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Psychosocial Variables and Recovery from Coronary Artery Bypass Graft Surgery in Men and Women

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Psychosocial Variables and Recovery from Coronary Artery Bypass Graft Surgery in Men and Women

by

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Abstract

Coronary artery bypass graft surgery (CABG) is performed to improve impairing coronary artery disease (CAD). Although there is interest in how psychosocial factors impact CABG surgery recovery, little research has investigated psychological and social variables in combination in predicting long-term outcomes following CABG surgery. This dissertation examines the association of depression symptoms and social variables with long-term post-CABG outcomes: life function impairment in social and occupational areas (FI), mortality and morbidity. We hypothesize perceived social support will buffer the association between depression symptoms and outcome and associations may differ for men and women. This prospective, observational, single site study recruited 296 (42% female) post-CABG patients of whom 241 (81%; 44% female) participated at one-year follow-up. Depression symptoms, perceived social support, marital status, household responsibility and life function were assessed by self-report questionnaires in-hospital post-CABG and again one-year later. Mortality and CAD procedures were collected over 12 – 15 year follow-up. In adjusted models, greater baseline depression symptoms, lower perceived social support, lower household responsibilities, and not being married predicted greater one-year FI ($R^2=.20$, $p<.001$). Baseline social support buffered the association between depression and FI in women ($b=.14$; 95%CI [.04, .23]) and more strongly predicted one-year FI for women ($b=.29$; 95%CI [.06, .52]). Long-term survival was also associated with one-year psychosocial measures. A one SD increase in depression symptoms led to greater hazard of mortality only at mean (HR = 1.67; 95% CI [1.21, 2.26]) and high social support (HR = 2.23; 95% CI [1.46, 3.40]). Additively, over the five years after follow-up, being married, greater household responsibility and better life functioning were also associated with improved survival. Regarding CAD procedures, only one-year depression
symptoms and life function impairment were associated with greater odds of CAD procedure. Overall, this dissertation supports associations of depression symptoms, social variables and life function with long-term outcomes from CABG surgery. Results suggest perceived social support may be more important for women’s functional outcomes, while depression symptoms and being married with more household responsibilities may be important for men and women. Further, results suggest research should investigate timing of interventions for depressed mood and poor social support.
Preface

This dissertation is composed of two manuscripts prepared for publication. Each is included as a chapter. The first has been submitted, and is under review. For both works, the dissertation author prepared the data, planned and undertook the analyses, interpreted the results, and wrote the manuscripts. This process was supervised and guided by Drs. Linden and Campbell. Drs. Linden, Con and Ignaszewski planned and developed the original study, while Dr. Con, who had not yet received her PhD, served as project manager. The dissertation author (S. Young) recruited and ran the participants, as a research assistant, under the supervision of Dr. Con. Dr. Linden planned the process to gain long-term follow-up data and he and the dissertation author underwent the process to gain these data. All authors contributed intellectual content to the manuscripts and provided critical reviews.

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I would also like to acknowledge financial support for this project from the Heart and Stroke Foundation of British Columbia. Without their support this project would not have been possible. As well, I want to thank the many participants who made the effort and took the time to be part of this research. I know participating in this study during the stressful period following heart surgery was not always easy. I also know each of these individuals only participated because they wanted to help others going through similar surgeries.

I would be greatly remiss if I didn’t thank my family and friends. Without you I would not have been able to pursue my goals and finish this. To my children, Ella, Alex and Zachary, thank you for giving me the time to work on something for myself and thank you also for distracting me and taking me on great adventures every day. I want to especially thank my husband, Matt, who always helps bring me back to earth when my mind begins to rocket away. You have encouraged me, supported me, and grounded me. I do not know how I would have kept going without you. To my classmates at The University of British Columbia, and The
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Dedication

I dedicate this thesis to Matt, Ella, Alex and Zachary.
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<td>Coronary Artery Bypass Graft</td>
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<td>WHYMPI</td>
<td>West Haven Yale Multidimensional Pain Inventory</td>
</tr>
<tr>
<td>MDD</td>
<td>Major Depressive Disorder</td>
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<td>LR</td>
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Epigraph

A physician is obligated to consider more than a diseased organ, more than even the whole man - he must view the man in his world.

Harvey Cushing (1869-1939)

Statement by Dubos, René (1965), that Cushing, Harvey “is reported to have taught”, in Man Adapting, New Haven, CT.: Yale University Press. (p. 342)
Chapter One: Introduction and literature review

1.1 Introduction

Disease is best understood by examining biological, psychological and social indices together. Studying medical disease in isolation from a person’s emotional well-being and social context may ignore important contributors to health and illness. Patients with cardiac disease define their cardiac health and quality of life by means of their ability to function well in multiple domains (Prince et al., 2007; Salvador-Carulla & Garcia-Gutierrez, 2011).

Coronary artery disease (CAD) is the leading cause of mortality and morbidity globally (WHO, 2009). In Canada, each year 65 out of every 100,000 people undergo coronary artery bypass graft surgery (CABG) to improve cardiac blood flow, with approximately one-quarter of those being women (Canadian Institute for Health Information, rates of procedures, downloaded May 6, 2013). Given the success of medical and surgical interventions CAD, there is great interest regarding which contextual variables, such as psychosocial variables, may play a role in informing outcomes from treatments such as CABG surgery. Research has most notably investigated the association between depression and its symptoms, and mortality and morbidity outcomes following CABG surgery, finding a positive relationship (Blumenthal et al., 2003; Burg, Benedetto, & Soufer, 2003; Connerney, Shapiro, McLaughlin, Bagiella, & Sloan, 2001; Connerney, Sloan, P., Bagiella, & Seckman, 2010; Oxlad,Stubberfield, Stuklis, Edwards, & Wade, 2006a; Peterson et al., 2002; Phillips-Bute et al., 2008; Rafanelli, Roncuzzi, & Milaneschi, 2006). Among other psychosocial constructs, additional research supports associations of poorer post-CABG long-term mortality with anxiety symptoms (Székely et al., 2007), loneliness (Herlitz et al., 1998), not being married (Idler, Boulifard, & Contrada, 2012;
King & Reis, 2012) and poor marital satisfaction (King & Reis, 2012). Arguably, given a goal of CABG surgery is to decrease angina pain and thus increase people’s ability to function, endpoints such as functioning seem equally important to mortality and morbidity. Research has associated depressed mood and social isolation with poorer long-term physical function after CABG surgery and myocardial infarction (MI) (Goyal, Idler, Krause, & Contrada, 2005; Kendel, Dunkel, Muller-Tasch, et al., 2011; Leifheit-Limson et al., 2010). Additionally, poor physical function is associated with increased mortality rates after CABG surgery (Koch et al., 2007). Although it is clear that psychosocial variables are related to physical function and this is related to later survival, it seems crucial to investigate not only outcomes such as physical disability, morbidity and mortality, but also people’s ability to function in their lives after CABG surgery. Ability to function in work, social, recreational and family areas is pertinent to quality of life and research is lacking in this arena.

Given the range of psychosocial variables associated with CABG surgery outcomes, further attention should be paid to how these variables may act together. Additionally, although inter-relations among these psychological and social variables have been postulated, little research has investigated these relationships in patients experiencing CABG surgery. For example, social support is thought to buffer the effects of negative affect (Cohen & Wills, 1985). This has been supported in patients who have suffered an MI (Frasure-Smith et al., 2000). In this sample social support moderated the association between baseline depression symptoms and later mortality, but this buffering relationship has not been investigated in patients following CABG surgery. Given the interest in the associations between psychosocial variables and outcomes from CABG surgery and the interrelationships among psychosocial variables, investigation of their joint influence is of interest. Furthermore, although associations among
psychosocial variables and post-CABG surgical outcomes have been investigated, it is still unclear at what point during recovery from CABG surgery psychosocial factors are most associated with later outcomes. Measures of depression symptoms or perceived social support following a surgical intervention may only reflect emotional and physical reactions to surgery, while measures completed much later in recovery may be more indicative of depressed mood. Given inter-relationships among psychosocial variables and lack of clarity regarding when depression symptoms may be most predictive of post-CABG surgery outcome, further investigation of these topics is warranted to improve our understanding of the associations between psychosocial variables and outcome.

A further area of weakness in the literature investigating outcomes from CABG surgery is that sex specific analyses are generally lacking. This is problematic throughout cardiovascular disease trials (Blauwet, Hayes, McManus, Redberg, & Walsh, 2007). Much of the research examining predictors of post-CABG outcomes has been conducted in samples largely, or even exclusively, composed of men, and have not focused on variables which may be important to women’s recovery. To provide the best care, it is important to investigate variables important to men and women, along with possible sex differences (Tsang, Alter, Wijeysundera, Zhang, & Ko, 2012). Given that women undergo CABG surgery and may experience psychological and social variables differently (Kristofferzon, Lofmark, & Carlsson, 2003; Shanmugasegaram, Russell, Kovacs, Stewart, & Grace, 2012; S. E. Taylor et al., 2000), it is important to investigate the unique associations of psychosocial variables with post-CABG outcomes in men and women. It may also be important to investigate variables which may be more relevant to women’s recovery, such as household responsibility (Kendel, Dunkel, Lehmkuhl, Hetzer, & Regitz-Zagrosek, 2008).

Given that CAD is the primary cause of death for women over 55 (Public Health Agency of
Canada, 2009) and approximately one quarter of all CABG surgeries occur in women (Bestawros, Filion, Haider, Pilote, & Eisenberg, 2005), research investigating the possibility of sex-differences in variables associated with recovery would better inform treatment (Tsang et al., 2012).

Given these factors, this dissertation attempts to investigate post-CABG outcomes in a sample composed of a high proportion of women, using variables important to women’s recovery in particular. Household responsibility was chosen as women report greater involvement in this area and greater stress due to household activities following CABG surgery, which may be linked to poorer recovery (Kendel et al., 2008). Choosing variables important to women’s recovery led to the decision not to investigate anger or hostility as these may play a greater role in men’s CAD than women’s (Chida & Steptoe, 2009). Further, the time dependency of assessments, since measurement was performed after surgery, guided the choice of negative affect variables. Anxiety ratings close after a stressful surgery such as CABG may be difficult to interpret since numerous contextual variables may influence symptom presence at this time point in the disease trajectory. Hence depression rather than anxiety was chosen as the more relevant negative affect variable. Additionally, given interrelations between depression, anxiety and anger/hostility (Suls & Bunde, 2005), only depression was chosen to reflect negative affect. This dissertation reports the investigation of whether I) depression and social variables measured at the time of surgery (depression symptoms, perceived social support, marital status, household responsibility, and the interaction between depression symptoms and perceived social support) are associated with one-year post-CABG surgery life function, over and above traditional medical risk factors, in men and women and II) whether these psychosocial variables (depression symptoms, perceived social support, marital status, household responsibility, and the interaction
between depression and perceived social support) in addition to life function impairment, measured at time of surgery and one year later, predict additional variance in mortality and CAD procedure recurrence over a 13-15 year follow-up period, after adjustment for traditional medical risk factors. The strengths of this research are a sample of adequate size to power analyses of my hypotheses, a large proportion of female participants, multiple important psychosocial variables measured at more than one time point, and more than a decade of follow-up of important hard end points (mortality and CAD procedures).

1.2 Coronary artery disease and coronary artery bypass graft surgery

1.2.1 Coronary artery disease

Cardiovascular diseases (CVD) impact the heart and blood vessels. Coronary heart disease (CHD), also known as CAD, is a CVD caused by plaques or fatty deposits occurring in the coronary arteries (atherosclerosis) (Venes, 2013). These deposits may lead to narrowing of the arteries and decreased cardiac blood flow, and may even block cardiac blood vessels. Decreased cardiac blood flow may lead to decreased oxygenation of the heart muscle and to angina (chest pain), and/or decreased exercise tolerance. Blockage of one or more coronary arteries can result in an MI (heart attack) or sudden cardiac death (Dorland's, 2011).

Globally CAD is a leading cause of mortality and morbidity (WHO, 2008, 2009). It is estimated that in 2008, 7.3 million people died as a result of CAD, approximately 12.7% of all deaths (WHO, 2011). CAD accounts for approximately 1 in 6 deaths in the United States (Go et al., 2013). In Canada it is the second leading cause of mortality contributing to 21% of all deaths (Statistics Canada, 2009). CAD and stroke continue to be the largest cause of hospitalization in Canada, accounting for 16.9% of all in-patient hospital stays (19.8% for men and 14.0% for women; Public Health Agency of Canada, 2009).
1.2.1.1 Sex differences in coronary artery disease

Although CVD impacts men and women, men experience it at younger ages. Increased rates of hospitalization due to CVD occur for men at approximately 45 years of age, but women do not experience this until 55 years of age (Public Health Agency of Canada, 2009). Although women account for less than half of hospitalizations (up to 41%) for cardiovascular (CV) events (Public Health Agency of Canada, 2009), morbidity and mortality due to these events in women is still a significant concern for public health. One in three women will experience CVD, with CAD being the primary cause of death for women over 55 (Public Health Agency of Canada, 2009). Although mortality from CVD is equal in men and women (Public Health Agency of Canada, 2009), sex differences exist. For example more women die from stroke than men (Go et al., 2013; StatsCan, 2012; WHO, 2011). Additionally, young women experiencing a heart attack are more likely to die than young men who have a heart attack (Pilote et al., 2007). Clearly, this disease is an important health concern for both men and women.

Sex differences in CAD contribute to different rates of diagnosis, mortality and morbidity. Less women (4.2%) than men (5.3%) report being diagnosed by a physician with heart disease (PHAC, 2009) and sex-based population rates diagnosis of ischemic heart disease also reveal higher rates of diagnosis in men than women (women 109.9/100,000; men 136.2/100,000 in 2007; PHAC 2009). CAD is also not as well understood in women. For example, research supports greater mortality in women than men from stable angina and acute coronary syndrome (Shaw et al., 2008). Women present a paradox in which they are less likely to exhibit obstructive CAD by angiography with stable angina or acute coronary syndrome, but they are more likely to die in-hospital from stable angina, even after adjusting for other risks (Merz, 2011; Merz et al., 2006; Shaw et al., 2008; Tamis-Holland et al., 2013). It is clear that
lack of confirmation of CAD by angiography does not correlate with better health outcomes in women. Instead, in women, persistent chest pain, without visibly obstructed coronary arteries is related to increased rates of CV events compared to women without persistent chest pain (Johnson et al., 2006). This decreased objective measure of disease may contribute to lower rates of CAD diagnosis in women and add to delays in treatment. A further factor which may delay women’s CAD treatment is that women may experience the chest pain of CAD differently from men and not recognize the seriousness of the cardiac pain signal, (O'Keefe-McCarthy, 2008).

Treatment may also differ in women. A review of international studies revealed that upon hospital discharge after an acute coronary event, in individuals with documented CAD, men are more likely to receive secondary prevention drugs for CAD (aspirin, beta-blockers and statins), although they receive similar levels of ACE inhibitors (Bugiardini, Estrada, Nikus, Hall, & Manfrini, 2010). Although some postulate this reduced treatment is due to women being older and presenting with greater comorbidities, this study, controlling for these factors, did not support this notion. Other research does confirm that women present for CABG surgery with a greater number of cardiac risk factors (Daviglus et al., 2004), and the rate of death from ischemic heart disease increases with the number of cardiac risk factors experienced (Wu et al., 2012). These factors may contribute to under-diagnosis of CAD in women, presentation for CABG at a later stage in the disease process, lower medical treatment rates, and could lead to increased mortality.

1.2.2 Coronary artery bypass graft surgery

Coronary artery bypass graft (CABG) surgery is a well-established revascularization procedure for treatment of CAD with impairing coronary artery stenoses (Hillis et al., 2011; Umakanthan, Solenkova, Leacche, Byrne, & Ahmad, 2011). Rates of CABG surgery have
decreased over the past decade as medicine turns to less invasive procedures, but it remains an important intervention (Riley, Don, Powell, Maynard, & Dean, 2011). For example, one study found from 2001 to 2009 in the United States, CABG surgery decreased by 5% per year (Riley et al., 2011). CABG surgery is performed by surgically bypassing one or more blocked coronary arteries with healthy blood vessels (Umakanthan et al., 2011). This cardiac surgery occurs through a chest incision and the patient may or may not be connected to a heart-lung bypass machine, called cardiopulmonary bypass, during the surgery (De Milto, Costello, Davidson, & Lerner, 2011). Depending on the number and location of blocked cardiac vessels to be bypassed, the surgeon will most often use a blood vessel from the leg (saphenous vein), arm (radial artery) and/or chest (internal mammary artery also called the internal thoracic artery) as the bypass graft. If a leg or arm vessel is used, one end of the bypass graft vessel is connected to an opening made in the aorta and the other end is connected to an opening made in the blocked cardiac vessel below the blockage, allowing oxygenated blood to bypass the blockage and reach the heart. If a mammary artery is used, it is already connected at one end to the aorta, so only needs to be connected to the blocked artery in a similar manner to an arm or leg vessel. This type of cardiac revascularization improves myocardial blood flow, decreases angina, increases quality of life by impacting physical, psychological and social functioning, and even increases length of life in some groups (Hawkes, Nowak, Bidstrup, & Speare, 2006; Hillis et al., 2011), even in elderly patients over lengthy follow-up (Herlitz et al., 2009; Herlitz et al., 2001).

1.2.2.1 Sex differences in CABG surgery

CABG surgery is conducted in men and women, although women experience lower rates of CABG surgery (Shaw et al., 2008). Approximately 20 - 30% of CABG surgeries are performed in women (Alam et al., 2012; Bukkapatnam, Yeo, Li, & Amsterdam, 2010; Guru,
Fremes, & Tu, 2004; Jacobs et al., 1998). For example, in a sample of 12,017 patients undergoing CABG surgery, drawn from four Canadian and five American hospitals, 24% of patients were female (Bestawros et al., 2005). Overall in Canada, in 2010, approximately four times as many men received CABG surgery as women (26/100,000 women underwent CABG surgery compared to 104/100,000 men; Canadian Institute for Health Information, rates of procedures, downloaded May 6, 2013). Despite the seeming imbalance in these numbers, men and women receive this cardiac revascularization surgery at similar rates once diagnosed, although men are more likely to receive diagnostic angiograms and aggressive medication therapy as outlined above (Bugiardini et al., 2010). An additional sex difference seen in the literature is that once women are diagnosed and undergoing CABG surgery, they are less likely than men to receive internal mammary artery grafts (Bukkapatnam et al., 2010; Jacobs et al., 1998; Lehmkuhl et al., 2012). Lower use of internal mammary artery grafts in women may be due to women having smaller vessels and presenting more often for non-elective CABG surgery (Edwards et al., 2005). Whatever the reason for sex differences in their use, internal mammary artery grafts have been associated with greater long-term survival (Cameron, Davis, Green, & Schaff, 1996).

Regarding sex differences in short-term post-CABG outcomes, most studies find that women experience increased in-hospital mortality and longer hospital stays (Alam et al., 2012; Bestawros et al., 2005; Bukkapatnam et al., 2010; Eaker, Kronmal, Kennedy, & Davis, 1989; Guru, Fremes, Austin, Blackstone, & Tu, 2006; Kim, Redberg, Pavlic, & Eagle, 2007; Vaccarino, Abramson, Veledar, & Weintraub, 2002), especially younger women (Vaccarino et al., 2002). For example, in a study adjusting for age and comorbidities post-CABG surgery (N=12,017, 24% women), women had longer length of stay in hospital (10%, p < .001) and almost
double (97% increase, \( p < .001 \)) in-hospital mortality compared to men (Bestawros et al., 2005).

In a Canadian population-based study, women, especially older women, had greater one-year post-CABG hazard of mortality (HR = 1.44, \( p = .02 \); 95% CI [1.29, 1.61]) (Guru et al., 2004).

Further, an additional population-based study revealed women experienced higher rates of hospital readmission over the first year (HR = 1.5, 95% CI [1.36, 1.56]) and up to 11 years after CABG (HR = 1.2, 95% CI [1.14, 1.31]) (Guru et al., 2006). In a study investigating post-operative factors associated with sex differences in early mortality, women were more likely to experience a complicated course following CABG surgery, with increased rates of postoperative low cardiac output and resuscitation accounting for much of the variance in women’s early mortality (Lehmkuhl et al., 2012).

Factors contributing to women’s greater early-mortality following CABG surgery have been postulated. Increased early-mortality may be due to women being: older when they present for first CABG (Anand et al., 2005); having smaller and possibly more easily occluded, technically difficult blood vessels (Sheifer et al., 2000), which may contribute to higher graft failure (Jacobs, 2006); being physically smaller; and having higher comorbidities than men (Fukui & Takanashi, 2010). Additionally, although men presenting for CABG are more likely to have greater vessel disease, women are more often emergent, older, hypertensive, diabetic, and have greater kidney disease, unstable angina, congestive heart failure and chronic lung disease (Bukkapatnam et al., 2010; Eaker et al., 1989; Guru et al., 2004; Jacobs et al., 1998). A further factor may be related to rehabilitation. Even with known benefits of cardiac rehabilitation (Engberding & Wenger, 2013), women have twice the risk for non-completion as men (Caulin-Glaser, Maciejewski, Snow, LaLonde, & Mazure, 2007).
Despite an imbalance by sex in early post-CABG mortality, most studies support equivalent longer-term post-CABG mortality rates in men and women, or even better survival for women after adjusting for women’s increased risk factors and older age (Blasberg, Schwartz, & Balaram, 2011; Eaker et al., 1989; Guru et al., 2004; Jacobs et al., 1998; Tamis-Holland et al., 2013; van Domburg, Kappetein, & Bogers, 2009). For example, in a sample composed of patients with diabetes who underwent CABG surgery, five-year mortality was equivalent in women and men (11% compared to 12%, \( p = 0.45 \); adjusted HR = 0.91, \( p = .53 \); 95% CI [0.63, 1.32]) (Tamis-Holland et al., 2013). In the Canadian population-based study mentioned earlier, despite greater hazard of mortality for women over the first year post-CABG, women and men had equivalent ten-year mortality (HR = 0.89, \( p = .06 \); 95% CI [0.78, 1.00]) (Guru et al., 2004). Despite CABG surgery conferring greater early mortality risk to women and greater rates of post-operative complications and rehospitalisations, the sum of these factors indicate CABG surgery is an effective revascularization procedure for both men and women with significant coronary artery stenosis.

