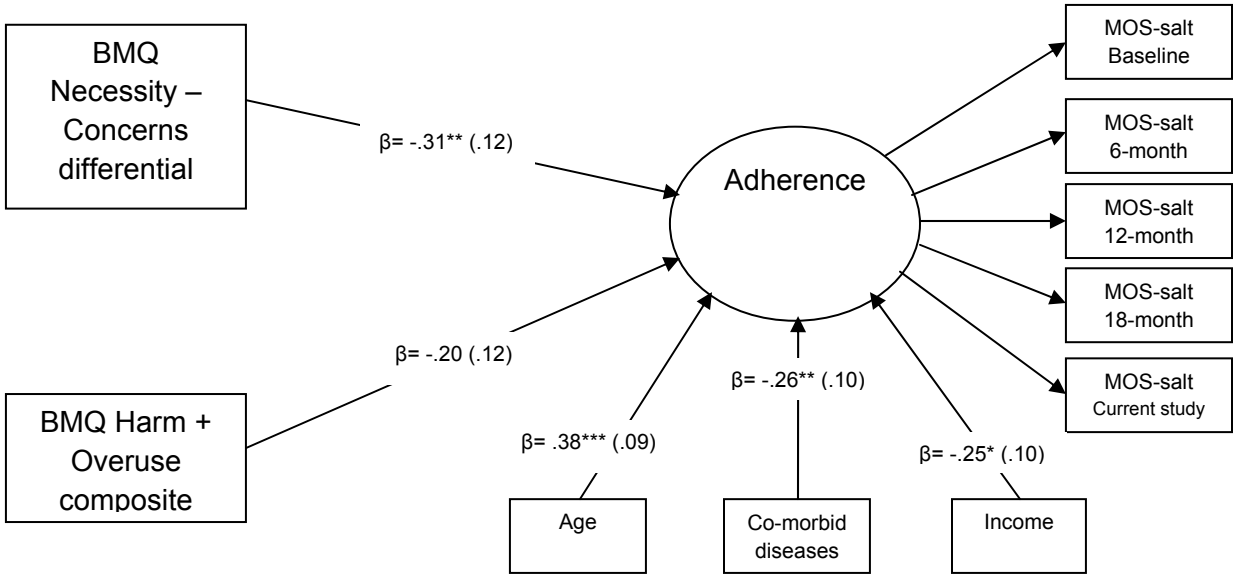
Standardized coefficients and standard errors of all paths and covariances for testing Hypothesis 2 with the MAS as outcome



***$p \leq .001$, **$p \leq .01$, *$p \leq .05$

Figure 5

Standardized coefficients and standard errors of all paths and covariances for testing Hypothesis 2 with low-salt diet adherence as outcome