Although cardiac research increasingly includes women, historically, men have more often been included in research regarding cardiac recovery, rehabilitation and CVD trials (Grace et al., 2002; Heran et al., 2011; Melloni et al., 2010; Oldridge, 2012; Tsang et al., 2012). As older women experience high rates of CAD and equally benefit from CABG surgery, research investigating recovery trajectories in this population would better inform their treatment and recovery (Tsang et al., 2012).

1.2.3 Pain severity and function

Angina pain related to CAD may impair patient’s ability to function well both physically and in other areas of life. One goal of CABG surgery is to decrease angina pain and improve
patient’s ability to function well (Hawkes et al., 2006). It is important for patients to function well in multiple domains such as family, work, social and recreational activities, as this is critical to perceived quality-of-life and serves as a proxy for cardiac health in the eyes of patients themselves (Hawkes et al., 2006; Prince et al., 2007; Salvador-Carulla & Garcia-Gutierrez, 2011). Not only pain, but also poor functioning is associated with CAD. Self-reported physical function (ability to walk one-quarter mile unassisted) is associated with CAD diagnosis in men and women (OR 1.81, p < .001; 95% CI [1.42, 2.31]) even after adjustment for demographic factors, medical risk, sleep and depression symptoms (Olafiranye et al., 2012). In the Canadian Community Health Survey, 30.3% of respondents with CAD reported needing help with activities of daily living, while 68.6% felt limited in participating in enjoyable activities (PHAC, 2008). This suggests that CAD may interfere more with enjoyable activities than it does with physical activities needed to accomplish basic daily tasks. Although CABG surgery is generally thought to remedy pain associated with CAD, and cardiac pain experienced after surgery does tend to resolve, for some patients pain can persist for months or years (Taillefer et al., 2006). Even nine-weeks after CABG surgery, one quarter of all patients report moderate to severe pain (Parry et al., 2010). Similarly to chest pain associated with CAD, postoperative angina has been related to impaired physical function, interference with daily activities and anxiety and depression at 12-month follow-up (Morone et al., 2010). Most patients undergoing CABG surgery experience improvements in quality of life, including physical function and mental health. A Finnish study was conducted comparing quality of life (N=508, 17.3% women; age 34-92 years), as assessed with the RAND 36 (Hays, Sherbourne, & Mazel, 1993) the day before CABG surgery and one and 12 years post-CABG surgery, between patients experiencing on and off-pump CABG surgery. Overall a general improvement in QOL is seen in almost all subscales.
for both groups at one-year, and despite these scores decreasing again somewhat by 12 years, 12-year scores were still above those at baseline (Jarvinen, Hokkanen, & Huhtala, 2013). Considering the one-year post-CABG outcomes more closely, patients reported improvements in physical functioning, social functioning, physical role functioning, emotional role functioning, emotional well-being, energy and pain at $p < .001$ with no significant differences between on and off pump groups. Both the SF-36 (Ware & Sherbourne, 1992) and RAND-36 (Hays et al., 1993) are common measures of QOL with the same items, but different scoring systems.

Regarding sex differences, women are more likely to report moderate to severe pain with movement after CABG and pain that interferes with walking (Parry et al., 2010) and have less relief from ischemia (Merz et al., 2006). Additionally, women report greater interference of pain symptoms with activities of daily living (Tamis-Holland et al., 2013) and women with chest pain due to CAD report lower general QOL (Olson et al., 2003). Although CABG surgery improves physical function for men and women alike, men consistently report significantly higher overall functioning and higher satisfaction associated with otherwise comparable levels of physical functioning (Martin et al., 2012; Sawatzky & Naimark, 2009). Given that women report poorer physical function, we would expect they would be less active than men, yet they report spending more time than men on household activities after CABG surgery, but then experience significantly greater levels of stress due to these activities (Kendel et al., 2008). Further research has also found a relationship between gender roles and QOL that suggests gender roles may be associated with poorer QOL in male CAD patients (Norris, Murray, Triplett, & Hegadoren, 2010).

As CABG surgery is meant to improve angina and function, it makes sense that patients may have more trouble with physical function both prior to CABG surgery, due to angina, and/or
after surgery, due to surgical incision pain. This may explain why results are mixed in research investigating associations between physical function at time of surgery and longer-term post-CABG surgery outcomes. In one mainly male sample (N = 1503, 95.5 men; Mean age = 62.0 years), functional impairment pre-CABG, adjusted for comorbidities at time of surgery, was not associated with morbidity or all-cause mortality at 30 days (OR = 1.4, p = .67; 95% CI [0.3, 5.8]) or over ten years (OR = 1.0, p = .85; 95% CI [0.7, 1.4]) (Cervera et al., 2012). In this case functional impairment was defined as “…those who required the use of equipment or assistance from another person for any ADL, patients from nursing homes, and patients receiving long-term dialysis or oxygen therapy” (Cervera et al., 2012; p.1951) which may have limited the study to investigating only those with extremely poor physical function abilities. A second study (N = 1290, approximately 20% women) found that endorsing the statement, “I have difficulty climbing stairs”, prior to CABG surgery, was associated with five-year mortality (RR = 1.50, p = .04; 95% CI [1.02, 2.22]) after controlling for medical risk variables (Herlitz et al., 1998). A more recent, international study (N = 4811, 977 women) investigating the physical component summary of the Short Form-12 measure of QOL did find an association between physical function prior to CABG and lengthy hospital stay (greater than 14 days; OR = 1.20, p < .001; 95% CI [1.09, 1.33]) but not in-hospital mortality (Szekely et al., 2011). Due to expectations that physical function may necessarily be poor surrounding CABG surgery, other research has instead investigated physical function following recovery from CABG surgery. Impaired six to 12-month post-CABG physical function, measured with the Duke Activity Status Index (DASI), has been related to greater mortality after CABG (HR = 0.98, p < .001; 95% CI [0.97, 0.98]; Koch et al., 2007).
Although research has investigated physical function post-CABG, less research has investigated how patients function in other areas of their lives and it is unclear if CABG surgery increases patients’ social, recreational or occupational functioning. Descriptive studies of social function following CABG are mixed with some indicating patients do not report much greater social function (Jenkins, Stanton, Savageau, Denlinger, & Klein, 1983) and others indicating improved social function (Mayou & Bryant, 1987; Ross & Ostrow, 2001). One study of young men (N=79 under 65 years of age), reported leisure activity and family life improved one year following CABG surgery (Mayou & Bryant, 1987).

Some research has been conducted investigating occupational function post-CABG. Early research investigating return to work post-CABG revealed that patients have difficulty in this area. In one study of young patients (under 40 years of age; N=52, 9 women) experiencing CABG surgery 62% did not return to work over three years following surgery (Samuels, Sharma, Kaufman, Morris, & Brockman, 1996). In another sample of male, previously-employed patients who experienced CABG surgery (N = 119, 40-59 years of age), the numbers are more promising, with 62.2% returning to work during the first year post-CABG surgery (Mittag, Kolenda, Nordman, Bernien, & Maurischat, 2001). In a more recent, population-based, study in Sweden (CABG n =22,985, 16% women; 30-63) 52.4% of female and 39.0% of male patients experiencing CABG surgery took long-term sickness leave from work of greater than 180 days following surgery and 34% of female and 24.0% of male patients took one year or longer (Voss et al., 2012). This study found that women had a 23% higher probability of long-term sickness leave (leave greater than 180 days; 95% CI [1.19, 1.28]) following CABG surgery. Demographic and work-related factors such as age, schooling, job satisfaction, anxiety and depression appear to play a significant role in returning to work after CABG, and these factors
seem to have a greater association with who may return to work than medical factors (Budde, Keck, & Hamerle, 1994; Fiabane et al., 2013; Mittag et al., 2001). Therefore, how patients function post-CABG surgery is not only relevant for subjective QOL but has substantial economic consequences.

1.2.4 Summary

CAD is a leading cause of mortality and morbidity for men and women (WHO, 2008, 2009). CABG surgery is a surgical revascularization procedure conducted to correct significant coronary artery stenosis due to CAD (Hillis et al., 2011). The goal of CABG surgery is to decrease pain, increase function and, in some, increase length of life. Women exhibit lower rates of blocked coronary arteries despite significant chest pain, but once diagnosed with coronary artery stenosis, women receive CABG surgery at similar rates to men. Women experience greater complications and operative mortality from CABG surgery, but their long-term mortality rates are similar to men’s. Given this, CABG surgery is a recommended treatment for significant coronary artery stenosis in men and women. Although physical function and pain have been investigated as outcomes from CABG surgery, little research has investigated broader life function in these patients.

1.3 Psychosocial variables in CAD and CABG

The most frequently studied psychosocial risk factors implicated in the development of CAD are anxiety, depression, anger/hostility and social support (Albus, 2010; Linden, DesMeules, Dressler, & Luo, 2008). Anxiety, depression, and social support are most frequently researched when considering recovery from CABG surgery (Cserép, Székely, & Merkely, 2013). Evidence exists linking depressed mood, anxiety, anger/hostility and social factors to development and worsening of CAD (Chida & Steptoe, 2009; Cserép et al., 2013; Lett et al.,
2005; Lichtman et al., 2009; Linden et al., 2008; Roest, Martens, de Jonge, & Denollet, 2010); participation in, and outcomes from, cardiac rehabilitation (Husak et al., 2004; McGrady, McGinnis, Badenhop, Bentle, & Rajput, 2009; Milani & Lavie, 2007; Shen, McCreary, & Myers, 2004); mortality and morbidity (Holt-Lunstad, Smith, & Layton, 2010; Leung et al., 2012; Tully, Baker, & Knight, 2008; Uchino, Bowen, Carlisle, & Birmingham, 2012; Wong, Na, Regan, & Whooley, 2013), and outcomes following CABG surgery in mainly male samples (Blumenthal et al., 2003; Con, Linden, Thompson, & Ignaszewski, 1999; Cserép et al., 2013; Hawkes et al., 2006; Kulik & Mahler, 2006; Pignay-Demaria, Lespérance, Demaria, Frasure-Smith, & Perrault, 2003; Székely et al., 2007; Tully & Baker, 2012; Tully, Baker, Turnbull, & Winefield, 2008). Little research has investigated sex differences in these associations.

Additionally, despite possible links between depression and social support (e.g. the buffering hypothesis; Cohen & Wills, 1985) and support for associations of depression and social support with health outcomes, research has not investigated the additive and interactive role of depression and social factors in predicting outcomes from CABG surgery. Further, although research has investigated relationships between psychosocial variables in predicting physical impairment post-CABG surgery, little research has investigated these relationships in predicting how patients function in important life areas post-CABG surgery despite its importance to how patients view their health (Prince et al., 2007; Salvador-Carulla & Garcia-Gutierrez, 2011). Assessing these psychosocial variables in combination, at the time of CABG surgery and following recovery, may allow us to predict who may benefit long-term from greater assistance, and allow better application of limited resources.

Although anxiety and hostility have been related to CAD (Linden et al., 2008; Roest et al., 2010) and poor outcomes after CABG (Tully & Baker, 2012), they were not measured in our
sample. Measures of depression, anxiety and hostility may be seen as overlapping measures of distress in cardiac populations (Suls & Bunde, 2005), given this, only depression symptoms were assessed in this sample. Furthermore, since it is difficult to differentiate the normal apprehension of surgery from a more trait-like anxiety (Suls & Bunde, 2005), anxiety was not assessed subsequent to surgery in this sample. A further variable was measured in our sample indicating marital satisfaction using the Dyadic Adjustment Scale (DAS; Spanier, 1986). These data were not analysed because considering marital satisfaction in analyses would have greatly reduced the sample size. The goal of the present study is aimed at the analysis of gender differences, which should not be restricted to married patients. Furthermore, given the smaller proportion of married women, many more women (57% married) than men (84% married) would have been excluded.

Of all psychosocial constructs, depression has been investigated most often in association with outcomes following CABG surgery (Blumenthal et al., 2003; Connerney et al., 2001; Connerney et al., 2010; Herlitz et al., 1998). Although, social support is arguably just as important to health (Barth, Schneider, & von Kanel, 2010; Uchino, 2004, 2006), less research has been conducted investigating social variables in outcomes following CABG surgery. Social support is thought to both buffer stress (Cohen & Wills, 1985) and be positively associated with health (Uchino, 2004), development of CAD (Lett et al., 2005), and mortality and morbidity in cardiac populations (Barth et al., 2010; Mookadam & Arthur, 2004). Furthermore, marital status, a measure of structural social support was considered an important predictor of post-CABG adjustment as spouses provide valuable instrumental support being essential for initial recovery after CABG surgery (Herlitz et al., 1998; Idler et al., 2012; King & Reis, 2012; Kulik & Mahler, 2006). The choice of psychosocial factors was also guided by focussing on investigating variables important for women’s recovery. As women tend to have greater household
Responsibilities and these are associated with increased stress (Kendel et al., 2008), household responsibility was chosen as a social role variable. The following sections briefly review the literature surrounding anxiety and anger, and review important literature linking the targeted psychosocial variables and cardiac related outcomes.

1.3.1 Anger/hostility and anxiety

Anger, hostility, and aggressiveness have been measured in numerous ways and are often conceptualized as being equivalent despite being separate concepts (Smith, Glazer, Ruiz, & Gallo, 2004). Due to varying definitions, these concepts are often collapsed and investigated under one heading of anger or hostility (Chida & Steptoe, 2009). Over time, there has been difficulty showing definitive associations between anger and hostility and CAD. Reviews support only a possible etiological role for trait hostility and trait anger (Hemingway & Marmot, 1999; Kubzansky & Kawachi, 2000). A more recent review of large studies and meta-analyses supports a strong role for anger and hostility in CHD development (Linden et al., 2008). A further recent meta-analysis showed a significant association between anger and hostility and increased CHD events, such as cardiac mortality or MI, in healthy samples, in addition to being associated with poorer CAD prognosis (Chida & Steptoe, 2009). Some research suggests that the impact of hostility on increased CAD events may be mediated by poor health behaviours such as smoking and inactivity (Wong et al., 2013).

Research regarding anxiety in cardiac populations may focus on various disorders or general trait or state anxiety. Although less research has focused on anxiety and CAD development, one meta-analysis investigating anxiety in initially healthy individuals and CAD; defined as cardiac mortality, MI, CAD diagnosis or hospitalization; found a relationship comparable to that of the association between depressed mood and CAD (Roest et al., 2010).
Individuals diagnosed with a variety of types of anxiety, in adjusted analyses, exhibited increased risk of CAD (HR = 1.26, \( p < .001 \); 95% CI [1.15, 1.38]) and cardiac death (HR = 1.48, \( p = .003 \); 95% CI [1.14, 1.92]), but not MI without death (HR = 1.43, \( p = .18 \); 95% CI [0.85, 2.40]).

Although less research has been conducted assessing the relationship between anxiety and post-CABG outcomes, associations are supported. In a study investigating both pre-CABG anxiety and depression symptoms (N=440, 20% women) as measured by the Depression, Anxiety and Stress Scale (DASS), only adjusted preoperative elevated anxiety symptoms (HR =1.88, \( p = .02 \); 95% CI [1.12, 3.17]) were related to increased hazard of five-year mortality (Tully, Baker, & Knight, 2008). In a further study (N = 180, 33.9% women, mean age = 57.9), models using only significant univariate predictors investigated the association of STAI state, STAI trait, & BDI, assessed prior to CABG surgery and six-months post-CABG surgery, with four-year mortality and cardiac hospitalization (Székely et al., 2007). In this model adjusted for post-operative congestive heart failure, only preoperative STAI trait was associated with four-year mortality (OR = 1.07, \( p = .05 \); 95% CI [1.01, 1.15]). Predicting post-operative four-year cardiac hospitalization, only six-month post-CABG surgery STAI trait was associated with greater hazard of cardiac hospitalization over four years, although it is unclear if this is an adjusted model. One further study (N = 180, 33.9% women) suggested that both BDI (HR = 1.05, \( p = .001 \); 95% CI [1.02, 1.08]), state anxiety (HR = 1.05, \( p = .001 \); 95% CI [1.03, 1.08]) and trait anxiety (HR = 1.04, \( p = .002 \); 95% CI [1.01, 1.06]) prior to CABG surgery were related to combined mortality and cardiac hospitalizations at five-years post-CABG surgery in individual models, while social support, as measured by the Social Support Inventory (SSI; Berkman et al., 2003), was not (Cserep et al., 2010).
Depression and CAD

A host of studies have investigated the role of depression as a risk factor for the development of cardiac disease, with the majority of studies confirming this assumption (Frasure-Smith & Lesperance, 2005; Hawkins, Callahan, Stump, & Stewart, 2014). Depression in non-cardiac populations has been related to development of CAD (RR = 1.64, 95% CI [1.29, 2.08], p < 0.001; Rugulies, 2002) and subsequent cardiac mortality and morbidity (RR = 1.79, 95% CI [1.45, 2.21]; Leung et al., 2012). Furthermore, in individuals with CAD, being depressed does not only predict poorer self-reported health (Sullivan, LaCroix, Russo, & Walker, 2001), it is also a powerful (2:1) predictor for cardiac mortality and morbidity (Barth, Schumacher, & Herrmann-Lingen, 2004; Frasure-Smith, Lespérance, Juneau, Talajic, & Bourassa, 1999; Leung et al., 2012; Lichtman et al., 2009).

Rates of depression in CAD populations are high (18.7% for women and 12% for men; Shanmugasegaram et al., 2012) and elevated compared to the general population (12-month prevalence of 6.7% for major depressive disorder and 1.5% for dysthymia; Kessler, Chiu, Demler, Merikangas, & Walters, 2005). Elevated depression symptoms occur more often in women compared to men in the general population (Kessler, 2003), in cardiac populations (Blumenthal et al., 2003; Connerney et al., 2001; Grace, Yee, Reid, & Stewart, 2013; Lichtman et al., 2008; Mallik et al., 2005; Pilote et al., 2007; Shanmugasegaram et al., 2012), and surrounding CABG surgery (Dunkel et al., 2009; Tully, 2012) alike. Due to the high prevalence of depression in cardiac populations, a significant amount of research has investigated the relationship between depression and CAD, yet little research has investigated the differential
associations between depression and outcome by sex, despite differences in how women report depression symptoms (Grace, Yee, Reid, & Stewart, 2013).

1.3.2.2 Depression and CABG surgery outcomes

Depression is common surrounding CABG surgery, with a point–prevalence of major depressive disorder of 15-30%, and higher proportions if considering only elevated symptoms of depression (Beresnevaitė et al., 2010; Blumenthal et al., 2003; Connerney et al., 2001; Doering, Magsarili, Howitt, & Cowan, 2006). Depression before CABG is related to being female, younger and living alone (Dunkel et al., 2009). Additionally, while research supports a decrease in depression symptoms over time post-CABG surgery (Doering et al., 2006; Khoueiry et al., 2011; Mitchell et al., 2005; Ravven, Bader, Azar, & Rudolph, 2013), over 40% of patients continue to have signs of depressive symptomatology at lengthy follow-up (Blumenthal et al., 2003; Khoueiry et al., 2011), with some studies even seeing no decrease in depressive symptoms over six months (Elliott et al., 2010). Both a diagnosis of depression and symptoms of depression have been related to increased mortality and morbidity in CABG patients surrounding surgery (Beresnevaitė et al., 2010; Dao et al., 2010), and over long-term follow-up (Blumenthal et al., 2003; Burg, Benedetto, & Soufer, 2003; Connerney et al., 2001; Connerney et al., 2010; Oxlad et al., 2006a; Peterson et al., 2002; Phillips-Bute et al., 2008; Rafanelli et al., 2006). In the following paragraphs pertinent studies are described.

In an Australian sample (N = 100, 19 female, mean age = 63.3 years) morbidity was assessed following elective CABG surgery, measured as hospital readmission (Oxlad, Stubberfield, Stuklis, Edwards, & Wade, 2006b). Cox proportional hazards models revealed preoperative depression (HR = 5.15, p = .01; 95% CI [1.45, 18.28]) and postoperative anxiety symptoms (HR = 2.96, p = .04; 95% CI [1.06–8.26]), as measured by the Depression Anxiety
and Stress Scales (DASS), predicted hazard of hospital readmission during 6-months post-CABG. This model was only adjusted for cardiopulmonary bypass time, the single significant univariate medical covariate. Unfortunately small numbers of women prevented sex-specific analyses. In another study, patients undergoing first-time CABG surgery (N=222, 83% male, mean age = 63 years; Tully, Baker, Turnbull & Winefield, 2008) were asked to complete the DASS and reported readmission to hospital over six months post-CABG. Adjusted Cox proportional hazards models were developed with time to first unplanned readmission to hospital as the outcome. Both preoperative anxiety, adjusted for preoperative depression and stress (HR = 3.14, p < .001; 95% CI [1.66–5.94]) and postoperative depression, adjusted for postoperative anxiety and stress (HR = 2.06, p = .06; 95% CI [.97–4.40]) predicted hazard of rehospitalisation post-CABG. Although the analysis was adjusted by entering sex as a covariate, a potential moderator effect of sex was not examined.

In a smaller sample (Rafanelli et al., 2006) of Italian patients receiving CABG surgery (N=47, 11 female, age = 41-88 years), minor depression (diagnosed by SCID) was related to six to eight-year self-reported cardiac events. Unfortunately, as models were planned to include only significant covariates and no medical or demographic variables attained significance in unadjusted analyses, the final model was unadjusted. This approach is useful for exploratory purposes in generating further research, but remains an equivocal result. Another unadjusted study (N=411, 30% female, mean age = 61 +/-10.9yrs) investigating genetic polymorphisms in relation to depression and cardiac events found that depression symptoms, as assessed by CESD > 26 on the day before CABG surgery, predicted increased odds of experiencing a new cardiac event over two-year follow-up (OR = 2.6, p < .001; 95% CI [1.6, 4.3]) (Phillips-Bute et al., 2008).
In an all-male sample, the association between depression symptoms and post-CABG mortality has been investigated over two years (Burg, Benedetto, & Soufer, 2003). Consecutively recruited patients (N = 89, age = 42 - 83 years) completed the BDI prior to CABG surgery. Survival was determined from interviews with patient’s family and medical records search. Five cardiac deaths in the depression group and two in the non-depressed group occurred over the two-year follow-up period. An adjusted, multiple logistic regression model revealed depression (defined by BDI score >=10 pre-CABG) significantly contributed to the adjusted model predicting mortality ($X^2 = 3.86, p < .05$).

In a study investigating the relationship between post-CABG depression and cardiac outcome at one-year (n = 207 men, n = 102 women), 27% of patients with Major Depressive Disorder at one week post-CABG (assessed as either meeting criteria for Major Depressive Disorder by Diagnostic Interview Schedule or BDI >=10) had experienced combined outcome by one-year post-CABG, compared to 10% of those who were not depressed post-operatively (HR = 2.3, p < .05; 95% CI [1.17, 4.56]; Connerney et al., 2001). The combined outcome included cardiac event requiring hospitalization, further cardiac surgery or cardiac death. A combined endpoint was required to obtain adequate power for this analysis as few events of any one type would be expected over a single year. This study adjusted for significant medical risk: cardiac events, sex, living alone, low ejection fraction, length of hospital stay after CABG, NYHA class IV and number of vessels operated. In this study adjusted female sex was also related to adverse outcomes (HR = 2.4, p <.05; 95% CI [1.24, 4.44]), although interactions with sex were not reported.

Connerney’s group (2010) conducted a further follow-up (N = 309, 102 women; mean age = 63.1 years) at ten-years post-CABG in a sample composed of 1/3 women. Cox
proportional hazards for an adjusted model (age, sex, diabetes, LVEF) revealed that age, LVEF and Major Depressive Disorder (HR = 1.78, \( p = .04 \); 95% CI [1.04, 3.04]) were significant predictors of cardiac mortality over ten-year follow-up. Although women exhibited greater hazard of mortality compared to men in unadjusted analyses, sex was no longer a significant predictor in adjusted analyses. Additional models were constructed to investigate a variety of forms of the depression diagnosis and depression symptoms as predictors. Major depressive disorder (MDD), MDD with no previous depression diagnosis, BDI as a continuous variable, BDI cognitive/affective scores as continuous variables all predicted greater hazard of cardiac mortality. Interactions between modifiable risk factors (e.g. smoking) were investigated, but interactions with sex were not.

In a study investigating new onset of depression symptoms in patients undergoing elective CABG surgery, only patients with no symptoms of depression at time of CABG surgery were studied (\( N = 123, 12\% \) women). Depression symptoms were re-assessed with CESD at 6-month follow-up (Peterson et al., 2002). Logistic regression was conducted using a combined endpoint of self-reported new cardiac morbidity and mortality up to 36 months post-CABG. This study found a significant association between new 6-month onset of depression post-CABG and experience of cardiac morbidity and mortality up to 36 months (\( OR = 2.12, p < .05; 95\% \) CI [0.50, 8.94]). Unfortunately, low numbers of women precluded sex-moderating analyses.

In one of the largest studies investigating the association of depression with post-CABG surgery mortality, 817 (27% women, mean age = 61) post-CABG patients were investigated (Blumenthal et al., 2003). Mean follow-up was 5.2 years. Mortality was collected using medical records, phone calls, and national databases. Patients were assessed using the CESD on the day before surgery and six months post-CABG. Moderate to severe baseline depression (CESD >=
27: HR = 2.4, [95% CI 1.4–4.0]; p=0.001) and mild or moderate to severe depression (CESD = 16-26) which persisted for six months (HR 2.2, [1.2–4.2]; p=0.015) predicted increased mortality over and above demographic and medical risk variables (age, sex, number of grafts, diabetes, smoking, left ventricular ejection fraction and previous MI).

In analysis adjusted for medical and demographic risk factors (N = 180, 33.9% women), assessing multiple psychosocial factors including social support, suggested that BDI (HR = 1.05, p = .001; 95% CI [1.02, 1.08]) and anxiety assessed as STAI state (HR = 1.05, p = .001; 95% CI [1.03, 1.08]) and STAI trait (HR = 1.04, p = .002; 95% CI [1.01, 1.06]), assessed prior to CABG surgery, were related to a combined mortality and cardiac hospitalization outcome at five-years post-CABG surgery in individual models, while social support was not (Cserep et al., 2010).

Although most research has found an association between depression and post-CABG mortality and morbidity, one large, more recent study found no association. A recent study (N= 440, 80% male, mean age = 64 years) conducted in Australia investigated depression and anxiety as measured by the self-report DASS (Lovibond & Lovibond, 1995), administered the week before surgery (Tully, Baker, & Knight, 2008). Mortality data were collected from a national database and median follow-up was 5 years and 10 months. Three Cox proportional hazards models, one for each psychological predictor, were constructed to predict mortality from dichotomized depression, anxiety, and stress at baseline using significant medical risk and demographic variables as covariates (age, renal disease, concomitant valve procedure, cerebrovascular disease, and peripheral vascular disease). Only anxiety symptoms were significantly associated with hazard of mortality post-CABG surgery (HR = 1.88, p = .02; 95% CI [1.12, 3.17]). Dichotomized depression and stress were not, although the association with depression approached significance (HR = 1.61, p = .10; 95% CI [0.91, 2.85]). It is possible that
dichotomizing the predictors led to loss of information and power, but interestingly anxiety was associated with outcome. The study is lacking a joint analysis of psychological predictors in a single model as well as a potential moderator effect of sex.

In summary, the majority of research supports depression being associated with long-term outcomes following CABG surgery. This literature indicates a substantial number of studies have demonstrated methodological weaknesses, such as lack or deficient adjustment for traditional clinical risk predictors, including medical, behavioural and surgical variables, absence of more complex models based on multiple, associated psychosocial variables in a single model, and lack of analyses investigating gender effects.

1.3.2.3 Depression, pain and impairment after CABG

Pain and physical function post-CABG surgery have been investigated in association with depressed mood. Patients with more symptoms of depression report greater pain and decreased physical function following CABG surgery (Borowicz et al., 2002; Burg, Benedetto, Rosenberg, & Soufer, 2003; Foss-Nieradko, Stepnowska, & Piotrowicz, 2012; Goyal et al., 2005; Karlsson, Berglin, Pettersson, & Larsson, 1999; Kendel et al., 2010) and are less likely to return to work (Soderman, Lisspers, & Sundin, 2003). At a cross-sectional level, increased symptoms of depression post-CABG have been associated with greater impairment in activities of daily living, associated with physical function, when not adjusted for surgical risk (McKenzie, Simpson, & Stewart, 2009). Longitudinally, depression has been related to later increased cardiac pain and impaired physical function in the following studies.

At one year post-CABG in a large sample (N = 883, 19.8% women, age = 35-93 years; Kendel et al., 2010), depression was assessed 1-3 days pre-CABG surgery and 2-12 months post-CABG surgery, using the Patient Health Questionnaire. Structural equation modeling related pre-
operative depression symptoms to impaired physical function at one year ($B = -0.17, \ p < .0010$). Further, in a propensity matched sample ($N = 157, \ 50\% \ women$), individual sex-based analyses showed women reported greater impairments in activities of daily living at all time points (Kendel, Dunkel, Jonen, et al., 2011). Pre-operative depression predicted decreased ability to attain goals ($B = -0.17, \ p = .003; \ 95\% \ CI [-2.79, -0.59]$), and impaired physical functioning ($B = -0.13, \ p = .01; \ 95\% \ CI [-1.47, -0.17]$) in an adjusted multiple regression model containing education, sex, partner status and baseline functioning (Kendel, Dunkel, Muller-Tasch, et al., 2011). In this sample, pre-operative depression additionally significantly predicted greater bodily pain ($B = 0.19, \ p = .002; \ 95\% \ CI [-2.11, -0.47]$) at one year in a multiple regression model after adjustment for pre-operative pain, sex, education and partner status. Although the researchers postulated that sex most likely interacted with depression, interactions with sex were not investigated.

A sample of young, mostly male ($N = 93, \ all \ under \ 61 \ years, \ 10\% \ women$), elective CABG surgery patients was assessed pre-operatively and one-year post-operatively on psychosocial variables (social support, sense of coherence and emotional state). Both depression (OR = 3.86, $p = .04; \ 95\% \ CI [1.06, 13.99]$) and sense of coherence (OR = 6.62, $p = 0.006; \ 95\% \ CI [1.73, 25.40]$) predicted chest pain at one-year follow-up in adjusted multiple regression, after partialling out variance due to ejection fraction and BMI (Karlsson et al., 1999). A second study ($N = 117, \ approximately \ 10\% \ female$) found that chronic depression, assessed by elevated BDI, post-CABG was independently associated with recurrent angina (16.4% non-depressed compared to 45% depressed with angina, $p = .003$) over the following two years (Foss-Nieradko et al., 2012). A further prospective study additionally found a relationship between depression symptoms and cardiac pain. In a prospective study of 172 CABG patients (38 women), one
(N=128) and five-year (N=95 men, 22 women) depression (CESD greater than or equal to 16) predicted greater adjusted report of angina at all four measurement times: preoperative (t (120) = 0.18, p = 0.03), one month (t (115) = 3.67, p < 0.001), one year (t (105) = 2.86, p = 0.005), and five years (t (100) = 2.14, p = 0.03), over the five-year follow-up (Borowicz et al., 2002). Further individual sex-based analyses revealed results were only significant for men. However as a consequence of the small number of female patients in this sample, the lack of significant difference is likely due to low power. Despite individual sex-based analyses being conducted, no omnibus test of sex moderating the association between depression and pain was performed.

Depressed mood may also be associated with difficulty returning to work after CABG. In cardiac rehabilitation patients under 60 years-of-age (N = 292, 14.4% women), including CABG, Percutaneous Coronary Intervention and Acute MI, those who presented with depressed mood prior to rehabilitation, diagnosed by a BDI score greater than 15, were less likely to return to full-time (OR = 9.43, p < .001; 95% CI [1.08, 7.70]), or part-time work (OR = 5.44, p =.006; 95% CI [1.60, 18.53]) (Soderman et al., 2003). Even those with mild symptoms of depression (BDI from 10-15) were less likely to return to full-time work (OR = 2.89, p = .03, 95% CI [1.08, 7.70]).

Despite investigating psychosocial variables as predictors of later pain, physical function and occupational function, little research has investigated other important life functioning areas, such as social, family, and recreational areas, despite their importance to patients (Prince et al., 2007; Salvador-Carulla & Garcia-Gutierrez, 2011). Longitudinal association between baseline psychosocial variables and later decreased functioning in multiple life domains (family, marital, work and social-recreational activities) has been supported, using scales from an adapted West Haven Yale Multidimensional Pain Inventory (WHYMPI; Kerns, Turk, & Rudy, 1985), in
patients undergoing cardiac catheterization (Sullivan, LaCroix, Baum, Grothaus, & Katon, 1997). In cardiac catheterization patients, baseline depression ($r = 0.2, p < .01$) and anxiety ($r = 0.3, p < .001$) were independently related to one year life functioning, by partial correlation, controlling for age, sex, education, social class, and medical versus surgical management of CAD. Given the aforementioned findings regarding function in life domains, the present research also aimed at testing these associations in CABG surgery patients. Furthermore, as depression at the time of CABG surgery has been related to long-term cardiac pain, (Karlsson et al., 1999; Kendel, Dunkel, Jonen, et al., 2011) and functioning is closely tied to cardiac pain, investigating the association between psychosocial variables and later function in important life areas is warranted.

1.3.2.4 Depression mechanisms

Although the mechanism by which depression acts in patients who have undergone revascularization is not fully understood, relationships of depression with CAD have been postulated and supported by a great deal of research (Whooley & Wong, 2013). Depression symptoms appear to act both by influencing behaviours and impacting physiology directly. Depression symptoms have been associated with behaviours which influence post-operative recovery, such as decreased adherence to medical recommendations (DiMatteo, Lepper, & Croghan, 2000; Ziegelstein et al., 2000) and medication (Carney, Freedland, Eisen, Rich, & Jaffe, 1995; Safren et al., 2001), social isolation (Barefoot et al., 2003), and decreased participation in cardiac rehabilitation (Caulin-Glaser et al., 2007; McGrady et al., 2009). For example, patients with at least mild depression symptoms after an MI report not engaging in increased exercise, adhering to a low-fat diet, reducing stress nor increasing social support as recommended (Ziegelstein et al., 2000). Not surprisingly, post-CABG surgery patients reporting
symptoms of depression are less likely to return to preoperative routines (Theobald, Worrall-Carter, & McMurray, 2005) and previous functioning in social roles (Tully, Baker, Turnbull, Winefield, & Knight, 2009) and have poorer post-operative self-management (Fredericks, Lapum, & Lo, 2012). Depression has additionally been associated with physiological changes related to atherosclerosis and, thus, CAD (Lesperance, Frasure-Smith, Theroux, & Irwin, 2004; Lett et al., 2004; Shimbo, Davidson, Haas, Fuster, & Badimon, 2005). Increased systemic inflammation is a major factor thought to be involved in atherosclerosis. It is hypothesized to act by increasing inflammation within the endothelium and being associated with plaque formation, growth, and rupture (Hansson, 2005). In observational studies, depression has been associated with greater levels of inflammation biomarkers such as c-reactive protein (CRP), soluble intercellular adhesion molecules (sIAM), and interleukins (IL) (Empana et al., 2005; Howren, Lamkin, & Suls, 2009; Lesperance, Frasure-Smith, Theroux, & Irwin, 2004; Vaccarino et al., 2007). In a study investigating physiological markers of inflammation associated with depression in 481 (19% women) patients recovering from an acute coronary syndrome, depressed patients had higher levels of soluble intercellular adhesion molecules (Lesperance et al., 2004). Depression has also been associated with other physiological factors thought to be related to atherosclerosis, including increased platelet activation (Lesperance et al., 2004; Pollock, Laghrissi-Thode, & Wagner, 2000; Serebruany et al., 2003) which may be associated with greater plaque formation; endothelial dysfunction (Chen et al., 2013; Rajagopalan et al., 2001), which may be associated with decreased vasodilation; and hypothalamic-pituitary-adrenal axis dysfunction, indicating increased sympathetic activation possibly associated with greater cardiovascular events (C. B. Taylor et al., 2006).
1.3.3 Social factors

Consensus supports two broad domains of social support: structural and functional support (Barth et al., 2010; Langford, Bowsher, Maloney, & Lillis, 1997; O'Reilly, 1988; Uchino, 2004; Xanthopoulos & Daniel, 2012). Structural support describes size, type and frequency of contact of supports, for example marital status or network size, while functional support refers to the amount of support the network provides. Functional support has been broken down into further domains, including instrumental, emotional, informational and belonging support (Cohen, Mermelstein, Kamarck, & Hoberman, 1985). Social Support is additionally described as either perceived support or actual supportive behaviours described as received support (O'Reilly, 1988; Uchino, 2004).

1.3.3.1 Social support and CAD

Low levels of perceived social support have been linked to increased cardiac events (Hedblad, Östergren, Hanson, & Janzon, 1992; Lett et al., 2005; Pedersen, Van Domburg, & Larsen, 2004), increased rates of CAD progression in women (Wang, Mittleman, & Orth-Gomer, 2005) and increased cardiac and all-cause mortality (Barth et al., 2010; Holt-Lunstad, Smith & Layton, 2010; Williams et al., 1992). For example, lack of social support, specifically the absence of a close confidante and being unmarried, resulted in more than triple the risk of mortality (N = 1368 patients, 18% women, median age = 52 years; adjusted HR = 3.34, p < .0001; 95% CI [1.84, 6.20]) over five years after cardiac catheterization (Williams et al., 1992). Social support is also associated with increased hazard of mortality after MI (Dickens et al., 2004). In the latter study, retrospective assessment of depression symptoms prior to MI did not predict a combined outcome of further cardiac events or death over the year following MI, but not having a close confidant did (HR = 0.57, p = .022; 95% CI [0.35, 0.92]). In a further study,
after adjustment, low perceived social support was also associated with increased cardiac events in the nine months after a first MI (Pedersen et al., 2004). A systematic review suggests social isolation, a facet of social support, is related to increased CVD mortality and morbidity after an acute MI, as socially isolated individuals exhibit double to triple the risk of dying from CVD or having a CV event compared to socially integrated individuals (Mookadam & Arthur, 2004). Although it is evident in this systematic review that all included studies adjusted their analyses for the influence of female sex, it is unclear if the effect of social support on these outcomes is similar for men and women.

1.3.3.2 Social support and CABG surgery outcomes

Qualitative research indicates that after CABG surgery patients report viewing social support as crucial to their recovery process (Theobald et al., 2005). Most patients report they require both practical types of assistance, such as driving, cooking and cleaning, and emotional support following surgery (Theobald et al., 2005). Perceiving you have social support may improve psychological health, as perceived emotional and instrumental support have been related to better mental health outcomes after CABG surgery (Barry, Kasl, Lichtman, Vaccarino, & Krumholz, 2006). Although investigations of social support in relation to outcomes from CABG surgery are limited, the existing studies support an association.

Social isolation prior to CABG has been related to 30-day and five-year mortality in adjusted analyses (Herlitz et al., 1998). Responding positively to the statement, “I felt lonely”, prior to CABG, was predictive of 30-day (RR 2.61, 95% CI [1.15, 5.95]) and five-year mortality (RR 1.78, 95% CI [1.17, 2.71]) after controlling for medical risk variables in a sample containing 20% women. On the other hand, in a study mentioned previously, analysis adjusted for medical, psychological (BDI and STAI), and demographic risk factors (N = 180, 33.9% women),
perceived social support (Social Support Inventory), assessed prior to CABG surgery, was not associated with a combined mortality and cardiac hospitalization outcome at five years post-CABG surgery (Cserep et al., 2010).

Marital status, a structural component of social support, has been investigated in its ability to predict outcomes from CABG surgery. Being married appears to be protective post-CABG surgery. In one study (N = 569, 27.1% women, mean age = 65.3 years), compared to married patients, CABG patients who were not married had more than three times the adjusted hazard of in-hospital post-operative mortality (HR = 3.33; 95% CI [1.33-8.35]), and a 1.7 times greater adjusted hazard of five-year mortality (95% CI [1.08-2.73]; Idler et al., 2012). The authors posited this association was mediated by health behaviours such as smoking status. When health behaviours were entered into the model, they reduced the association of marriage with long-term survival. Another study investigating marital status at time of CABG surgery (N=225, 76.9% male, age = 33-80 years) found that married patients are 2.5 (p = .001; 95% CI [1.47, 4.24]) times more likely to survive during 15-year follow-up after CABG (King & Reis, 2012). In this study, adjusted analyses testing sex differences suffered from low power due to a small proportion of women in the sample, but patterns for women appeared similar to those of men.

1.3.3.3 Social support, pain and impairment after CABG

Although social support has not been well investigated in CABG surgical patients’ recovery, research in cardiac populations supports its importance. Perceived social support has been related to increased angina and decreased physical functioning one-year post MI (Leifheit-Limson et al., 2010). For those with low compared to high perceived social support relative risks of experiencing angina were greater at six months (RR = 1.45, 95% CI [1.19, 1.77]). In this
sample, significant interactions between sex and perceived social support revealed greater relationships between baseline social support and 12-month outcomes for women. Associations in sub-analyses revealed that in women those with high or moderate (versus low) perceived social support had greater one year QOL, physical functioning, and lower depression after MI. In a study investigating one-year outcomes in patients after an acute exacerbation of their heart failure, low perceived social support at the time of exacerbation was related to decline in physical functioning for men, but not women (Berard, Vandenkerkhof, Harrison, & Tranmer, 2012). Both of these studies suggest sex differences in the effect of social support on pain and function in cardiac populations, but they are not consistent and investigations have not been conducted in CABG surgery patients.

1.3.3.4 Caregiving burden/household responsibilities

Furthermore, caregiving and household responsibilities as contributing to gender roles were also considered. Women often take on the role of family manager and caretaker in western cultures generating greater household responsibilities (Bernard, 1972), so it is possible that household responsibilities are associated more strongly with women’s outcomes. Post-CABG, women report receiving less assistance with household duties than men (Kristofferzon et al., 2003), spending more time on household activities, and experiencing more stress because of this (Kendel et al., 2008). In Kendel et al.’s study (2008) greater household responsibility was not associated with poorer physical functioning, but very little research has investigated this relationship. An associated construct, excessive caregiving burden, has also been related to poorer health in non-cardiac populations. A meta-analysis supports that caregiving of dementia patients is related to an increase in health problems for caregivers (Vitaliano, Zhang, & Scanlan, 2003). Further, in a large (N= 122 683), Swedish, population-based study of caregiving disease
risk, caregivers, both men and women, of patients with cancer were found to have increased risk of CAD and stroke (Ji, Zoller, Sundquist, & Sundquist, 2012).

1.3.3.5 Social support mechanisms

Through the stress-buffering hypothesis (Cohen & Wills, 1985), perceived functional support is thought to be protective against the negative effects of stressful events. Perceiving greater social support may promote less threatening interpretations of events, changing stressor appraisals and improving coping (Cohen, 2004; Cohen & Wills, 1985). Given cardiac surgery and recovery are stressful events, and depression symptoms may increase this stress, social support may work by increasing coping and decreasing perception of threat, leading to better outcomes for those with depression symptoms. Alternatively, a main effect model postulates that integration within a social support network helps to create a positive stable environment, which may be positively associated with well-being, and healthier physiological responses, thus leading to more positive health outcomes (Cohen & Wills, 1985; Uchino, 2006; Uchino et al., 2012).

Social control theory additionally conceptualizes social support may be linked to health outcomes through behavioural processes, such that being part of a social network may help to regulate or constrain behaviours (Lewis & Rook, 1999; Uchino, 2006). Through social control, social support could then lead either to improved health behaviours, or negative health behaviours and distress, depending upon the quality of the relationships and the behaviours of the constituents (S. S. Cohen, 1988).

Support for the association of social support with health behaviours in men and women may come from a study conducted among employees from multiple worksites in two provinces in Canada (N=541; 317 male; age 17-68, from 2000-2004). Structural equation modeling revealed that social ties and job demand predicted greater biopsychosocial health (sleep,
emotional health, energy, concentration and stress), which was in turn related to a healthier lifestyle. This was then related to decreased risk of CAD (Ferris, Kline, & Bourdage, 2012). Having adequate social support additionally appears to predict better outcomes during cardiac rehabilitation. In patients participating in cardiac rehabilitation, tangible support is related to increased exercise tolerance (Fraser & Rodgers, 2010) and better six week physical functioning (Shen et al., 2004).