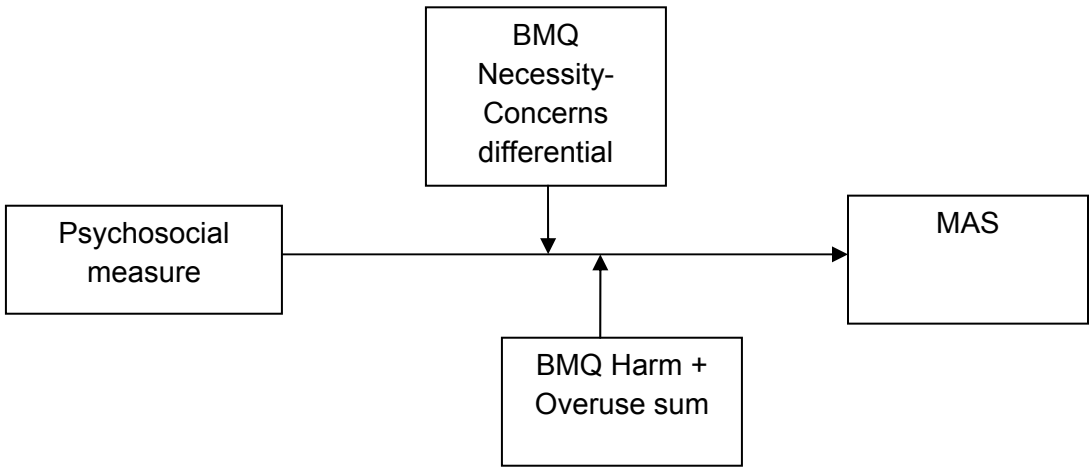


***$p \leq .001$, **$p \leq .01$, *$p \leq .05$

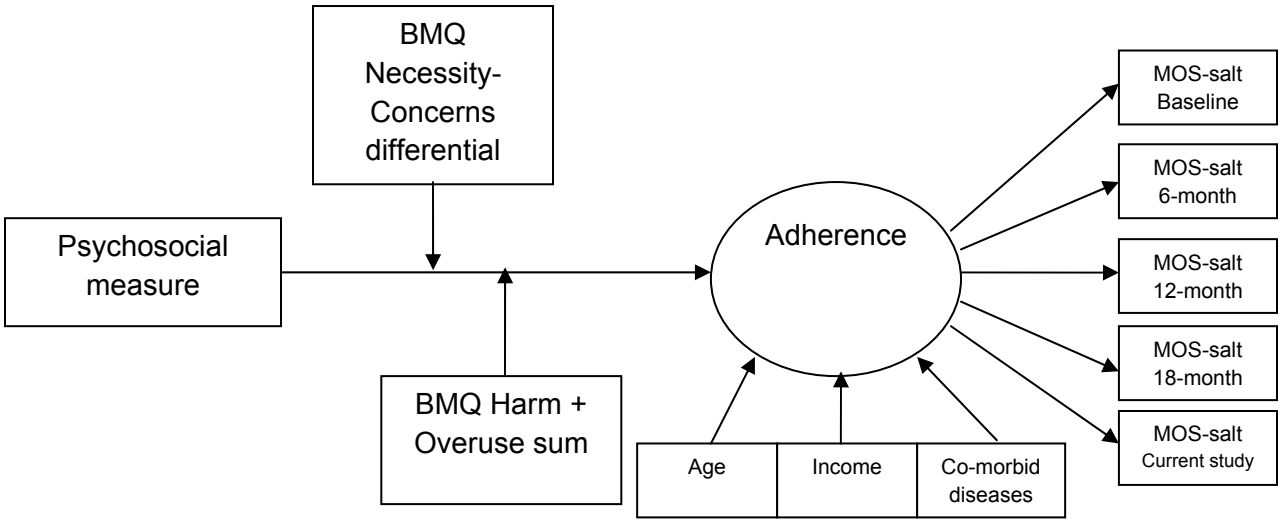
Figure 6

Structural models for testing Hypothesis 3 for a) the MAS as outcome and b) low-salt diet adherence as outcome

a)



b)



Note. Each of depression, social support, and hostility will be tested one at a time as the predictor "Psychosocial measure" with each of the BMQ scales tested one at a time as a moderator in both models "a" and "b".

***$p \leq .001$, **$p \leq .01$, *$p \leq .05$

Appendix

MAS

In the past 2 weeks:	Never	Rarely	Sometimes	Often	Always
Did you ever forget to take your medication?					
Were you careless at times about taking your medication?					
When you felt better, did you sometimes stop taking your medication?					
Sometimes, if you felt worse when you took your medicine, did you stop taking it?					

LSD

	never	rarely	sometimes	often	always
1. When shopping for groceries, I avoid buying foods that are salty (high in sodium).					
2. I do not eat foods with salt on them (i.e., chips, pretzels).					
3. I am confident I understand which foods are high in salt.					
4. I pay attention to food labels where I can find if they have a lot of salt/sodium					
5. My spouse's or children's food preferences make it difficult to avoid eating salty foods.					
6. I use herbs and spices to flavor my food rather than salt or other seasonings with a lot of salt (e.g., sauces).					
7. When eating in a restaurant, I am careful to avoid eating salty foods.					
8. I do not add more salt to my food.					
9. When shopping, when both regular and low-salt/sodium versions are available (e.g., canned soup, corns, etc.), I will buy the low-sodium ones.					
10. I use cookbooks or recipes for low-sodium cooking.					

CESD-R

Below is a list of **the ways you may have been feeling or behaving**. Please check the boxes to indicate how often you have felt this way **in the past 2 weeks**.

	Last Week				Nearly every day for 2 weeks
	Not at all or less than 1 day	1 to 2 days (or some of the time)	3 to 4 days (or medium amount of time)	5 to 7 days (or most of the time)	
1. My appetite was poor.	0	1	2	3	4
2. I could not shake off the blues.	0	1	2	3	4
3. I had trouble keeping my mind on what I was doing.	0	1	2	3	4
4. I felt depressed.	0	1	2	3	4
5. My sleep was restless.	0	1	2	3	4
6. I felt sad.	0	1	2	3	4
7. I could not get going.	0	1	2	3	4
8. Nothing made me happy.	0	1	2	3	4
9. I felt like a bad person.	0	1	2	3	4
10. I lost interest in my usual activities.	0	1	2	3	4
11. I slept much more than usual.	0	1	2	3	4
12. I felt like I was moving too slowly.	0	1	2	3	4
13. I felt fidgety (could not sit still).	0	1	2	3	4
14. I wished I were dead.	0	1	2	3	4
15. I wanted to hurt myself.	0	1	2	3	4
16. I was tired all the time.	0	1	2	3	4
17. I did not like myself.	0	1	2	3	4
18. I lost a lot of weight without trying.	0	1	2	3	4
19. I had a lot of trouble getting to sleep.	0	1	2	3	4
20. I could not focus on the important things.	0	1	2	3	4