1.3.3.6 Sex differences in social support and CVD

According to Taylor’s (S. E. Taylor et al., 2000) “tend and befriend” hypothesis, social support may play a larger role in women’s responses to stress than men’s. Therefore, for women, the quality of a relationship and perceived support during a stressful time may be more important than simply having a relationship. In cardiac populations, research has investigated how men and women perceive and use social support differently (Kristofferzon et al., 2003). Kristofferzon et al.’s (2003) research indicates men rely more on social support sources during the year after an MI. Women report not wanting to bother others with their health problems, while men tend to involve their spouses in their treatment. Women additionally report lower perceived social support, lower assistance from spouses, and receive less help with household duties than men (Kristofferzon et al., 2003). A further consideration in CABG populations is that women are more often widowed and thus single (King & Reis, 2012). This occurs because women experience CAD and undergo CABG surgery at a later age.

1.3.3.7 Social support and depression

It is hypothesized that social support is related to negative affect (S. S. Cohen, 1988; Uchino, 2006). In cardiac populations, social support appears to be associated with depression as illustrated by the following studies. Depression has been related to greater social isolation
following MI (Barefoot et al., 2003). In patients with CAD, higher levels of social support have been linked to greater improvements in depression symptoms over time (Barefoot et al., 2000). In one study patients were assessed at cardiac catheterization and again one month later. Analyses revealed an interaction between baseline social support (Interpersonal Support Evaluation List, ISEL) and depression (CESD) in predicting depression one-month post-catheterization. Improvement in depression scores over the month was best for those with the highest baseline social support (Barefoot et al., 2000). In a sample of patients (N = 142, 4 women, 62.15 years) enrolled in cardiac rehabilitation, baseline social support (Medical Outcome Study, MOS) appeared to provide protection from baseline depression, as measured by the BDI, such that those with higher social support had lower depression scores (Shen et al., 2004). Additionally, social support assessed at the time of MI has been related to lower depression at that time (Frasure-Smith et al., 2000; Leifheit-Limson et al., 2010).

Although perceived social support and depressed mood appear to be inversely related, it is unclear if social support moderates the association between baseline depression and outcomes following CABG surgery. There is evidence that it lessens the association of depression with poor outcomes in other cardiac populations. One-year survival after MI was related to levels of depressed mood (BDI) at time of first MI, but an interaction revealed that higher levels of social support (Perceived Social Support Scale, PSSS), at the time of MI, reduced the association between baseline depression and later survival (Frasure-Smith et al., 2000). This relationship was not explored between men and women. Further, in a large international sample of patients with concurrent atrial fibrillation and congestive heart failure (N = 974, 17.7% women), elevated depression symptoms predicted three-year mortality, but the greatest mortality was seen for unmarried participants with higher depression scores (Frasure-Smith et al., 2009).
As social support is related to outcomes in cardiac populations and associated with depression, it was hypothesized that social support moderates the relationship of depression and life function impairment, further procedures, and mortality. Higher levels of social support will buffer the association between depression and these outcomes after CABG surgery. As men and women report using social support differently after CABG surgery, this relationship may vary by sex.

1.3.4 Summary

Depressed mood and interpersonal relationship factors have been linked to cardiac disease and outcomes following CABG surgery (Barth et al., 2010; Blumenthal et al., 2003; Frasure-Smith & Lesperance, 2005; Hawkins et al., 2014; Herlitz et al., 1998; King & Reis, 2012). Depression, defined as depression symptoms, depressed mood or a diagnosis of depression, has clearly received the most attention in the cardiac literature. Depression and depression symptoms have been associated with development and worsening of CAD (Lichtman et al., 2009), and poorer outcomes following CABG surgery (Blumenthal et al., 2003). Both higher perceived social support (Lett et al., 2005) and structural support, in the form of a marital partner (Williams et al., 1992), have been related to lower levels of CAD. Being married has also been related to better long-term mortality following CABG surgery (Idler, Bouliafard & Contrada, 2012; King & Reis, 2012). Little research has investigated these psychosocial variables in combination either additively or interactively in patients experiencing CABG surgery. Given associations between depression and social support, investigation of these variables in combination is needed.

Although depression has been operationalized in many ways in this literature, for these studies, we chose depression symptoms measured as a continuous variable with the Beck
Depression Inventory (BDI; Beck, Ward, & Mendelson, 1961). Additionally, given the previous literature and the convention of dividing social support into functional and structural types of support (Barth et al., 2010; Langford et al., 1997; O'Reilly, 1988; Uchino, 2004; Xanthopoulous & Daniel, 2012), we chose to measure both perceived social support, as measured by the Interpersonal Support Evaluation List (ISEL; Cohen et al., 1985), as a functional support variable and marital status (married or common-law) as a measure of structural support. Further, given our goal to investigate variables important to women’s outcomes, we chose to investigate household responsibilities with the Marital Response Questionnaire (MRQ; Buxbaum, 1967), and consider it a gender-role variable.

1.4 Medical models and long-term mortality after CABG

Although the majority of patients undergoing CABG surgery have excellent long-term survival (Wu et al., 2012) and thorough guidelines regarding when and how to perform CABG surgery exist (Hillis et al., 2011), there is still interest in which medical risk factors may be associated with long-term survival following CABG surgery. Knowing medical risk associated with outcomes following CABG surgery assist medical teams in balancing risks of surgery. Operative mortality, morbidity and long length of hospital stay outcomes have been investigated surrounding the time of CABG and are often considered short-term risk outcomes (Anderson, 1994; Shahian et al., 2009a). As our study was interested in investigating outcomes of individuals who had survived CABG surgery without severe morbidity, our interest is in long-term survival (at least 30 days or longer) following CABG surgery. Two recent reports, conducted with large databases, have developed long-term calculators of mortality using traditional medical risk variables available at the time of CABG surgery (Shahian et al., 2012; Wu et al., 2012). This section briefly discusses both of these.
The ASCERT study (Shahian et al., 2012) was conducted to develop a long-term mortality calculator and included 348,341 older (≥65 years-of-age), patients undergoing isolated CABG surgery in the United States from 2002-2007. Follow up was conducted using national databases for one to six years and provided mortality estimates for 30 days (3.2%), 180 days (6.4%), 1 year (8.1%), and at 3 years (23.3%). The team concluded that different medical risk predictors were important for short-term versus long-term mortality, so developed a long-term mortality calculator using Cox proportional hazard models for better estimates of long-term outcome post-CABG. “The magnitude of effect of some important early predictors of risk, including current smoking, insulin-dependent diabetes mellitus, and dialysis-dependent renal failure, increased over time, suggesting an accumulation of risk from these debilitating chronic behaviors and diseases. On the other hand, the effect of some important early predictors of increased mortality (e.g. emergency status, cardiogenic shock, acute preoperative MI, and reoperation) diminished rather quickly and became nonsignificant for those patients who survived the early postoperative and recovery periods.” (Shahian et al., 2012; 1495). The regression model calculated fit the data well with a Harrell’s C for overall survival time of 0.732. This model was developed with an exceptionally large dataset collected through voluntary cooperation of surgical sites. Unfortunately, this calculator was developed using only patients 65 years-of-age or older, so may not be appropriate for all prediction calculations.

A similar long-term survival calculator was developed using the New York State Cardiac Surgery Reporting System Database (Wu et al., 2012). This is a state wide mandatory reporting database for all (33) non-federal hospitals. From July to December 2000, 8597 patients underwent isolated CABG in New York State. The seven-year mortality rate was 24.2%. An additive risk model to predict death was developed for one, three, five and seven years post-
CABG. Patient’s total points ranged from 0-28. Predictors that remain significant in the long-term model are: “age, body mass index, ejection fraction, unstable hemodynamic state or shock, left main coronary artery disease, cerebrovascular disease, peripheral arterial disease, congestive heart failure, malignant ventricular arrhythmia, chronic obstructive pulmonary disease, diabetes mellitus, renal failure, and history of open heart surgery”. The model had an adequate C-statistic to differentiate at seven years (0.782). A drawback of this model is that it did not include behavioural risk factors thought to be important to long-term outcome, such as smoking, as they were not available.

In investigating how psychosocial variables may be associated with outcomes following CABG surgery, we wanted to adjust for important medical variables associated with these same outcomes. By using a single score calculated with a risk calculator to estimate disease severity, we were able to capture those medical risk factors most associated with outcomes and then determine if our chosen variables predicted further variance in outcome. This allows decreasing the number of variables entered in the model, and given the sample size, would allow investigating a larger number of psychosocial variables. Although both of these calculators employed excellent psychometrics and are simple to employ with patients, the ASCERT calculator was developed using only patients over 64 years-of-age. The calculator developed in New York State used patients of all ages and employed a mandatory reporting for hospitals, so is most likely more inclusive than the ASCERT calculator, which employed a voluntary reporting scheme. As our patient population spans all ages we thought the New York based calculator may be more appropriate to use with our sample. Additionally, the New York calculator did not include sex as a covariate, allowing us to include this variable separately in analyses.
1.5 Rationale

Both depression symptoms and social support factors, such as perceived social support and structural support (e.g. marital status), are related to CAD. As CABG surgery is a recommended intervention for those with significant coronary artery stenosis in men and women, it offers an opportunity to study psychosocial variables in individuals with significant CAD. Although there is evidence that depression symptoms and social support are related to long-term outcomes from CABG, and sex differences exist in these psychosocial variables, little research has investigated how these factors may differentially be associated with outcomes in men and women. As well, despite relationships among psychosocial factors (Barefoot et al., 2000; Frasure-Smith et al., 2000; Shen et al., 2004), little research has investigated these interactions in relation to outcome following CABG surgery. Further, as one goal of CABG surgery is to improve how people function in their lives, it appears important to investigate factors associated with how people function in marital, familial, recreational and occupational areas. Currently only physical and occupational functioning have been investigated as a proxy for functioning in general. This dissertation seeks to investigate how depression symptoms, perceived social support, functional support (marital status), household responsibility, and life functioning are associated with outcomes from CABG surgery. For this dissertation we chose to assess depression symptoms as a psychological measure of depressed mood using the BDI (Beck et al., 1961). We also chose to measure three variables related to interpersonal relationships: Perceived social support (ISEL; Cohen et al., 1985), as a measure of functional support, marital status (being married or common-law) as a measure of structural support and household responsibilities (MRQ; Buxbaum, 1967), conceptualized as a gender-role variable. Additionally, we investigated life function impairment using the West Haven Yale Multidimensional Pain Inventory
(WHYMPI; Kerns et al., 1985). These studies will add to the literature due to the large proportion of women in the sample and the simultaneous measurement of multiple psychosocial variables, thought to be important to women’s recovery in particular, at more than one time point. This longitudinal, prospective, observational study investigates the relationships among these variables and outcomes from CABG surgery over two studies (chapter two and three).

In chapter two we present a study investigating whether immediate post-CABG psychological (depression symptoms) and social measures (perceived social support, household responsibility, and marital status) predict unique variance in life functioning (social, familial, marital, recreational and occupational) one-year post-CABG surgery, above that predicted by traditional risk factors (sex, smoking status at surgery, participation in cardiac rehabilitation after surgery, and disease severity (risk for long-term mortality)). Additionally, this study investigates the interaction between depression symptoms and perceived social support, and whether these variables are differentially associated with functional impairment for men and women.

Chapter three describes a study investigating the predictive association of psychological (depression symptoms) and socially related measures (perceived social support, household responsibility, and marital status), and life function (social, familial, marital, recreational and occupational), available following surgery and one year post-CABG, with mortality and cardiac procedures over 13-15 years post-surgery. Analyses are adjusted for variables traditionally used medically to predict mortality (sex, smoking, participation in cardiac rehabilitation, valve procedure during CABG, receipt of internal thoracic graft, and disease severity (risk for long-term mortality)). Although depression symptoms and social support variables have been related to long-term mortality and morbidity after CABG surgery in isolation, little research has investigated these predictors in combination, in samples with high proportions of women, or
investigated sex differences among predictors. Additionally, it is not clear at what point following CABG surgery depressive symptoms and socially related variables may be most highly related to long-term mortality and morbidity. Better delineation of these relationships would allow for better planning of interventions and determining when to best offer interventions. Finally, chapter four summarizes the findings of this research, discusses the results, reviews limitations and suggests areas for future research.

1.6 Measures included in this study

The following is a description of the standardized measures used in this study. They include measures of: depression symptoms, functional perceived social support, household responsibilities, pain and life function impairment, medical predictors of long-term mortality following CABG surgery, and a measure not used in analyses: marital satisfaction.

1.6.1 Depression symptoms

The Beck Depression Inventory (BDI) is a 21-item, multiple choice format, self-report scale measuring depression symptoms (Beck et al., 1961). For each item participants circle the statement that best describes their feelings over the past week. Items are scored on a 4-point Likert-type scale from 0-3 providing a total score ranging from 0-63 with higher scores indicating more severe symptoms. Clinical cut-off scores are provided indicating severity of symptoms: 0 to 9 minimal to no depression, 10 to 18 mild to moderate, 19 to 29 moderate to severe, and 30 to 63 severe. The BDI assesses affective, behavioral, physiological and cognitive symptoms of depression and is highly correlated with other measures of depression (Beck, 1967; Beck et al., 1988). The BDI demonstrates good discriminant validity by correctly categorizing individuals according to their levels of depression. In addition, it is a valid measure of depression in older individuals, such as cardiac patients (Gallagher, Neis & Thompson, 1982). Internal
consistency was adequate in the current sample (Cronbach $\alpha = .85$) and internal consistencies, ranging from coefficient $\alpha = .73$-.92 with a mean of .86, have been reported in validation samples (Beck, Steer, & Carbin, 1988). Although the BDI is meant to assess components of mood which are not necessarily considered stable over time, test-retest reliability of outpatients provides a range of correlations from 0.60 to 0.83 over times ranging from one hour to four months (Beck et al., 1988). In participants recently experiencing an MI, Cronbach’s $\alpha = 0.81$ and sensitivity (83.8) and specificity (71.7) to detect a diagnosis of depression by semi-structured interview was adequate (Strik, Honig, Lousberg, & Denollet, 2001).

1.6.2 Functional, perceived social support

The Interpersonal Support Evaluation List (ISEL; Cohen et al., 1985) is a 40-item, self-report measure of perceived social support (Appendix A). The ISEL provides a total score consisting of four subscales of 10 items each: appraisal, tangible, self-esteem and belonging. The ISEL has adequate test-retest reliability over 6 months ($r=.74$) and adequate internal consistency (Cronbach’s $\alpha = .88$.90). Adequate concurrent validity has been demonstrated with other measures of social support, such as the Functional Social Support Questionnaire (Isaacs & Hall, 2011). The current sample had good internal consistency (Cronbach $\alpha = .88$).

1.6.3 Household responsibilities

The Marital Roles Questionnaire (MRQ; Buxbaum, 1967) assesses housework involvement, household responsibilities and social activities (Appendix A). The MRQ has adequate internal consistencies ranging from .67 to .71 for four subscales. The MRQ was developed to assess wives’ changing roles after their husband had developed aphasia from stroke. The household responsibilities subscale (15 items) assesses participant’s responsibilities in maintaining a household, including housework, fixing things around the house, cooking, and
paying bills. Participants rated 15 roles/activities on a 1-4 Likert-Type scale with 1=‘done by me almost all of the time’, 2= ‘done by my spouse, 3=done together and 4=done by others.

Responses were modified to obtain an overall score indicating patient responsibility for each activity with 2=means done by patient almost all the time, 1=done with spouse or others, and 0=mainly done by spouse or others. This transformation permitted completion by individuals living alone (Responsibilities Questionnaire, RQ). For individuals living alone 2=done by me almost all the time, 1=done by myself and others, and 0=done primarily by others. The household responsibilities score was calculated by taking the mean of all the items, yielding a range of 0-2. The MRQ had moderate internal consistency (Cronbach’s α= .61). The second and third subscales, measuring liking of responsibilities and participation in social activities, were included in the questionnaire package but not used in the analysis. The fourth subscale, assessing marital satisfaction, was excluded as it was considered redundant to the already included Dyadic Adjustment Scale (DAS).

1.6.4 Pain and life function impairment

The West Haven-Yale Multidimensional Pain Inventory (WHYMPI; Kerns et al., 1985) measures pain severity and life function impairment (LFI; Appendix A). LFI is defined as interference from pain: “…including interference with family and marital functioning, work and work-related activities, and social-recreational activities.” (Kerns et al., 1985; p. 347). The WHYMPI is a 52-item inventory with items rated on 7-point Likert-type scale from 0-6. It consists of 12 subscales, of which two were utilized in this study: pain severity (3 items) and interference (9 items). Pain severity assesses perceived cardiac pain with higher numbers indicating greater pain. LFI evaluates the amount of interference with daily activities experienced as a result of cardiac pain. Higher numbers indicate greater LFI. Post-CABG,
patients were asked to rate their pain and LFI currently and retrospectively, prior to surgery. As elevated pain and LFI are expected immediately after CABG surgery, retrospective assessment of pain and LFI prior to surgery were used as baseline measures. WHYMPI internal consistency for interference (Cronbach $\alpha = .90$) and pain severity (Cronbach $\alpha = .83$) are adequate (Kerns, Turk & Rudy, 1985). In the current sample, both subscales demonstrated good internal consistency: Pain severity (Cronbach $\alpha = .80$), and interference (Cronbach $\alpha = .91$). Test-retest reliability over two weeks is adequate, ranging from .73-.89 (Bergstrom, Jensen, Linton, & Nygren, 1999).

1.6.5 Medical predictors of long-term mortality risk after CABG

We adjusted analyses for medical risk factors which could be associated with long-term mortality and FI after CABG. A long-term mortality risk score was chosen over the inclusion of multiple individual clinical risk predictors, to better capture risk factors with strong relationships to CABG health outcomes. The Risk Score for Predicting Long-Term Mortality After Coronary Artery Bypass Graft Surgery (NYLT) based on the New York State Cardiac Surgery Reporting System (Wu et al., 2012), was chosen as the most appropriate medical risk predictor for this study. It was developed using a Cox proportional hazards model on 8597 isolated CABG surgery patients (from July-December 2000) from 33 hospitals in New York State. All-cause mortality data were collected using the National Death Index up to December 31, 2007. A derivation and validation subgroup was used. Significant predictors included: age, BMI, Ejection Fraction, hemodynamically unstable or shock, left main coronary artery disease, cerebrovascular disease, peripheral arterial disease, congestive heart failure, malignant ventricular arrhythmia, chronic obstructive pulmonary disease, diabetes, renal failure and previous open heart operations. Item sub-scores are summed to derive a total score, which provides percent predicted mortality for 1,
3, 5 & 7 years. Benefits of this measure were that it was developed using patients undergoing CABG in the same era as our sample and it did not include sex, allowing us to separately investigate sex. The ASCERT Long-Term Survival Probability Calculator for CABG (Shahian et al., 2012) was ruled out as it was developed on patients over 65-years of age.

For our sample, NYLT scores were calculated using data from charts and provincial databases. Information was available for most NYLT risk factors, with the following exceptions. Exact ejection fraction (EF) was not available for 2/3 of our sample (n = 220), with EF coded as <35, 35-50 and >50 for the majority. Wu and colleagues (2012) coded EF as <30 = 2, 30-39 = 1, and >=40 = 0. We coded EF<35 as 2, 35-50 as 1 and >50=0. For our data, 2/3 of the sample (n = 220) had dialysis/elevated creatinine coded as present/absent, while NYLT coded elevated creatinine = 3 and dialysis = 6. Individuals coded elevated creatinine/dialysis present were coded 3 for elevated creatinine, but not 6 for dialysis, to ensure conservative bias in scoring. Missing risk factors were coded as no in our data, as was conducted with the New York database. Although the NYLT distribution frequency score of our sample was not expected to mirror the New York frequency exactly, due to more women in our sample, our median NYLT score was the same as the New York State sample (median = 5). A bootstrapped t-test of the mean NYLT score between those known to be deceased, hospitalized, or too confused/sick to participate one year post-CABG and participants provided predictive validity (t (281) = -1.655, p = .022; 95% CI [-3.30, -.12]). Individuals we were not able to contact at one year post-CABG were not included in this t-test.

1.6.6 Measure not used in analysis, marital satisfaction

The Dyadic Adjustment Scale (DAS; Spanier, 1976) is a 32-item measure of marital satisfaction, completed only by married patients (Appendix A). It assesses satisfaction with
marriage, dyadic cohesion, consensus among partners and expression of affection. Responses are recorded along a series of 5 and 6-point Likert-type scales, two yes/no questions, and one final question where individuals are asked to endorse the statement which best reflects their expectation of relationship continuity (six response alternatives provided). DAS total scores can range from 0-151. The DAS provides a total score composed of four subscale totals, but the scale total is the score most often reported. Higher total scores are indicative of greater marital quality. DAS total scores may be divided into four categories of marital quality: “divorce is likely” (total = <70), “distressed marriage” (total = 71-99), “stable marriage” (total = 100-113), and “happily married” (total = > 114). The DAS is a widely used measure of marital quality and satisfaction, and as such has good psychometric properties. Locke & Wallace (1959) report good discriminant validity, distinguishing between married and divorced couples, and good concurrent validity with the Marital Adjustment Scale (r = .86). Reliability (Cronbach’s α = .96) and validity are supported (Spanier & Thompson, 1983) and scores appear to be stable with eleven-week test-retest reliability good (r = .96; Spanier 2001). In the current sample, the DAS had high internal consistency (Cronbach α = .92).