MOS-SS

People sometimes look to others for companionship, assistance, or other types of support. How often is each of the following kinds of support available to you if you need it?

		None of the time	A little of the time	Some of the time	Most of the time	All the time
2	Someone to help you if you were confined to bed	1	2	3	4	5
3	Some one you can count on to listen to you when you need to talk	1	2	3	4	5
4	Someone to give you good advice about a crisis	1	2	3	4	5
5	Someone to take you to the doctor if you need it	1	2	3	4	5
6	Someone who shows you love and affection	1	2	3	4	5
7	Someone to have a good time with	1	2	3	4	5
8	Someone to give you information to help you understand a situation	1	2	3	4	5
9	Someone to confide in or talk to about yourself or your problems	1	2	3	4	5
10	Someone who hugs you	1	2	3	4	5
11	Someone to get together with for relaxation	1	2	3	4	5
12	Someone to prepare your meals if you were unable to do it yourself	1	2	3	4	5
13	Someone whose advice you really want	1	2	3	4	5
14	Someone to do things with to help you get your mind off things	1	2	3	4	5
15	Someone to help with daily chores if you were sick	1	2	3	4	5
16	Someone to share your most private worries and fears with	1	2	3	4	5
17	Someone to turn to for suggestions about how to deal with a personal problem	1	2	3	4	5
18	Someone to do something enjoyable with	1	2	3	4	5
19	Someone who understands your problems	1	2	3	4	5
20	Someone to love and make you feel wanted	1	2	3	4	5

GREENGLASS

Please read each of following statements and decide **how much you agree** with each statement. Circle the appropriate number (1-4) that best applies to you.

		Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
1.	I think most people would lie to get ahead.	**1**	**2**	**3**	**4**
2.	Most people are honest chiefly through fear of being caught.	**1**	**2**	**3**	**4**
3.	Most people will use somewhat unfair means to gain profit for an advantage rather than to lose it.	**1**	**2**	**3**	**4**
4.	I commonly wonder what hidden reason another person may have for doing something nice for me.	**1**	**2**	**3**	**4**
5.	No one cares much what happens to you.	**1**	**2**	**3**	**4**
6.	It is safer to trust nobody.	**1**	**2**	**3**	**4**
7.	Most people make friends because friends are likely to be useful to them.	**1**	**2**	**3**	**4**
8.	Most people inwardly dislike putting themselves out to help other people.	**1**	**2**	**3**	**4**
9.	When a man is with a woman he is usually thinking about things related to her sex.	**1**	**2**	**3**	**4**

BMQ

Please indicate to what extent you agree or disagree with the following statements:

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
1. My health at present depends on medicines.	1	2	3	4	5
2. My life would be impossible without medicines.	1	2	3	4	5
3. Without medicines, I would be very ill.	1	2	3	4	5
4. My health in the future will depend on medicines.	1	2	3	4	5
5. Medicines protect me from becoming worse.	1	2	3	4	5
6. Having to take medicines worries me.	1	2	3	4	5
7. I sometimes worry about long-term effects of medicines.	1	2	3	4	5
8. Medicines are a mystery to me.	1	2	3	4	5
9. Medicines disrupt my life.	1	2	3	4	5
10. I sometimes worry about becoming too dependent on medicines.	1	2	3	4	5
11. Most medicines are addictive.	1	2	3	4	5
12. People who take medicines should stop their treatment for awhile every now and again.	1	2	3	4	5
13. Medicines do more harm than good.	1	2	3	4	5
14. All medicines are poisons.	1	2	3	4	5
15. Doctors use too many medicines.	1	2	3	4	5
16. Doctors place too much trust on medicines.	1	2	3	4	5
17. If doctors spent more time with patients, they would prescribe fewer medicines.	1	2	3	4	5
18. Natural remedies are safer than medicines.	1	2	3	4	5

Subscales:

Items 1-5: Specific Necessity
Items 6 – 10: Specific Concerns
Items 11-14: General Harm
Items 15-18: General Overuse