This measure was not used in our analyses as the focus of this study was to investigate differences between men and women in outcome. In our sample, many more men (n = 112, 84.21% of men) than women (n = 58, 56.86% of women) were married, leading to a problem in that analysis of marital satisfaction would be an analysis conducted on a smaller sample size (of only married participants) which would have very few women.
Chapter Two: **Psychosocial and medical predictors of one-year functional outcome in male and female coronary artery bypass graft recipients**

2.1 Abstract

*Background* This study examines the association of baseline medical and psychosocial variables with one-year post-CABG life function impairment in social, family, recreational and occupational areas (LFI). Sex differences and the buffering effect of social support are investigated. *Methods* This prospective, observational study recruited 296 (42% female) post-CABG patients of whom 234 (79%; 43% female) participated at one-year follow-up and had complete data. Clinical variables and demographics were collected after surgery. Depression symptoms, perceived social support, household responsibilities, marital status and life function impairment were assessed at baseline and one-year later. Hierarchical linear regression examined adjusted relationships between baseline psychosocial variables and one-year life function impairment. *Results* Disease severity did not predict one-year life function impairment which was, however, partially predicted by baseline depression, social support, household responsibilities, and marital status ($R^2 = .20$, $p < .001$). Baseline depression predicted one-year FI at mean ($b = 0.15$, 95%CI [0.29, 1.93]) and higher ($b = 0.30$, 95% CI [0.12, 0.48]) perceived social support. Baseline perceived social support was associated with greater reduction in one-year life function impairment for women (interaction $b = 0.29$; 95%CI [0.06, 0.52]) and buffered the association between depression symptoms and life function impairment in women only ($b = -0.25$, 95%CI [-0.42, -0.09]). *Conclusions* A cluster of psychosocial factors, but not disease severity, was a significant indicator for long-term life function impairment in bypass graft recipients. For women perceived social support buffered the effect of depression on life function impairment.
2.2 Introduction

2.2.1 Background and rationale

Given excellent survival rates after first myocardial infarction (MI) (Goodman et al., 2009), clinical practice and research increasingly focus on rehabilitation, aiming to restore function and quality-of-life (QOL). Rehabilitation activities and concerns vary as patients move along the recovery trajectory. The first few months of care focus on medical stabilization and physical rehabilitation, the next phase is more concerned with health behaviour change and return to function. Ultimately, the goal of cardiac surgery is of course to extend life span but, given the lengthy survival rates of cardiac patients, only very long-term follow-ups are sufficient to detect differential predictors of mortality. Therefore, the current study focused on 1-year follow-up data and is concerned with return-to-function and its predictors. Among these, the relationships among pain and physical function, along with depression and social support, have been investigated (Borowicz et al., 2002; Burg, Benedetto, Rosenberg, et al., 2003; Foss-Nieradko et al., 2012; Goyal et al., 2005; Karlsson et al., 1999; Kendel et al., 2010; Lee, 2009), but little research has prospectively assessed these predictors of long-term interference with functioning in family, occupational, social and recreational arenas. The consequences of coronary artery bypass graft surgery (CABG) on life function and recovery are wide ranging and affect patient QOL but also have significant economic consequences. For example, accelerated return to work saves money to health insurance carriers and the larger economy while boosting the individual’s sense of worth.

2.2.2 Psychological characteristics, social environment and adjustment

For the study of adjustment processes, we differentiate between within-person characteristics, in particular depression, and characteristics of the social environment (e.g., social
support). Depression is the most studied singular predictor of post-CABG adjustment and carries a roughly 2:1 independent risk for subsequent mortality (Blumenthal et al., 2003). Depression is elevated surrounding CABG surgery (20-30%; Tully, 2012), and more prevalent in women (Blumenthal et al., 2003). Depression may raise cardiac risk through increased inflammation (Lesperance et al., 2004) and endothelial, autonomic and hypothalamic-pituitary-adrenal axis dysfunction (Chen et al., 2013; C. B. Taylor et al., 2006), and by reducing medication adherence (Safren et al., 2001), and impairing post-operative self-management (Fredericks et al., 2012). Further, post-CABG, patients with elevated depression symptoms report greater pain, decreased physical function (Borowicz et al., 2002; Burg, Benedetto, Rosenberg, et al., 2003; Foss-Nieradko et al., 2012; Goyal et al., 2005; Kendel et al., 2010; Lee, 2009), and are less likely to return to work (Soderman et al., 2003). Although less research exists investigating social variables in this population, perceived social support is also related to decreased physical function post-MI (Leifheit-Limson et al., 2010), while feeling lonely (Herlitz et al., 1998) and structural support (in the form of not having a marital partner) are associated with increased mortality following CABG surgery (King & Reis, 2012).

No research has investigated the combined influence of depression and social factors on how individuals function in important life roles after CABG and filling this void is the goal of the current manuscript. Despite known associations between social support and mood (Barefoot et al., 2000; Leifheit-Limson et al., 2010; Shen et al., 2004), and the stress buffering effect of social support (Cohen & Wills, 1985), few studies recognize the association of depression with poor outcome may be moderated by patient’s social resources.
2.2.3 Sex differences

Sex differences have been shown in both medical treatment and psychosocial rehabilitation. At the medical level, men and women receive cardiac revascularization at similar rates once diagnosed, but men with ischemia are more likely to receive diagnostic angiograms and aggressive medical therapy (Bugiardini et al., 2010). Post-CABG surgery, women experience higher mortality, more pain, complications, and physical impairment (Lehmkuhl et al., 2012; Tamis-Holland et al., 2013) and drop out of cardiac rehabilitation at higher rates than men (Caulin-Glaser et al., 2007). Due to these differences, sex specific analyses are called for, but rarely undertaken (Blauwet et al., 2007).

At the psychological level, functional impairment is likely a cause and a consequence of differential emotional adjustment. Psychosocial factors, in particular depression, perceived social support, and marital status likely form a cluster of factors that impacts long-term cardiac rehabilitation and should be studied together while simultaneously recognizing consistently reported sex differences in these variables and processes. Furthermore, activity in the home and its association with outcome may reflect a sex-role variable because women spend more time on household activities after CABG surgery, and experience significantly greater stress due to these activities (Kendel et al., 2008). In summary, social environment factors and depression may affect cardiac outcomes, but research has not clarified how depression and social variables combine and interact to predict outcomes after CABG surgery among men and women.

2.2.4 Hypotheses

This prospective, observational study examines predictors of one-year life function impairment after CABG surgery with a focus on sex differences. We hypothesize that post-operative depressed mood, low perceived social support, lack of a partner (low structural
support), and high household responsibilities will independently predict life function impairment one year post-CABG surgery over and above traditional medical risk predictors. As structural support and functional support are associated with outcomes following CABG surgery (Herlitz et al., 1998; King & Reis, 2012), we sought to investigate both. Given previous associations of depressed mood with poor outcomes post-CABG, depression and social variables will be entered separately to investigate whether social variables explain additional variance. We also hypothesize that perceived social support will buffer the association of depression symptoms with outcome, and the relationships of depression and social variables with outcome will differ by sex.

2.3 Methods

2.3.1 Participants

After first CABG, 296 patients (M=171, F=125; age range: 36-88 years) were recruited within a Canadian cardiac centre (see Figure 2.1). Of the 438 patients initially approached, 67.6% participated at baseline. At one-year post-CABG, questionnaires from 231 complete participants (M = 133, F = 101) were available for analysis (79% of baseline participants and 53.4% of initial patients approached).

Inclusion criteria: Minimum 18 years of age and first CABG surgery; surgery conducted at target hospital; patient still in hospital and day three or later following CABG surgery. Exclusion criteria were developed to ensure participants were able to complete questionnaires with minimal assistance and to minimize strain or harm which might interfere with recovery. Exclusion criteria were assessed by examining chart notes and discussion with nursing staff and include: serious medical problems; unstable vital signs; angina in the last 12 hours; history of previous CABG surgery; complicated course following CABG surgery; deaf, blind, or hard of
hearing; insufficient ability to comprehend, read, and/or speak English; mental illness/behavioural disorder including anxiety, distressed, hostile or negative affect as claimed by nursing staff; or confused or exhibiting neurological deficits.

2.3.2 Procedures

Two trained research assistants approached participants on the ward on day 3 or later after a first CABG +/- valve surgery. To ensure confidentiality and honesty of responding, patients were provided a questionnaire package to complete independently, and an envelope to leave the questionnaire with the nurses prior to discharge. Recruitment continued until 125 women enrolled. Participants were contacted again by mail one-year post-CABG surgery to complete a further questionnaire package including the original questionnaires and questions regarding activities since the CABG surgery. Baseline medical risk and surgical variables were obtained from hospital charts and a provincial database (Cardiac Services BC). Questionnaires assessed depression symptoms, perceived social support, household responsibilities, marital status, pain severity and life function impairment. This study was approved by local ethics boards and all participants provided written informed consent.

2.3.3 Measures

2.3.3.1 Disease severity

The Risk Score for Predicting Long-Term Mortality after CABG Surgery, based on the New York State Cardiac Surgery Reporting System (NYLT), has well demonstrated predictive validity for cardiac mortality (Wu et al., 2012). It was chosen to adjust analyses for baseline cardiac disease severity, over the inclusion of multiple, individual clinical risk predictors, to better capture risk factors with strong relationships to CABG outcomes. The NYLT score is a sum of weighted item subscores for baseline: age, BMI, ejection fraction, hemodynamically
unstable or shock, left main coronary artery disease, cerebrovascular disease, peripheral arterial disease, congestive heart failure, malignant ventricular arrhythmia, chronic obstructive pulmonary disease, diabetes, renal failure, and previous open heart operations. Missing risk factors (except for LVEF) were coded as “no”.

2.3.3.2 Self-report measures

The West Haven-Yale Multidimensional Pain Inventory (WHYMPI) is composed of 12 subscales, of which two were utilized in this study: pain severity (3 items) and interference (9 items). Pain severity assesses perceived cardiac pain. Life function impairment was assessed with the interference subscale which evaluates the amount of interference “… in family and marital functioning, work and work-related activities, and social-recreational activities” (Kerns et al., 1985 p. 347) experienced as a result of cardiac pain. Scores range from 0-6, with higher numbers indicating greater pain or life function impairment. Retrospective assessment of life function impairment prior to surgery was used for baseline adjustment, while the one-year measure was used as our outcome with high internal consistency (Cronbach’s $\alpha = .91$ and .80).

Depression, operationalized as a continuous measure of depression symptoms, was assessed with the Beck Depression Inventory (BDI; Beck et al., 1961). This measure has been widely used and validated and is a valid measure of depression in older individuals, such as cardiac patients (Gallagher, Nies, & Thompson, 1982). The BDI had high internal consistency in this sample (Cronbach’s $\alpha = .85$). Marital status was used as a measure of structural support, while the Interpersonal Support Evaluation List (ISEL) measured overall perceived social support (Cohen et al., 1985). Mean ISEL scores ranged from a low of 0 to a high of 10. The ISEL has adequate concurrent validity with other measures of social support (Isaacs & Hall, 2011) and exhibited high internal consistency in this sample (Cronbach’s $\alpha = .88$). The household responsibilities
subscale (15 items) of the Marital Roles Questionnaire (MRQ) assessed patient participation in: housework, repairs, cooking, and paying bills, with higher scores indicating greater patient responsibility (Buxbaum, 1967). Responses on the MRQ were modified to obtain a score indicating patient responsibility with 2=done primarily by patient, 1=done with spouse or others, and 0=mainly done by spouse or others. This transformation permitted completion by individuals living alone. The MRQ had high internal consistency (Cronbach’s α = .86).

2.3.4 Statistical analyses

All participants with complete one-year post-CABG follow-up questionnaires were included in analyses. To describe unadjusted differences in baseline variables between men and women, Mann-Whitney U and chi-square tests, as appropriate, were conducted by sex. To investigate univariate relationships among dependent and independent variables, Pearson’s Correlations, for continuous, ordinal, and Spearman’s Rho, for dichotomous variables, were employed. Finally, ordinary least squares multiple regression was used to test adjusted associations between baseline psychosocial variables and one year FI. Given predictor variables exhibited heteroscedasticity, standard errors and confidence intervals were generated with heteroscedasticity-consistent estimators and bootstrapping to ensure unbiased estimates (Hayes & Cai, 2007). To provide regression coefficients describing the SD change in life function impairment due to a 1SD increase in predictor, after partialling out included predictors, all variables were standardized to z-scores (with mean = 0 and SD = 1). Hierarchical forced entry regression was conducted to investigate whether social variables added further explanatory power over depressed mood. Predictor variables were retained regardless of significance. Block one includes sex, baseline life function impairment, disease severity (NYLT), smoking status at surgery, and cardiac rehabilitation participation; block two is depression symptoms; block three
includes social variables: perceived social support, household responsibilities, and marital status; and interactions were tested in block four. One-tailed tests assessed predictors with prior directional hypotheses (BDI, ISEL, Marital Status, MRQ, and NYLT). P-values < .05 were considered significant. Given our priority of investigating the buffering effects of social support and sex differences among predictors, interactions were investigated in one block and individually. Significant interactions were explored with simple slopes, estimated either at levels of dichotomized variables or at the mean and 1SD above and below the mean for continuous variables. Analyses were conducted using IBM SPSS Statistics v.21 (IBM Corporation, 2012).

2.3.5 Results

2.3.5.1 Patient characteristics by sex

Sample characteristics by sex are presented in Table 2.1. Although an equal proportion of men and women reported experiencing life function impairment prior to CABG surgery, by one-year, a higher proportion of women reported life function impairment. Additionally, at both times, women reported higher levels of life function impairment. Pain was similar for both sexes. Regarding sex differences, women reported higher depression symptoms and household responsibilities, at both times, and lower perceived social support at one-year. Baseline-only participants and one-year post-CABG participants differed only by higher baseline disease severity for female compared to male participants (U(294) = 8932.0, Z = 2.42, p = .015).

2.3.5.2 Unadjusted relationships

At baseline, higher depression was moderately related to lower social support, but also related to greater household responsibilities, while social support was unrelated to household responsibilities (Table 2.2). Both higher baseline depression symptoms and lower baseline social support were moderately associated with greater follow-up pain and life function impairment.
Married participants reported lower household responsibilities (large effect size), indicating household activities were most likely shared with a partner. Furthermore, at baseline, greater disease severity had small positive correlations with being unmarried, but also with higher perceived social support and lower smoking status at surgery. Given only a small number of participants reported smoking (18%) at surgery, this result may not be reliable. Opposite directions for correlations of marital status and perceived social support with disease severity lend support these variables are measuring different constructs. Finally, a high correlation exists between one-year cardiac pain and life function impairment however their overlap (shared variance 42%) is not so strong that either can be treated as a proxy for the other.

2.3.5.3 Multiple regression

In block one, only baseline life function impairment was related to one-year post-CABG life function impairment (Table 2.3) and remained significant throughout the analyses. In the model adjusted for sex, disease severity, smoking, cardiac rehabilitation participation, clinical risk and baseline life function impairment, depression significantly predicted one-year life function impairment (block two $\Delta R^2 = .01, p = .049$). In block three, after the addition of social variables, greater perceived social support, household burden and being married were all related to lower life function impairment, but depression symptoms were no longer associated with outcome (block three $\Delta R^2 = .07, p = .004$). At this stage, depression symptoms becoming non-significant indicating some of the variance in outcome previously attributable to depression was now accounted for by perceived social support, being married and household responsibilities. In the final model (block 4 $\Delta R^2 = .04, p = .01$), both depression symptoms x perceived social support and perceived social support x sex interactions significantly explained 3.0% and 1.6% of the variance in an overall model accounting for 19.8% of the variance in one-year FI (medium
effect size, $f^2 = .16$). These interactions were interpreted with the following simple effects analyses.

2.3.5.4 Analysis of simple effects (Figure 2.2)

Analysis of the depression symptoms $\times$ perceived social support interaction was conducted first and indicated a 1SD increase in baseline depression symptoms was associated with greater one-year life function impairment at high ($b = .30$, $SE = .09$, $p = .007$, 95% CI [0.12, 0.48]) and mean social support ($b = .15$, $SE = .07$, $p = .027$, 95% CI [0.01, 0.31]), but not low social support ($b = .01$, $SE = .06$, $p = .876$, 95% CI [-0.12, 0.15]). This supports baseline depression symptoms being related to greater one-year life function impairment, but only when perceived social support is not low and does not support an overall buffering effect of perceived social support on the association between depression symptoms and one-year life function impairment.

Given concurrent, significant perceived social support $\times$ sex and depression symptoms $\times$ perceived social support interactions, ISEL was analyzed as conditional effects at levels of baseline depression symptoms and sex (Figure 2). For men, a 1SD increase in perceived social support was associated with decreased one-year life function impairment at low baseline depression ($1SD < \text{mean}; b = -.25$, $SE = .11$, $p = .037$, 95% CI [-.47, -.02]), but not mean ($b = -.11$, $SE = .10$, $p = .34$, 95% CI [-.30, .08]) or high depression ($b = .03$, $SE = .10$, $p = .81$, 95% CI [-.17, .22]). This signifies no perceived social support buffering of the association between high depression symptoms and life function impairment for men, and indicates perceived social support is only associated with outcome when men report low depression symptoms. For women, a 1SD increase in baseline social support was associated with decreased one-year life function impairment at all levels of baseline depression: low ($b = -.53$, $SE = .10$, $p < .001$, 95%
CI [-.74, -.32]), mean (b = -.40, SE = .08, \( p < .001 \), 95% CI [-.56, -.23]) and high (b = -.25, SE = .09, \( p = .009 \), 95% CI [-.42, -.09]). This supports a buffering role for perceived social support on the association between high baseline depression symptoms and later life function impairment and indicates high perceived social support had a larger effect in reducing one-year life function impairment in women.

2.4 Discussion

Disease severity and traditional medical risk factors did not longitudinally predict life function impairment one-year post-CABG whereas psychosocial factors did. Higher perceived social support buffered the association between depression at surgery and one-year life-function for women, but an overall buffering role was not found. After adjusting for: sex, baseline life function impairment and factors traditionally associated with medical risk; depression symptoms explain unique variance in impairment and social variables add further explanatory power. An interaction between baseline depression and lower perceived social support, being single, and reporting lower household responsibilities at the time of CABG surgery are associated with poorer life function one-year post-CABG. These findings predict those who are married, reporting high household responsibilities, high perceived social support and low depression symptoms would have the highest life function one-year post-CABG.

Unexpectedly, higher depression symptoms after CABG surgery are only associated with reduced one-year life function when perceived social support at surgery is average or higher. Sex differences also revealed for men both depression symptoms and poor perceived social support are related to lower one-year life function, but for women, although low perceived social support is related to impairment in one-year life function, those with both high depression symptoms and higher perceived social support at CABG surgery have better one-year life function.
Although perceived social support has not been previously investigated in how patients function after undergoing CABG surgery, our results are consistent with research in other cardiac populations in which social support was more strongly related to QOL for women during the year after recovery from an MI (Leifheit-Limson et al., 2010) and previous literature associating post-CABG depression with later physical impairment (Burg, Benedetto, Rosenberg, et al., 2003; Goyal et al., 2005; Kendel et al., 2010; Lee, 2009). Although we expected single individuals to report greater one-year life function impairment, due to less in-home assistance and support (Uchino, 2006), we also expected household responsibilities to be associated with poorer function, particularly in women. Contrary to our expectations, greater household responsibility at baseline, which we had hypothesized to be sex-specific and reflective of increased stress for women (Kendel et al., 2008), is associated with less one-year life function impairment for both men and women. Baseline ‘household responsibilities’ may indicate better functioning prior to surgery, and may provide increased desired activity after surgery.

It is not unexpected that our outcome of function in social, family, recreational and occupational areas is associated with pain and social support. Support for the structural support of a marital relationship in increasing healthy behaviours was proposed by Social Control Theory. This conceptualizes social support as helpful to regulate or constrain behaviours, possibly in a healthier direction, even if this control increases distress (Lewis & Rook, 1999; Uchino, 2006). Possibly being married and having higher perceived social support at time of CABG improve patients’ abilities to participate in more activities in their lives, leading to better function in these areas despite possible lingering cardiac pain. Although greater perceived social support improved function in women with depressed mood it did not for men. For women social support may play a larger role in buffering stress responses (S. E. Taylor et al., 2000). For
women, affiliating with a social group may have developed as an adaptive way to increase safety and may play a greater role in their stress responses.

This study adds information about the additive and interactive relationships of socially related variables and sex differences with long-term impairment in life functioning. No previous study has investigated life functioning in social and occupational areas with a balanced sample of men and women. Our study stands out due to a sufficient number of female patients to provide adequate statistical power to investigate sex differences. In support of sex-specific predictors, our findings of sex-differences were similar to those seen in previous studies with women showing higher depression symptoms (Blumenthal et al., 2003), household responsibilities (Kendel et al., 2008) and life function impairment (Kendel, Dunkel, Jonen, et al., 2011) at both time points, and lower perceived social support at one-year (Kristofferzon et al., 2003).

Our results suggest perceived and structural support during recovery may allow patients, even women with greater depression symptoms, to better function in social, recreational, and occupational areas following recovery. Functioning well may act as part of a cycle, encouraging more activity and social contact, thus positively impacting rehabilitation and possibly longer-term outcomes.

2.4.1.1 Limitations

Our effort to oversample women did not allow for consecutive recruitment, but permitted the desired balance in sample size for both sexes. Further, our exclusion criteria biased our sample in favour of a healthier subset of patients undergoing CABG surgery, so our results may apply only to those healthier patients. Another possible limitation is the present sample contains patients who had both isolated CABG surgery and CABG combined with valve surgery, which may have increased the heterogeneity of the sample (Shahian et al., 2009). We were unable to
adjust for this in analyses as this would have compromised power and we believe our adjustment for disease severity may have compensated for this.
Figure 2.1 Flow through study

Assessed for eligibility (n=1388)

-35 discharged before approached
-Excluded (n=1092)
-95M, 47F declined participation
-950 not meeting inclusion criteria
- 104 redo CABG
- 81 complicated course
- 5 mental illness/bhvrl disorder
- 17 deaf/hard of hearing
- 15 blind/unable to read
- 78 English language difficulties
- 41 anxious/dep/hostile
- 29 confused/ neurological def
- 580 males too young

Enrollment

Male participants (n=171)

T1: in hospital post-CABG

Male participants (n=137)
Male lost to follow-up (n=34)
- 23 denied,
- 6 unable to contact
- 3 deceased
- 1 hospitalized/too sick
- 1 confused.

Male analysed (n=133)
- Excluded from analysis (n=4) if a questionnaire is missing >25% of items.

T2: one-year post-CABG

Female participants (n=125)

Female participants (n=104)
Female lost to follow-up (n=21)
- 9 denied
- 7 unable to contact
- 1 deceased
- 1 hospitalized/too sick
- 2 confused

Female analysed (n=101)
- Excluded from analysis (n=3) if a questionnaire is missing >25% of items.

Analysis
Figure 2.2 Predicted one-year functional impairment by baseline BDI and ISEL for men and women.

BDI, Beck Depression Inventory; FI, Functional Impairment; ISEL, Interpersonal Support Evaluation List
Table 2.1 Characteristics of complete one-year post-CABG participants according to sex.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>p value</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>n=133 (56.60)</td>
<td>n=101 (43.40)</td>
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</tr>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
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<td>Age</td>
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<td>67.32 ± 10.27</td>
<td>.004</td>
</tr>
<tr>
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<td>112 (84.21)</td>
<td>58 (56.86)</td>
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</tr>
<tr>
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<td>110 (82.71)</td>
<td>56 (54.90)</td>
<td>&lt;.001</td>
</tr>
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<td>33 (24.81)</td>
<td>17 (16.66)</td>
<td>.130</td>
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<td>Working T2</td>
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<td>19 (19.00)</td>
<td>.012</td>
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<td></td>
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<td>7.77 ± 5.47</td>
<td>10.76 ± 7.99</td>
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<tr>
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<td>6.17 ± 5.32</td>
<td>10.60 ± 7.99</td>
<td>&lt;.001</td>
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<td>8.46 ± 1.51</td>
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<td>1.37 ± 0.42</td>
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<td>Pain T1 (presence / mean)</td>
<td>137 (97.7) / 2.47 ± 1.16</td>
<td>100 (99.0) / 2.76 ± 1.26</td>
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</tr>
<tr>
<td>Pain T2 (presence / mean)</td>
<td>59 (44.4) / 0.66 ± 1.04</td>
<td>51 (50.5) / 0.95 ± 1.26</td>
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</tr>
<tr>
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<td>127 (95.5) / 2.79 ± 1.42</td>
<td>96 (95.0) / 3.25 ± 1.61</td>
<td>.875/.009</td>
</tr>
<tr>
<td>(presence / mean)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life function impairment T2</td>
<td>74 (55.6) / 1.00 ± 1.32</td>
<td>72 (71.3) / 1.29 ± 1.40</td>
<td>.014/.032</td>
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<td>(presence / mean)</td>
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<tr>
<td><strong>Clinical history</strong></td>
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<tr>
<td>Disease severity (NYLT score)</td>
<td>5.20 ± 3.05</td>
<td>5.69 ± 2.73</td>
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<td>CCS 1</td>
<td>7 (5.60)</td>
<td>2 (2.08)</td>
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<td>CCS 2</td>
<td>10 (8.00)</td>
<td>13 (13.54)</td>
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<td>Female</td>
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<td>CCS 4</td>
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<td>41 (42.71)</td>
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<td>15 (14.71)</td>
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<td>15 (11.28)</td>
<td>5 (4.90)</td>
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<td>CVD</td>
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<td>5 (4.90)</td>
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<td>.994</td>
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<td>LVEF &gt;50</td>
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<td>.541</td>
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<td>29 (28.43)</td>
<td>&lt;.001</td>
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<td>Hypertension</td>
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<td>.001</td>
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<td>LMS</td>
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<td>21 (20.59)</td>
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<td>LVEDP</td>
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<td>5 (4.90)</td>
<td>.006</td>
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<td>PVD</td>
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<td>8 (7.84)</td>
<td>.905</td>
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<td>14 (13.72)</td>
<td>.162</td>
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<td>Smoking T2</td>
<td>13 (9.85)</td>
<td>9 (8.82)</td>
<td>.790</td>
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<tr>
<td>Cardiac Rehabilitation participation</td>
<td>49 (37.12)</td>
<td>29 (28.43)</td>
<td>.359</td>
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**Surgical description**

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<td>Isolated CABG</td>
<td>18 (13.53)</td>
<td>23 (22.55)</td>
<td>.071</td>
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<tr>
<td># Vessels bypassed</td>
<td>4 ± 1</td>
<td>3 ± 1</td>
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Numbers indicate +/- SD or column-wise count (%)

T1, during hospitalization from CABG surgery; T2, one-year post-CABG surgery; NYLT, Risk Score for Predicting Long-Term Mortality After Coronary Artery Bypass Graft Surgery based on the New York State Cardiac Surgery Reporting System; LMS, left main stenosis; LVEDP, left ventricular end diastolic pressure; CHF,
<table>
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<th>$p$ value</th>
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<tr>
<td>$n$</td>
<td>133 (56.60)</td>
<td>101 (43.40)</td>
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</table>

congestive heart failure; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; PVD, peripheral vascular disease; CCS; Canadian Cardiovascular Society grading of angina pectoris; LVEF; left ventricular ejection fraction.

$P$ values are for Mann-Whitney U tests or chi-square as appropriate.
Table 2.2 Intercorrelations of baseline measures with one-year post-CABG FI and pain for one-year participants

<table>
<thead>
<tr>
<th></th>
<th>NYLT Cardiac rehabilitation</th>
<th>Smoking T1</th>
<th>Depression T1</th>
<th>Perceived social support T1</th>
<th>Household responsibility T1</th>
<th>Married T1</th>
<th>Pain T2</th>
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<tr>
<td>Cardiac rehabilitation</td>
<td>- .12</td>
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<tr>
<td>Smoking T1</td>
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<td>-.02</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Depression T1</td>
<td>- .10</td>
<td>.02</td>
<td>.13*</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Perceived social support T1</td>
<td>.14*</td>
<td>.02</td>
<td>-.04</td>
<td>-.44**</td>
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<td></td>
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<tr>
<td>Household responsibility T1</td>
<td>.06</td>
<td>-.06</td>
<td>-.02</td>
<td>.15*</td>
<td>-.09</td>
<td></td>
<td></td>
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<tr>
<td>Married T1</td>
<td>-.13*</td>
<td>.02</td>
<td>-.01</td>
<td>-.06</td>
<td>.06</td>
<td>-.70**</td>
<td></td>
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<tr>
<td>Pain T2</td>
<td>.12</td>
<td>.01</td>
<td>.01</td>
<td>.18**</td>
<td>-.21**</td>
<td>-.04</td>
<td>-.00</td>
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<tr>
<td>Life function</td>
<td>.06</td>
<td>.02</td>
<td>.09</td>
<td>.22**</td>
<td>-.26**</td>
<td>-.05</td>
<td>-.03</td>
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</table>

T1, during hospitalization post-CABG surgery; T2, one-year post-CABG surgery; BDI, Beck Depression Inventory; ISEL, Interpersonal Support Evaluation List; MRQ, Marital Roles Questionnaire; NYLT, Risk Score for Predicting Long-Term Mortality After Coronary Artery Bypass Graft Surgery based on the New York State Cardiac Surgery Reporting System; Pain, West Haven-Yale Multidimensional Pain Inventory pain subscale.

* p < 0.05, ** p < 0.01
Table 2.3 Linear model of baseline predictors of one-year post-CABG FI for all one-year participants

<table>
<thead>
<tr>
<th></th>
<th>Coefficient b</th>
<th>SE</th>
<th>95% CI</th>
<th>t</th>
<th>p</th>
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<tr>
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<td>.10</td>
<td>-32,.08</td>
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<td>.04</td>
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<td>-06,.16</td>
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<td>.232</td>
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<td>.14</td>
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<td>.02</td>
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<td>-21,.24</td>
<td>.12</td>
<td>.454</td>
</tr>
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<td>.21</td>
<td>.19</td>
<td>-11,.53</td>
<td>1.08</td>
<td>.141</td>
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<td>.07</td>
<td>.11,.33</td>
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<td>.08</td>
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### Coefficient Table

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<th>t</th>
<th>p</th>
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<td>.027</td>
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<td>-.47, -.11</td>
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<td>Married</td>
<td>-0.52</td>
<td>0.26</td>
<td>-.95, -.08</td>
<td>-1.97</td>
<td>.025</td>
</tr>
<tr>
<td>Depression X Perceived social support</td>
<td>0.14</td>
<td>0.06</td>
<td>.04, .23</td>
<td>2.44</td>
<td>.016</td>
</tr>
<tr>
<td>Perceived social support X Sex</td>
<td>0.29</td>
<td>0.14</td>
<td>.06, .52</td>
<td>2.05</td>
<td>.042</td>
</tr>
</tbody>
</table>

Standard errors and confidence intervals are generated with heteroscedastic consistent estimators and bootstrapping.

Note for block 4. Given included interactions, b coefficients for sex, depression T1 and perceived social support T1, are not interpretable in the usual way. See simple effects analysis for interpretation.

Significance at $p < .05$
Chapter Three: Psychosocial and medical predictors of 13-15 year mortality and morbidity in male and female coronary artery bypass graft recipients: a prospective observational study

3.1 Preface

The goal of this research is to investigate how biological, psychological, social and functioning factors are associated in outcomes form CABG surgery in men and women. Our previous investigation indicated that baseline psychosocial variables, over and above disease severity, predicted life function impairment at one-year post-CABG. The next step in this research is to investigate whether depression symptoms and social variables, measured post-CABG and one year later are associated with long term mortality and procedure recurrence. In our first study baseline predictors were chosen, due to their proximity to CABG surgery, to investigate longitudinal predictors of our one-year outcome of interest, life function impairment. Given the previous study supports a relationship between depression symptoms and social factors with later life function and prior research exists to indicate an association between physical function and long-term mortality following CABG surgery (Koch et al., 2007), it is of interest to determine if life function impairment, measured in our sample, is also associated with long-term mortality and morbidity following CABG surgery. This dissertation was also guided by the goal of investigating when depression and social variables may be predictive of long term outcomes, and given both post-CABG and one-year measures of depression, social and function variables exist, we were able to investigate measures from both time points in this model. Given the positive relationship between functional impairment and depression, it is possible that by investigating life function as a predictor in the same model as depression would decrease the association between depression and mortality, so this was additionally of interest. Also, given that baseline disease severity (NYLT mortality risk score) was correlated with one-year post-
CABG pain in the previous study it was decided to again use this measure to adjust analyses for important medical risk factors.

3.2 Abstract

Background: Psychosocial factors may influence mortality and morbidity after CABG surgery, but it is unclear: at what point these factors may best predict outcome, if these factors interact with each, or if they differ for men and women. Methods: This prospective, observational, single-site study tested whether depression symptoms, perceived social support, marital status, household responsibility and life function impairment predicted mortality or CAD procedures experienced over 12-15 years post-CABG (mean 14.1 years). Participants completed self-report questionnaires in-hospital post-CABG and again one-year later. Mortality and CAD procedures experienced were merged by the BC Cardiac Registry from Vital Statistics BC. Cox extended models were conducted to test the association between psychosocial predictors and all-cause mortality after adjustment for traditional medical covariates. Logistic regression models predicted the adjusted association between psychosocial measures and CAD procedure experienced over 12-year follow-up. Results: Of 296 baseline participants 231 (78%; 43% women) had complete data at one-year post-CABG. Survival was associated with one-year psychosocial measures. An interaction between depression symptoms and social support ($\chi^2 (11) = 111.05, p < .001$), revealed a 1SD increase in depression symptoms leading to greater hazard of mortality only at mean (HR = 1.67; 95% CI [1.21, 2.26]) or higher social support (HR = 2.23; 95% CI [1.46, 3.40]). Additively, over the five years after follow-up, being married, greater household responsibility and better life functioning were also associated with better survival. Regarding CAD procedures, a one-SD increase in one-year depression symptoms was associated with almost twice the odds of procedure (HR = 1.91; 95% CI [1.24, 4.04]), and a one-SD
increase in one-year life function impairment led to 50% greater odds of CAD procedure (HR = 1.53; 95% CI [1.08, 2.41]) over 12-years post-CABG surgery. Conclusions: In a sex-balanced sample, psychosocial variables measured at one-year post-CABG predicted unique variance in long-term mortality and disease recurrence independent of traditional medical risk.

3.3 Introduction

Given over 90% of patients who make it to hospital survive their first MI (Goodman et al., 2009) and fatal outcomes from coronary artery bypass graft (CABG) surgery are rare (from 2-8% from 2000-2003 in the UK) (Keogh & Kinsman, 2004), clinical practice and research increasingly focus on rehabilitation and adjustment, aiming to restore function and quality of life (QOL). The majority of patients return to good function within months but a substantial subgroup continues to struggle emotionally (Schrader, Cheok, Hordacre, & Marker, 2006). Little is known about the how long-term adjustment is associated with subsequent mortality. Some known predictors of poor outcome are unmodifiable (i.e., genetics, sex, age) which then directs attention to risk factors we can effectively address, such as psychosocial variables, and health behaviors.

3.3.1 Psychosocial factors

Psychosocial factors, such as depression and social support, are associated with QOL, participation in cardiac rehabilitation and mortality post-CABG (Caulin-Glaser et al., 2007; Con et al., 1999; Goyal et al., 2005). Psychosocial risk factors negatively associated with outcomes of CABG surgery differ by sex, are often inter-related, and may act together in the recovery process. Depression is elevated surrounding CABG surgery (20-30%) (Tully, 2012) but occurs twice as often in women than men (Blumenthal et al., 2003). Although depression tends to decrease over recovery from CABG surgery, over 40% of patients continue to have symptoms at
follow-up, and post-CABG depression is associated with greater mortality with a roughly 2:1 risk ratio of mortality (Blumenthal et al., 2003). In terms of mechanisms, depression may raise cardiac risk through increased inflammation (Khoueiry et al., 2011), endothelial, autonomic and hypothalamic-pituitary-adrenal axis dysfunction (Chen et al., 2013; C. B. Taylor et al., 2006), and by impairing post-operative self-management and reducing medication adherence (Fredericks et al., 2012; Safren et al., 2001). Although depression is well established as a risk factor, it can be difficult to interpret symptoms of depression surrounding an MI or cardiac surgery because it may be a sign of pre-existing depression or can represent a transient reaction. Typical measures of depression may confound physical inactivity and lack of interest in typical activities due to surgery and recovery with symptoms of depression (Delisle, Beck, Ziegelstein, & Thombs, 2012). Over a 1-year interval, as was studied in this same sample, the typical patient has resumed usual activities and natural resilience had a chance to ‘kick in’ (Schrader, Cheok, Hordacre, & Guiver, 2004). Approximately one-third of patients initially depressed after cardiac hospitalization move to non-depressed status within three months, but by 12 months another third of patients, who respond well initially, develop signs of depression (Schrader et al., 2004; Schrader et al., 2006). Consistent with such shifts in psychiatric diagnoses, results of a meta-analysis on the benefits of cardiac rehabilitation revealed no mortality benefits when patients were identified as depressed and treated within 1-2 months after the cardiac event, whereas significant mortality reduction resulted when patients were identified and treated a few months later (Linden, Phillips, & Leclerc, 2007). As depression needs to be stable to affect long-term health outcomes (Uchino, 2006) it is important to study it longitudinally.
Low social support, both functional and structural, is also associated with increased post-CABG mortality (Herlitz et al., 1998; Idler et al., 2012; King & Reis, 2012). Although the stress buffering hypothesis predicts social support may moderate associations with depression (S. S. Cohen, 1988; Uchino, 2006), and social support has been seen to buffer the association between depression and one year survival after MI (Frasure-Smith et al., 2000), this relationship has not been investigated in CABG patients or longer-term mortality. In summary, both social support and depression have been related to cardiac outcomes but it is unclear when depression best predicts later mortality and research has not yet clarified how depression and social support interact to predict differential outcomes after CABG surgery in a sex-balanced sample.

Research supports sex differences in medical treatment and psychosocial rehabilitation. Although men and women receive cardiac revascularization at similar rates once diagnosed, men with ischemia are more likely to receive diagnostic angiograms in investigation of symptoms, additionally, following diagnosis of obstructive coronary artery disease or experience of acute coronary syndrome, women are less likely to receive aspirin, beta-blockers and statins as treatment (Bugiardini et al., 2010). Post-CABG surgery, women experience higher mortality, more pain, complications, and physical impairment (Lehmkuhl et al., 2012; Tamis-Holland et al., 2013) and drop out of cardiac rehabilitation at rates 2.5 times that of men (Caulin-Glaser et al., 2007). Women additionally report more pain and lower function following CABG surgery. Significant post-CABG surgical pain affects 25% of patients 9 weeks after surgery, with more women (36 vs.13%) reporting pain with movement after CABG (Parry et al., 2010). Activity in the home and its association with outcome may differ by sex because women spend more time on household activities after CABG surgery, and experience significantly greater stress due to
these activities (Kendel et al., 2008). Due to these differences, sex specific analyses are called for, but rarely undertaken (Blauwet et al., 2007).

### 3.3.2 Study rationale and research questions

This prospective, observational study examines 13-15 year mortality and morbidity outcomes following CABG surgery with a focus on sex differences. This study was undertaken to investigate the associations of depression symptoms, perceived social support, household responsibility, life function impairment and marital status with mortality and morbidity outcomes from CABG surgery. The authors were able to take advantage of existing mortality data and electronic charts that listed procedures received for the 12-15 years after a first CABG surgery. The choice of study questions was additionally guided by earlier analyses of the same sample at one-year following CABG surgery. In that study, it was learned that medical severity did not predict life function impairment one-year post-CABG whereas psychosocial predictors accounted for significant variance (Young et al., unpublished).

The ultimate goal of this research is to inform models of long-term care for post-CABG patients by seeking answers to the following questions. Do psychological (depression), social (perceived social support, household responsibility, and marital status), and functional (life function impairment) variables, available post-operatively and one year post-CABG, predict mortality and number of coronary artery disease related cardiac procedures over 13-15 years, over and above traditional medical predictors of mortality (sex, operative variables, smoking history, participation in cardiac rehabilitation, and disease severity)? Due to the confounding of post-operative recovery, we posit psychosocial variables measured one-year post-CABG may best predict long-term outcome. Further, given that social support has previously been seen to buffer depression, interactions between depression and perceived social support will be modeled.
Additionally, we hypothesize that due to sex differences in depression, socially related and functional variables, these outcomes may be different for men and women, but no directions are hypothesized.

3.4 Methods

3.4.1 Participants

After first CABG, 296 patients (M=171, F=125; age range: 36-88 years) were recruited within a Canadian cardiac centre (see Figure 2.1). At one-year post-CABG, 241 of these participants (81%; M = 137, F = 104; age range: 36-84 years) participated with a final 234 with complete questionnaires and mortality data (M = 132, F = 99) available for analysis (78% of baseline participants and 52.7% of initial patients approached).

Inclusion criteria: Minimum 18 years of age and first CABG surgery; surgery conducted at target hospital; patient still in hospital and day three or later following CABG surgery. Exclusion criteria were developed to ensure participants were able to complete questionnaires with minimal assistance and to minimize strain or harm which might interfere with recovery. Exclusion criteria were assessed by examining chart notes and discussion with nursing staff and include: serious medical problems; unstable vital signs; angina in the last 12 hours; history of previous CABG surgery; complicated course following CABG surgery; deaf, blind, or hard of hearing; insufficient ability to comprehend, read, and/or speak English; mental illness/behavioural disorder including anxiety, distressed, hostile or negative affect as claimed by nursing staff; or confused or exhibiting neurological deficits.

3.4.2 Procedures

Two trained research assistants approached participants on the ward on day 3 or later after a first CABG +/- valve surgery. To ensure confidentiality and honesty of responding,
patients were provided a questionnaire package to complete independently, and an envelope to leave the questionnaire with the nurses prior to discharge. With a goal of 250 patients, recruitment continued until 125 women enrolled. Lower rates of women undergoing CABG surgery allowed for continued recruitment of older men over the latter part of the study to increase likelihood of similarity of age between men and women. Participants were contacted again by mail one-year post-CABG surgery to complete a further questionnaire package including the original questionnaires and questions regarding activities since the CABG surgery. Baseline medical risk and surgical variables were obtained from hospital charts and a provincial database (Cardiac Services BC). Questionnaires assessed depression symptoms, perceived social support, household responsibilities, marital status, pain severity and life function impairment. This study was approved by local ethics boards and all participants provided written informed consent.

3.4.3 Measures

Medical predictors of long-term mortality risk after CABG. A composite long-term mortality risk score was chosen to index cardiac disease severity over the inclusion of multiple, individual clinical risk predictors, to better capture risk factors with strong relationships to CABG outcomes. Aggregation and weighting of singular factors resulted in a solitary score allowing greater statistical power. The Risk Score for Predicting Long-Term Mortality After Coronary Artery Bypass Graft Surgery, based on the New York State Cardiac Surgery Reporting System (NYLT) (Wu et al., 2012) has well demonstrated predictive validity for cardiac mortality in 8597 isolated CABG surgery patients (from July-December 2000) from 33 hospitals in New York State. Significant predictors include: age, BMI, ejection fraction, hemodynamically unstable or shock, left main coronary artery disease, cerebrovascular disease, peripheral arterial
disease, congestive heart failure, malignant ventricular arrhythmia, chronic obstructive pulmonary disease, diabetes, renal failure and previous open heart operations. Weighted item sub-scores are summed to derive a total score. Missing risk factors were coded as “no” in our calculations, as was done with the NYLT database (except for EF). NYLT score was also thought appropriate as it was derived from an all-age sample and did not include sex, allowing separate investigation of sex.

The West Haven-Yale Multidimensional Pain Inventory (WHYMPI; Kerns et al., 1985) assessed pain severity and life function impairment using a 7-point Likert-type scale. Higher numbers indicate greater pain and life function impairment. One of 12 subscales, interference/life function impairment (9 items), was used in this study. Given expectations of elevated pain and life function impairment immediately after surgery, retrospective assessment of pain and life function impairment prior to surgery was collected at baseline in addition to one year pain and life function impairment. Internal consistency for interference and pain severity were high in this sample (Cronbach’s α = .91 and .80). Depression, operationalized as a continuous measure of depression symptoms, was assessed with the Beck Depression Inventory (BDI; Beck et al., 1961). This measure has been widely used and validated and is a valid measure of depression in older individuals, such as cardiac patients (Gallagher et al., 1982). The BDI had high internal consistency in this sample (Cronbach’s α = .85). Marital status was used as a measure of structural support, while the Interpersonal Support Evaluation List (ISEL) measured overall perceived social support (Cohen et al., 1985). Mean ISEL scores ranged from a low of 0 to a high of 10. The ISEL has adequate concurrent validity with other measures of social support (Isaacs & Hall, 2011) and exhibited high internal consistency in this sample (Cronbach’s α = .88). The household responsibilities subscale (15 items) of the Marital Roles Questionnaire
(MRQ) assessed patient participation in: housework, repairs, cooking, and paying bills, with higher scores indicating greater patient responsibility (Buxbaum, 1967). Responses on the MRQ were modified to obtain a score indicating patient responsibility with 2=done primarily by patient, 1=done with spouse or others, and 0=mainly done by spouse or others. This transformation permitted completion by individuals living alone. The MRQ had high internal consistency (Cronbach’s $\alpha = .86$). Mortality and CAD procedures were accessed by data merger performed by the provincial database registry, Cardiac Services BC. They obtained information from Vital Statistics BC and BC Hospital databases.

3.4.4 Statistical analyses

All participants with complete one-year post-CABG follow-up questionnaires and available database records were included in analyses. To describe unadjusted differences in baseline variables between men and women, Mann-Whitney U and chi-square tests, as appropriate, were conducted by sex. To investigate univariate relationships among dependent and independent variables, Pearson’s Correlations, for continuous, and Spearman’s Rho, for dichotomous variables, were employed. Unadjusted and adjusted hazard of mortality was investigated with Cox proportional hazards models. Model significance was assessed using chi-square tests of $-2\log$ likelihood. Significance of individual covariates was assessed using chi-square comparing the model with and without the covariate. Assumption of proportionality of hazards was assessed for all covariates using interactions with time. Extended Cox models included modeling of variables with non-proportional hazards, where necessary. Variables with non-proportional hazards were investigated by cutting time at yearly intervals indicated as appropriate after viewing unadjusted hazard functions. Periods at risk of all-cause mortality were measured in months and defined as time from one-year post-CABG (1999-2001), up to mortality
or right censored if death was not reported at 6 months prior to data merger (August 1, 2013) to allow for lag in updating database. Possible inaccuracies in reporting of death or procedures by Vital Statistics BC, which could have resulted in lack of data, were considered missing at random. All participants experienced on-pump CABG, with mainly saphenous vein and internal thoracic artery grafts. As no obvious change in surgical procedure was observed over the course of the study, survival experience was considered to be similar throughout the recruitment period (1998-2000).

Logistic regression was used to model unadjusted and adjusted relationship between predictors and the odds of receiving a CAD procedure over the 12 years post-CABG surgery (PTCAs, coronary catheterizations, or open heart surgeries) for those who either received a procedure or survived to 12 years without a procedure. A cut point of 12 years was used to maximize time analyzed and create equal time periods for comparison among participants. This reduced N to 160 for this analysis and limited the power and number of covariates which could be considered. Due to lack of normality and homoscedasticity in some predictors, all models were bootstrapped to provide reliable coefficient confidence intervals. Hosmer and Lemeshow tests were used to indicate adequacy of model fit.

For all multiple regression, continuous independent variables were z-transformed resulting in variables with mean = 0 and SD = 1 to provide a coefficient that describes change in outcome due to a 1SD increase in predictor, partialling out effects of covariates. Variables were chosen a-priori, tested with forced entry and retained regardless of significance. All multiple predictor analyses are adjusted for numerous covariates related to medical risk: disease severity (baseline NYLT score), sex, cardiac rehabilitation participation, smoking history, valve procedure during CABG, and receipt of internal thoracic artery graft. Given CABG +/- valve
surgery may increase the heterogeneity of the sample (Shahian et al., 2009b) and internal mammary artery grafts are associated with improved long-term survival (Cameron et al., 1996) both were adjusted for. As age is related to mortality, adjustment for age was considered crucial to these analyses. Although many methods exist, the NYLT score included in our analyses contains age, and was considered sufficient adjustment. Independent variables included marital status and baseline and one-year measures of depression symptoms (BDI), perceived social support (ISEL), household responsibility (MRQ) and life function impairment (FI) along with BDI X ISEL interaction and interactions between psychosocial variables and sex. Considering our goal of the importance of detecting sex differences in predictors, all interactions were assessed within blocks and individually. Only prior directional hypotheses were evaluated with one-tailed tests (NYLT, cardiac rehabilitation participation, smoking history, internal thoracic graft, depression symptoms, perceived social support, marital status, household responsibility, and life functional impairment). P-values < .05 were considered significant.

To maintain confidence in results, initial simplified models were conducted with one covariate per ten events in both Cox and logistic regression. As relaxing this rule to one covariate per five events is acceptable to determine adequate control of confounding (Vittinghoff & McCulloch, 2007), full models were then run to assess control of all risk factors identified. Additionally, the significant BDIXISEL interaction was run in a bootstrapped model with all medical risk covariates to assess its reliability and then investigated by calculating simple slopes of BDI by centering ISEL at its mean and 1 SD above and below the mean (Aiken & West, 1991). Analyses were conducted using IBM SPSS Statistics v.21 (IBM Corporation, 2012).
3.5 Results

Follow-up times post-CABG surgery ranged from 12 years, 9 months to 15 years, 6 months, (median = 14 years, 3 months; mean = 14 years, 1 month). More men were recruited early in the study resulting in a mean follow-up for men being 6.86 months longer (mean = 172.42 (3.64) months) than women (mean = 165.56 (7.32) months) (t (165.3) = 9.49, p < .0001). Overall 40.0% of one-year participants died during follow-up (n=90; 46 women (46.5%) and 44 men (33.3%); χ² (1) = 4.10, p = .043). For all one-year completers cumulative survival: 3-year = 0.96 (F=.93, M=.98); 5-year 0.92 (F=.92, M=.92); 7-year = 0.83 (F=.81, M=.85); 10-year = 0.72 (F=.68, M=.75); and 12-year = .63 (F=.54, M=.70).

Table 3.1 provides a breakdown of participant characteristics split by sex. On average, complete one-year post-CABG participants were 65.3 years of age (36-84 years), mostly male (57.1%), married or common-law and not working at time of surgery (78.8%). Women were older, less likely to be married and less likely to be employed one-year post-CABG. Median NYLT mortality score was 5.0 (95% CI [5.0, 6.0]), ranging from 0-18 and did not differ by sex after excluding baseline participants who did not participate at one year. More men had an elevated left ventricular end diastolic pressure (LVEDP >15mmHg) and angina with mild exertion (Canadian Cardiovascular Society Angina Classification (CCS class 3)), while more women had a diagnosis of hypertension, hypercholesterolemia, and angina at any level of physical exertion (CCS class 4). Women had fewer coronary arteries bypassed and received fewer internal thoracic artery grafts. Women also reported higher depression and household responsibility at both time points and lower social support at one-year post-CABG. The only significant differences in participant characteristics between one-year completers and non-completers was a significantly higher NYLT score for female compared to male participants at
baseline (U(294) = 8932.0, Z = 2.42, p = .015), although overall NYLT did not differ between baseline and one-year post-CABG participants (U(294) = 6049.5, Z = 0.86, p = .391). Even after excluding baseline participants who died within the first year, significantly more non-one-year completers died during follow-up period (61.5% compared to 38.8%, χ²(1) = 6.243, p = .012), and non-completers mean time to death (107.8 vs. 143.5 months) was 35.8 months earlier (p=.001).

3.5.1 Unadjusted relationships among covariates

In Table 3.2 unadjusted correlations reveal depression symptoms (at both times) are negatively associated with social support (moderate to large effect), and positively with life function impairment and baseline household responsibility. Social support negatively correlated with life function impairment and, at one-year post-CABG, higher social support was related to lower household responsibility. Married individuals reported lower depression and higher perceived social support one-year post-CABG and less household responsibility overall (large effect). Baseline disease severity was associated with lower life function impairment prior to CABG, but not at one year, and was associated with greater perceived social support at both times. Having an internal thoracic graft was related to lower life function impairment one-year post-CABG. Number of post-CABG CAD related procedures was related to greater life function impairment at one-year post-CABG. The occurrence of death over follow-up was positively correlated with one-year post-CABG depression but not with baseline depression.

3.5.2 Survival analyses

Unadjusted and adjusted HRs of isolated psychosocial covariates indicated significantly greater mortality for: elevated one-year depression symptoms, adjusted for baseline depression symptoms; and lower one-year household responsibilities, adjusted for baseline responsibilities.
Further greater one-year life function impairment was related to increased hazard of mortality over the subsequent 8 years (see Table 3.3). This indicates greater mortality is associated with higher one-year depression symptoms and lower one year household responsibilities throughout follow-up, while greater one-year life function impairment was only associated with increased mortality for the first eight years of follow-up. No social support was associated with survival.

3.5.2.1 Multiple Cox regression

The simplified multiple Cox model (adjusted for disease severity and sex) indicated household responsibility, life function impairment, marital status (along with time interactions of household responsibility, life function impairment, marital status) and an interaction between ISEL and BDI, reliably predicted survival time (-2LL = 831.89; \( \chi^2 (11) = 111.05, p < .001 \); see Table 3.4). No additional interactions between psychosocial variables and gender reached statistical significance. A fully adjusted model also significantly predicted time to mortality (-2LL = 812.748; \( \chi^2 (19) = 127.41, p < .001 \)) with no change in direction or significance of the psychosocial predictors. A 1-point NYLT score increase, being female and having a positive smoking history were associated with a 33%, 211% and 232% increased hazard of mortality. Investigations of proportionality indicated that lower household responsibility, greater life function impairment, not being married were significantly associated with greater hazard of mortality over 6-years post-CABG (Block \( \chi^2 (3) = 10.63, p = .014 \)). During the 5 years after participants completed one-year follow-up, a one SD decrease in one-year household responsibility (associated with the participant doing less household activities on their own) was associated with 2.3 times the hazard of death (\( \chi^2 (1) = 4.52, p = .017; 95\% \text{ CI} [1.31, 4.05] \)), a one SD increase in life function impairment and being single increased hazard by 45% (\( \chi^2 (1) = 11.05, p < .001 \)).
Analysis of simple effects of one-year depression symptoms at levels of perceived social support indicate significant effects of depression symptoms at mean and high levels of social support (see Figure 3.2). At Low ISEL (1 SD below the mean), a 1SD increase in BDI score is associated with a non-significant 23% increase in hazard of mortality (95% CI [0.88, 1.72]). At mean ISEL, a 1SD increase in BDI predicted 67% greater hazard of mortality (95% CI [1.21, 2.26]). At High ISEL (1 SD above the mean), a 1SD increase in BDI scores predicted 2.23 times the hazard of mortality (95% CI [1.46, 3.40]). To further assess reliability of the significant BDIXISEL interaction, a bootstrapped model including sex and all medical risk covariates was run (9 predictors; 1 predictor per event) and indicated equivalent significance of depression symptoms, perceived social support and their interaction.

3.5.3 CAD procedure experienced

In this study, need for a cardiac procedure was used as a proxy for disease recurrence. One hundred and sixty complete one-year participants either received a procedure (n = 62; 38.8%) or survived 12 or more years post-surgery, without receiving a procedure (n = 99, 61.2%). In unadjusted and adjusted isolated analyses of our psychosocial variables, similar to isolated survival analyses; both greater depression symptoms and life function impairment at one-year post-CABG surgery were associated with increased odds of having a cardiac procedure over the 12 years following CABG surgery (see Table 3.5).

3.5.3.1 Multiple predictor model

Given only 62 individuals had procedures recorded, only 6 predictors could reliably be used to avoid critical loss of power (Vittinghoff & McCulloch, 2007). The initial, simplified
multiple logistic regression model (adjusted for NYLT and sex) indicated increased odds of receiving a cardiac procedure were associated with greater one-year depression symptoms and life function impairment (see Table 3.6). A one-SD increase in BDI score was associated with double the odds of having a procedure, while a one SD increase in life function impairment predicted 50% greater odds of having a procedure over 12 years post-CABG surgery. These associations remained in oversized models after adjustment for further medical risk factors (NYLT, sex, valve procedure during CABG surgery, internal thoracic graft, cardiac rehabilitation attendance, and smoking history) and baseline psychosocial risk. The Hosmer and Lemeshow Test for all models was non-significant, indicating adequate model fit.

### 3.6 Discussion

Overall, in a sex balanced sample, psychosocial variables were able to predict unique variance in long-term mortality and CAD procedure recurrence (used as an index of disease recurrence) independent of traditional medical risk factors. Although perceived social support moderated the association between depression and mortality, it was not in the expected direction and a buffering role was not supported. Psychosocial variables measured at one-year post-CABG as opposed to the time of CABG, were associated with outcomes.

Mortality was best predicted by a mix of psychosocial, functional, and clinical risk factors. At mean or higher perceived social support, greater one-year post-CABG depression symptoms were associated with increased hazard of mortality. Additively, the structural support of having a partner, greater one-year household responsibilities, and low one-year functional impairment were associated with decreased hazard of five-year mortality. None of the psychosocial and functional variables measured at the time of surgery, as predicted, were significantly associated with hazard of mortality during 13-15 year follow-up. Our hypothesis
that perceived social support would decrease hazard of mortality and buffer the association between depression and mortality was not confirmed. Instead, one-year perceived social support was not associated with hazard of mortality as a main effect. Prior research regarding social support has indicated greater adjusted hazard of five-year mortality in those feeling lonely post-CABG, a proxy for social support (Herlitz et al., 1998). Interestingly perceived social support was positively correlated with disease severity in our sample, this may indicate confounding between perceived and received support in those who have more severe disease and may be receiving more assistance. Received support is not always associated with positive health outcomes, especially in older individuals or if there is a mismatch in the support received and that wanted (Bolger & Amarel, 2007; Uchino, 2009).

We had expected depression symptoms to be related to mortality as it has previously been associated with mortality and health care utilization in revascularization groups (Blumenthal et al., 2003; Sullivan, LaCroix, Spertus, Hecht, & Russo, 2003) and other cardiac populations (Frasure-Smith et al., 2009). It is unclear why depression symptoms would be more strongly associated with mortality at higher levels of social support, unless perceived social support had a stronger relationship with mortality, which was not the case. Perhaps the previously discussed confound also impacted this interaction or individuals who are depressed despite high social support may be at much greater risk of mortality due to the nature of their depression. It is additionally possible that either the effect of social support did not reach significance due to poor power, or the expected effect of social support is moderated by another variable which we did not test.

Given that being married was associated with four-times greater five-year survival, we postulate those with a marital partner benefit greatly from the structural support of a marital
relationship. Being married may increase healthy behaviours or decrease social isolation leading to better coping and improved physiological responding (Lewis & Rook, 1999; Uchino, 2006). Previous research indicates an even lengthier association of marriage with adjusted 15-year post-CABG survival in a sample with 23% women, (King & Reis, 2012). The discrepancy in our results might be explained in that marital status is not necessarily stable, especially in older individuals at greater risk of experiencing their partner’s illness or death, and mean age of the latter study was approximately five years less than ours. Additionally, the fact that our sample consisted of a greater proportion of older women, who were much less likely to be married than the men, may have inflated the comparison of married individuals and influenced our results. Additionally, one-year post-CABG life function impairment and household responsibilities were associated with mortality, but only for the first five years. Prior research has investigated baseline and post-CABG physical functioning, finding this also increased hazard of five-year mortality (Koch et al., 2007). Although we had postulated that household responsibilities may be related to greater stress for women and thus poorer outcome, it was actually associated with better outcomes. This indicates household responsibilities may be a proxy for good functioning and could provide a level of desirable activity which is sought to support cardiac rehabilitation. Additionally, those who are functioning poorly in marital, social, familial and recreational domains are also likely less active, which in turn detracts from cardiac rehabilitation. Possibly the increased activity levels due to household responsibilities and the increased social, recreational, family and occupational function associated with life function, provided increased activity which supported health. A long-term effect may not have been seen due to changing life circumstances which may have changed these behaviours.
Whether or not a CAD procedure was received over the 12 years post-CABG was best predicted in fully adjusted analyses by greater 1-year depression symptoms and functional impairment. Although depression symptoms and functional impairment at one year were correlated in this sample, and depression has also been linked to physical function in previous studies (Kendel et al., 2011), both were still independently and additively associated with health care utilization for CAD procedures in this adjusted analysis. In support of our findings, depression has previously been related to CAD and procedure recurrence (Rugulies, 2002; Sullivan et al., 2003). Given that CAD is also related to poorer physical function (Olafiranye et al., 2012), and depression is related to decreased physical function (Goyal et al., 2005) our findings are not unexpected, but do point to the additive effects of depression and poor life function. In our sample, those individuals who are experiencing symptoms of depression in addition to greater difficulties functioning in their lives have the greatest odds of receiving a CAD procedure. In fact, odds related to life function impairment and depression symptoms did not decrease when both variables were entered together in the multivariate model, indicating neither accounted for the variance in the other. It may be that these individuals have the lowest participation in health promoting activities, in addition to experiencing the poor behavioral and physiological sequelae of depression (Chen et al., 2013; Fredericks et al., 2012; Khoueiry et al., 2011; Safren et al., 2001; C. B. Taylor et al., 2006). It is additionally interesting to note that although social variables did not reach significance (.10 > p > .05) both being married and greater one-year social support were related to greater odds of receiving a procedure over 12 years of follow-up. Those with individuals around them may be more likely to attend medical appointments and be more likely to be scheduled for further procedures (DiMatteo, 2004; Uchino, 2006).
A unique feature of this particular prospective study design was that both baseline and one-year measures were used in the prediction model. Our results suggest that psychosocial and functional variables measured one-year after CABG surgery were more strongly related to mortality and CAD procedures over long-term follow-up. Possibly, providing psychosocial interventions later in the recovery process (as recommended by Linden et al 2007), once individuals have stabilized, may be more effective in improving mortality outcomes because at this time continuing presence of depression is no longer confounded with initial reactions to the surgery. The decision to compare the status at baseline and one-year was based on the prediction that one-year emotional functioning is more likely to reflect actual long-term emotional adjustment. This hypothesis was supported here and implies a warning to future researcher not to rely on immediate post-even measures only.

3.6.1 Limitations

As mentioned previously, this study was conducted on a sample of patients who underwent CABG surgery 13-15 years ago. Since that time there have been many changes in CABG surgery including changes in procedures, increased participation of women in CABG surgery and better and more aggressive medical control of risk factors. Unfortunately it is impossible to conduct long-term follow-up without encountering some confounding via changes in treatments. Additionally, the oversampling of women allowed for sex comparisons across variables, but selective recruitment of women may have biased the sample by not including all men who underwent CABG surgery concurrently with the women and not allowing for consecutive recruitment of all patients undergoing CABG surgery.

Additionally, our exclusion criteria may have biased our sample. By selecting only patients who were healthy enough to participate post-operatively we are not sampling those
which may have been the most disabled after surgery. This sample may reflect a slightly
healthier subset of all of the individuals who underwent CABG surgery at this time. This type of
bias could only serve to reduce the power of our study and reduce the strength of our results.

3.6.2 Further areas for research

Given one-year measures of depression were related to mortality, future research should
investigate assessment and treatment throughout the recovery period. Further, due to prior
research implicating perceived social support in survival, future research should investigate other
factors which may moderate the association between social support and survival in these
populations.
Table 3.1 Characteristics of participants with complete questionnaires at one-year post-CABG overall and split by sex.

<table>
<thead>
<tr>
<th></th>
<th>Overall N=231</th>
<th>Female n= 99 (42.9%)</th>
<th>Male n=132 (57.1%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sociodemographics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>65.3 ± 10.1</td>
<td>67.1 ± 10.2</td>
<td>64.0 ± 9.8</td>
<td>.006</td>
</tr>
<tr>
<td>Married</td>
<td>169 (73.2)</td>
<td>58 (58.6)</td>
<td>111 (84.1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Working T1</td>
<td>49 (21.2)</td>
<td>17 (17.2)</td>
<td>32 (24.2)</td>
<td>.193</td>
</tr>
<tr>
<td>Working T2</td>
<td>63 (27.5)</td>
<td>19 (19.6)</td>
<td>44 (33.3)</td>
<td>.021</td>
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<tr>
<td><strong>Medical</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCS 1</td>
<td>9 (4.1)</td>
<td>2 (2.0)</td>
<td>7 (5.6)</td>
<td></td>
</tr>
<tr>
<td>CCS 2</td>
<td>23 (10.6)</td>
<td>13 (13.1)</td>
<td>10 (8.1)</td>
<td></td>
</tr>
<tr>
<td>CCS 3</td>
<td>117 (53.9)</td>
<td>38 (38.4)*</td>
<td>79 (63.7)*</td>
<td></td>
</tr>
<tr>
<td>CCS 4</td>
<td>68 (31.3)</td>
<td>40 (40.4)*</td>
<td>28 (22.6)*</td>
<td>.001</td>
</tr>
<tr>
<td>CHF</td>
<td>36 (15.6)</td>
<td>15 (15.2)</td>
<td>21 (15.9)</td>
<td>.875</td>
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<tr>
<td>COPD</td>
<td>20 (8.7)</td>
<td>5 (5.1)</td>
<td>15 (11.4)</td>
<td>.091</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>9 (3.9)</td>
<td>5 (5.1)</td>
<td>4 (3.0)</td>
<td>.432</td>
</tr>
<tr>
<td>Cardiac rehabilitation participation</td>
<td>77 (33.3)</td>
<td>29 (29.3)</td>
<td>48 (36.4)</td>
<td>.259</td>
</tr>
<tr>
<td>Diabetes</td>
<td>41 (17.7)</td>
<td>17 (17.2)</td>
<td>24 (18.2)</td>
<td>.842</td>
</tr>
<tr>
<td>Dialysis</td>
<td>23 (10.0)</td>
<td>10 (10.1)</td>
<td>13 (9.8)</td>
<td>.949</td>
</tr>
<tr>
<td>EF&lt;35</td>
<td>26 (11.3)</td>
<td>9 (9.2)</td>
<td>17 (12.9)</td>
<td></td>
</tr>
<tr>
<td>EF 35-50</td>
<td>76 (33.0)</td>
<td>31 (31.6)</td>
<td>45 (34.1)</td>
<td></td>
</tr>
<tr>
<td>EF&gt;50</td>
<td>128 (55.7)</td>
<td>58 (59.2)</td>
<td>70 (53.0)</td>
<td>.559</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>39 (16.9)</td>
<td>28 (28.3)</td>
<td>11 (8.3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>114 (49.4)</td>
<td>62 (62.6)</td>
<td>52 (39.4)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>LMS</td>
<td>44 (19.0)</td>
<td>21 (21.2)</td>
<td>23 (17.4)</td>
<td>.468</td>
</tr>
<tr>
<td>LVEDP</td>
<td>27 (11.7)</td>
<td>5 (5.1)</td>
<td>22 (16.7)</td>
<td>.007</td>
</tr>
<tr>
<td>NYHA 1</td>
<td>25 (28.1)</td>
<td>10 (10.1)</td>
<td>15 (27.8)</td>
<td></td>
</tr>
<tr>
<td>NYHA 2</td>
<td>26 (29.2)</td>
<td>9 (9.1)</td>
<td>17 (31.5)</td>
<td></td>
</tr>
<tr>
<td>NYHA 3</td>
<td>31 (13.4)</td>
<td>11 (11.1)</td>
<td>20 (37.0)</td>
<td></td>
</tr>
<tr>
<td>NYHA 4</td>
<td>7 (3.0)</td>
<td>5 (5.1)</td>
<td>2 (3.7)</td>
<td>.326</td>
</tr>
<tr>
<td>NYLT</td>
<td>5.4 ± 2.9</td>
<td>5.7 ± 2.8</td>
<td>5.2 ± 3.0</td>
<td>.125</td>
</tr>
<tr>
<td>PVD</td>
<td>19 (8.2)</td>
<td>8 (8.1)</td>
<td>11 (8.3)</td>
<td>.945</td>
</tr>
<tr>
<td>Smoking at CABG</td>
<td>38 (16.5)</td>
<td>14 (14.1)</td>
<td>24 (18.2)</td>
<td>.402</td>
</tr>
<tr>
<td>Smoking History at any time</td>
<td>148 (64.3)</td>
<td>43 (43.4)</td>
<td>105 (80.2)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

**Surgical presentation & description**

<table>
<thead>
<tr>
<th></th>
<th>Overall N=231</th>
<th>Female n= 99 (42.9%)</th>
<th>Male n=132 (57.1%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve procedure during CABG</td>
<td>40 (17.3)</td>
<td>22 (22.2)</td>
<td>18 (13.6)</td>
<td>.088</td>
</tr>
<tr>
<td># arteries bypassed</td>
<td>3.4 ± 1.4</td>
<td>3.2 ± 1.3</td>
<td>3.6 ± 1.4</td>
<td>.019</td>
</tr>
<tr>
<td>Pump time (minutes)</td>
<td>98.2 ± 37.6</td>
<td>97.2 ± 37.9</td>
<td>99.0 ± 37.5</td>
<td>.761</td>
</tr>
</tbody>
</table>
Overall N=231
Female n= 99 (42.9%) Male n=132 (57.1%) p value

Radial artery 7 (3.1) 2 (2.0) 5 (3.8) .434
Internal thoracic artery 135 (59.0) 47 (48.0) 88 (67.2) .003

# post-CABG procedures 0.5 ± 1.0 0.4 (0.9) 0.6 (1.1) .308
Post-CABG procedure 64 (27.7) 24 (24.2) 40 (30.3) .222
Diagnostic catheterization post-CABG 56 (24.2) 21 (21.2) 35 (26.5) .255
PCI post-CABG 25 (10.8) 10 (10.1) 15 (11.4) .750
Open heart surgery post-CABG 5 (2.2) 2 (2.0) 3 (2.3) .892
Other surgery post-CABG 10 (4.3) 4 (4.0) 6 (4.5) .846
ICD post-CABG 13 (5.6) 0 (0.0) 13 (9.8) <.001
Other intervention post-CABG 3 (1.3) 2 (2.0) 1 (0.8) .404
Pacemaker post-CABG 22 (9.5) 10 (10.1) 12 (9.1) .805

Follow up
Time survived/censored post-CABG 143.5 ± 41.4 136.2 ± 41.7 149.1 ± 40.4 <.001
Time minus 6 139.9 ± 39.0 133.0 ± 39.5 145.1 ± 38.0 <.001
Sum time survived/censored post-CABG 33156.7 13481.0 19675.7
Sum time minus 6 32310.7 17563.7 19147.7
Death 90 (39.0) 46 (46.5) 44 (33.3) .045

Psychosocial
Depression T1 9.1 ± 6.8 10.7 ± 8.0 7.8 ± 5.4 .02
Depression T2 8.0 ± 6.8 10.4 ± 7.9 6.2 ± 5.3 <.001
Perceived social support T1 8.7 ± 1.3 8.5 ± 1.5 8.8 ± 1.0 .12
Perceived social support T2 8.5 ± 1.5 8.2 ± 1.7 8.8 ± 1.2 .005
Life function impairment T1 3.0 ± 1.5 3.2 ± 1.6 2.8 ± 1.4 .02
Life function impairment T2 1.2 ± 1.4 1.3 ± 1.4 1.0 ± 1.3 .04
Household responsibility T1 1.2 ± 0.4 1.4 ± 0.4 1.1 ± 0.4 <.001
Household responsibility T2 1.2 ± 0.4 1.4 ± 0.4 1.1 ± 0.4 <.001

---

Numbers are means +/- SD or column-wise count (valid%) by sex (for some medical characteristics, data are missing.)

P values are for univariate Mann-Whitney U tests or chi-square as appropriate.

T1=during hospitalization from CABG surgery, T2=1 year post-CABG surgery, CCS=Canadian Cardiovascular Society grading of angina pectoris, CHF=congestive heart failure, COPD=chronic obstructive pulmonary disease, EF=ejection fraction, CVD=cerebrovascular disease, NYLT= Risk Score for Predicting Long-Term Mortality After Coronary Artery Bypass Graft Surgery based on the New York State Cardiac Surgery Reporting System, LMS=left main stenosis, LVEDP=left ventricular end diastolic pressure, NYHA = New York Heart Association Functional Classification of extent of heart failure, PVD=peripheral vascular disease, Post-CABG procedure = diagnostic catheterization +/-or percutaneous coronary intervention +/-or open heart surgery.
Table 3.2 Relationships between covariates and psychosocial measures in patients assessed in-hospital and one-year post-CABG for all complete one-year participants.

<table>
<thead>
<tr>
<th>N = 231</th>
<th>Depression T1</th>
<th>Depression T2</th>
<th>Perceived social support T1</th>
<th>Perceived social support T2</th>
<th>Life function impairment T1</th>
<th>Life function impairment T2</th>
<th>Household responsibility T1</th>
<th>Household responsibility T2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Psychosocial predictors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression T2</td>
<td>.62***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Perceived social support T1</td>
<td>-.44***</td>
<td>-.49***</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Perceived social support T2</td>
<td>-.45***</td>
<td>-.67***</td>
<td>.64***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life function impairment T1</td>
<td>.24***</td>
<td>.28***</td>
<td>-.18**</td>
<td>-.24***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life function impairment T2</td>
<td>.20**</td>
<td>.45***</td>
<td>-.26***</td>
<td>-.32***</td>
<td>.23***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household responsibility T1</td>
<td>.13*</td>
<td>.13**</td>
<td>-.06</td>
<td>-.13</td>
<td>.02</td>
<td>-.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household responsibility T2</td>
<td>.11</td>
<td>.10</td>
<td>-.06</td>
<td>-.14*</td>
<td>.02</td>
<td>-.08</td>
<td>.84***</td>
<td></td>
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<tr>
<td>Married</td>
<td>-.04</td>
<td>-.14*</td>
<td>.03</td>
<td>.14*</td>
<td>.08</td>
<td>-.03</td>
<td>-.69***</td>
<td>-.69***</td>
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<tr>
<td><strong>Clinical risk covariates</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Disease severity (NYLT score)</td>
<td>-.11</td>
<td>-.01</td>
<td>.14*</td>
<td>.17**</td>
<td>-.16*</td>
<td>.07</td>
<td>.06</td>
<td>-.04</td>
</tr>
<tr>
<td>Sex (female)</td>
<td>.16*</td>
<td>.30***</td>
<td>-.10</td>
<td>-.19**</td>
<td>.16*</td>
<td>.14*</td>
<td>.36***</td>
<td>.32***</td>
</tr>
<tr>
<td>Valve procedure during CABG</td>
<td>.04</td>
<td>.04</td>
<td>.00</td>
<td>.02</td>
<td>.00</td>
<td>.02</td>
<td>.05</td>
<td>-.01</td>
</tr>
<tr>
<td>Internal thoracic graft</td>
<td>-.05</td>
<td>-.11</td>
<td>.04</td>
<td>.03</td>
<td>-.04</td>
<td>-.18**</td>
<td>-.08</td>
<td>-.03</td>
</tr>
<tr>
<td>Positive Smoking Hx</td>
<td>-.02</td>
<td>-.01</td>
<td>.02</td>
<td>-.05</td>
<td>.00</td>
<td>.00</td>
<td>-.18**</td>
<td>-.11</td>
</tr>
<tr>
<td>Smoking at CABG</td>
<td>.14*</td>
<td>.15*</td>
<td>-.05</td>
<td>-.05</td>
<td>.10</td>
<td>.10</td>
<td>-.01</td>
<td>.03</td>
</tr>
</tbody>
</table>
Depression T1 | Depression T2 | Perceived social support T1 | Perceived social support T2 | Life function impairment T1 | Life function impairment T2 | Household responsibility T1 | Household responsibility T2
---|---|---|---|---|---|---|---
Cardiac rehabilitation participation | .04 | .00 | .02 | -.04 | .01 | .02 | -.04 | -.06

Outcomes
post-CABG procedure | .04 | .13* | -.01 | -.01 | .11 | .20** | .00 | .03
Time survived | .02 | -.11 | -.03 | -.02 | -.06 | -.14* | -.03 | .06
Deceased | -.02 | .14* | -.04 | .01 | -.10 | .01 | .06 | -.06

during follow-up
<.05*, <.01**, <.001***

T1=during hospitalization from CABG surgery, T2=1 year post-CABG surgery, NYLT= Risk Score for Predicting Long-Term Mortality After Coronary Artery Bypass Graft Surgery based on the New York State Cardiac Surgery Reporting System, Post-CABG procedure = diagnostic catheterization +/- percutaneous coronary intervention +/- open heart surgery.
Table 3.3 Univariate HRs of psychosocial measures for hazard of mortality subsequent to one-year post-CABG surgery for all one-year complete participants.

<table>
<thead>
<tr>
<th></th>
<th>HR (95% CI)</th>
<th>p</th>
<th>Adjusted HR (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression T1</td>
<td>0.94 (0.79, 1.12)</td>
<td>0.271</td>
<td>0.99 (0.78, 1.25)</td>
<td>0.455</td>
</tr>
<tr>
<td>Depression T2</td>
<td>1.11 (0.95, 1.29)</td>
<td>0.145</td>
<td>1.131 (0.95, 1.35)</td>
<td>0.122</td>
</tr>
<tr>
<td>Depression T2 adjusted</td>
<td>1.28 (1.04, 1.57)</td>
<td><strong>0.028</strong></td>
<td>1.27 (1.02, 1.59)</td>
<td><strong>0.036</strong></td>
</tr>
<tr>
<td></td>
<td>1.09 (0.91, 1.31)</td>
<td>0.211</td>
<td>1.01 (0.83, 1.23)</td>
<td>0.461</td>
</tr>
<tr>
<td>Perceived social support</td>
<td>1.15 (0.95, 1.39)</td>
<td>0.121</td>
<td>1.03 (0.83, 1.28)</td>
<td>0.407</td>
</tr>
<tr>
<td></td>
<td>1.14 (0.90, 1.45)</td>
<td>0.186</td>
<td>1.02 (0.79, 1.33)</td>
<td>0.448</td>
</tr>
<tr>
<td>Life function impairment</td>
<td>0.86 (0.72, 1.02)</td>
<td>0.074</td>
<td>0.88 (0.73, 1.06)</td>
<td>0.123</td>
</tr>
<tr>
<td>Life function impairment</td>
<td>1.06 (0.90, 1.26)</td>
<td>0.278</td>
<td>1.02 (0.84, 1.22)</td>
<td>0.443</td>
</tr>
<tr>
<td>Life function impairment</td>
<td>1.12 (0.94, 1.34)</td>
<td>0.148</td>
<td>1.05 (0.87, 1.28)</td>
<td>0.324</td>
</tr>
<tr>
<td>MRQ T1</td>
<td>1.08 (0.90, 1.28)</td>
<td>0.246</td>
<td>0.97 (0.80, 1.16)</td>
<td>0.382</td>
</tr>
<tr>
<td>MRQ T2</td>
<td>0.91 (0.76, 1.10)</td>
<td>0.206</td>
<td>0.86 (0.70, 1.04)</td>
<td>0.100</td>
</tr>
<tr>
<td>MRQ T2 adjusted for T1</td>
<td>0.62 (0.46, 0.83)</td>
<td><strong>0.004</strong></td>
<td>0.71 (0.52, 0.97)</td>
<td><strong>0.038</strong></td>
</tr>
<tr>
<td>Married</td>
<td>0.83 (0.56, 1.22)</td>
<td>0.210</td>
<td>1.19 (0.77, 1.84)</td>
<td>0.251</td>
</tr>
</tbody>
</table>

Proportionality analyses

1. Life function impairment T2
   \(X\ Time\ (months)\)
   \(0.99\ (0.99, 0.997)\)
   \(0.004\)
   \(0.99\ (0.99, 0.998)\)
   \(0.008\)

2. Life function impairment T2
   \(X\ Time\ (months)\)
   \(0.64\ (0.42, 0.98)\)
   \(0.034\)
   \(0.61\ (0.39, 0.95)\)
   \(0.027\)

Continuous variables HR is for 1SD change in predictor
Adjusted HR includes disease severity (NYLT score), valve procedure during CABG, internal thoracic artery graft, sex, cardiac rehabilitation participation & positive smoking history
*Nonproportionality of hazards over follow-up period detected on analyses
Non-proportionality tested by splitting variables at 96 months after one-year post-CABG surgery.
T1=during hospitalization from CABG surgery, T2=1 year post-CABG surgery, NYLT=Risk Score for Predicting Long-Term Mortality After Coronary Artery Bypass Graft Surgery based on the New York State Cardiac Surgery Reporting System.
Table 3.4 Multivariate Cox proportional hazards analysis of time to mortality for all complete T2 participants.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>1. Simplified</th>
<th>2. Oversized model</th>
<th>3. Bootstrapped; time dependent variables excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR (95% CI)</td>
<td>p</td>
<td>HR (95% CI)</td>
</tr>
<tr>
<td>Disease severity (NYLT score)</td>
<td>1.37 (1.28,</td>
<td>&lt;.001</td>
<td>1.33 (1.23,</td>
</tr>
<tr>
<td></td>
<td>1.45)</td>
<td></td>
<td>1.45)</td>
</tr>
<tr>
<td></td>
<td>1.53 (1.03,</td>
<td>.079</td>
<td>2.11 (1.20,</td>
</tr>
<tr>
<td></td>
<td>2.27)</td>
<td></td>
<td>3.71)</td>
</tr>
<tr>
<td>Sex (female)</td>
<td>1.36 0.84,</td>
<td>.152</td>
<td>1.49 (0.83,</td>
</tr>
<tr>
<td></td>
<td>2.20)</td>
<td></td>
<td>2.67)</td>
</tr>
<tr>
<td>Valve procedure during CABG</td>
<td>0.56 (0.36,</td>
<td>.014</td>
<td>0.62 (0.39,</td>
</tr>
<tr>
<td></td>
<td>.86)</td>
<td></td>
<td>0.98)</td>
</tr>
<tr>
<td>Internal thoracic graft</td>
<td>1.27 (0.84,</td>
<td>.171</td>
<td>1.25 (0.78,</td>
</tr>
<tr>
<td></td>
<td>1.92)</td>
<td></td>
<td>1.98)</td>
</tr>
<tr>
<td>Cardiac rehabilitation participation</td>
<td>2.32 (1.45,</td>
<td>.002</td>
<td>2.15 (1.23,</td>
</tr>
<tr>
<td></td>
<td>3.72)</td>
<td></td>
<td>3.75)</td>
</tr>
<tr>
<td>Smoking Hx</td>
<td>1.36 0.84,</td>
<td>.014</td>
<td>1.49 (0.83,</td>
</tr>
<tr>
<td></td>
<td>2.20)</td>
<td></td>
<td>2.67)</td>
</tr>
<tr>
<td>Depression T1</td>
<td>1.07 (0.81,</td>
<td>.348</td>
<td>1.72)</td>
</tr>
<tr>
<td>Depression T2 at low perceived social support</td>
<td>1.42</td>
<td></td>
<td>1.67 (1.21,</td>
</tr>
<tr>
<td>Depression T2 at mean perceived social support</td>
<td>1.39 (1.09,</td>
<td></td>
<td>2.26)</td>
</tr>
<tr>
<td>Depression T2 at high perceived social support</td>
<td>1.80 (1.27,</td>
<td></td>
<td>2.23 (1.46,</td>
</tr>
<tr>
<td>Perceived social support T1</td>
<td>0.95 (.62,</td>
<td>.068</td>
<td>0.80 (.62,</td>
</tr>
<tr>
<td></td>
<td>1.03)</td>
<td></td>
<td>1.03)</td>
</tr>
<tr>
<td>Perceived social support T2</td>
<td>0.96 (0.71,</td>
<td>.423</td>
<td>1.01 (.71,</td>
</tr>
<tr>
<td></td>
<td>1.31)</td>
<td></td>
<td>1.45)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life function impairment T1</td>
<td>0.89 (.73,</td>
<td></td>
<td>1.09)</td>
</tr>
<tr>
<td>Life function impairment T2</td>
<td>1.88 (1.22,</td>
<td>.088</td>
<td>1.80 (1.15,</td>
</tr>
<tr>
<td></td>
<td>2.90)</td>
<td></td>
<td>2.81)</td>
</tr>
<tr>
<td>Household responsibility T1</td>
<td>1.12 (.80,</td>
<td></td>
<td>1.58)</td>
</tr>
<tr>
<td>Household responsibility T2</td>
<td>0.36 (0.18,</td>
<td>.005</td>
<td>0.31 (.15,</td>
</tr>
<tr>
<td></td>
<td>0.69)</td>
<td></td>
<td>.62)</td>
</tr>
<tr>
<td>Married</td>
<td>0.13 (.03,</td>
<td>.007</td>
<td>0.11 (.02,</td>
</tr>
<tr>
<td></td>
<td>0.51)</td>
<td></td>
<td>0.50)</td>
</tr>
<tr>
<td>Life function impairment x Time (months)</td>
<td>0.99 (.99,</td>
<td>.004</td>
<td>0.99 (.987,</td>
</tr>
<tr>
<td></td>
<td>0.998)</td>
<td></td>
<td>.996)</td>
</tr>
<tr>
<td>Household responsibility x Time (months)</td>
<td>1.02 (1.003,</td>
<td>.024</td>
<td>1.01 (1.002,</td>
</tr>
<tr>
<td></td>
<td>1.04)</td>
<td></td>
<td>1.02)</td>
</tr>
<tr>
<td>Married x Time (months)</td>
<td>1.02 (1.01,</td>
<td>.007</td>
<td>1.03 (1.01,</td>
</tr>
<tr>
<td></td>
<td>1.04)</td>
<td></td>
<td>1.05)</td>
</tr>
<tr>
<td>Depression T2 x perceived social support T2</td>
<td>1.30 (1.05,</td>
<td>.433</td>
<td>1.34 (1.03,</td>
</tr>
<tr>
<td></td>
<td>1.60)</td>
<td></td>
<td>1.75)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.033</td>
</tr>
<tr>
<td>Model</td>
<td>( \chi^2 (11) = 111.05, p &lt; .001 )</td>
<td></td>
<td>( \chi^2 (19) = 127.41, p &lt; .001 )</td>
</tr>
</tbody>
</table>
Time covariate was set at the first month of follow-up and when viewed with included time interaction indicates effect of independent variable at first month of follow-up. Time interaction indicates ratio change in HRs from one subsequent month to the month prior (small confidence intervals are indicative of the large number of monthly time intervals).

T1=during hospitalization from CABG surgery, T2=1 year post-CABG surgery, NYLT= Risk Score for Predicting Long-Term Mortality After Coronary Artery Bypass Graft Surgery based on the New York State Cardiac Surgery Reporting System.
Table 3.5 Univariate ORs of psychosocial measures predicting post-CABG CAD procedure during first 12 years of study period for one-year completers.

<table>
<thead>
<tr>
<th></th>
<th>OR (95% CI)</th>
<th>p</th>
<th>Adjusted OR (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression T1</td>
<td>1.14 (0.84, 1.51)</td>
<td>.212</td>
<td>1.14 (0.80, 1.59)</td>
<td>.231</td>
</tr>
<tr>
<td>Depression T2</td>
<td>1.50 (1.14, 2.19)</td>
<td>.008</td>
<td>1.61 (1.11, 2.83)</td>
<td>.009</td>
</tr>
<tr>
<td>Depression T2 adjusted for T1</td>
<td>1.69 (1.18, 2.64)</td>
<td>.008</td>
<td>1.82 (1.14, 3.97)</td>
<td>.009</td>
</tr>
<tr>
<td>Perceived social support T1</td>
<td>0.84 (0.63, 1.14)</td>
<td>.156</td>
<td>0.81 (0.60, 1.13)</td>
<td>.126</td>
</tr>
<tr>
<td>Perceived social support T2</td>
<td>0.92 (0.69, 1.31)</td>
<td>.309</td>
<td>0.89 (0.62, 1.24)</td>
<td>.273</td>
</tr>
<tr>
<td>Perceived social support T2 adjusted for T1</td>
<td>1.04 (0.71, 1.71)</td>
<td>.438</td>
<td>1.03 (0.69, 1.78)</td>
<td>.453</td>
</tr>
<tr>
<td>Life function impairment T1</td>
<td>1.18 (0.90, 1.59)</td>
<td>.150</td>
<td>1.20 (0.85, 1.87)</td>
<td>.144</td>
</tr>
<tr>
<td>Life function impairment T2</td>
<td>1.58 (1.17, 2.27)</td>
<td>.004</td>
<td>1.57 (1.11, 2.51)</td>
<td>.011</td>
</tr>
<tr>
<td>Life function impairment T2 adjusted for T1</td>
<td>1.55 (1.16, 2.17)</td>
<td>.006</td>
<td>1.54 (1.08, 2.70)</td>
<td>.017</td>
</tr>
<tr>
<td>Household responsibility T1</td>
<td>1.12 (0.85, 1.49)</td>
<td>.253</td>
<td>1.20 (0.84, 1.77)</td>
<td>.163</td>
</tr>
<tr>
<td>Household responsibility T2</td>
<td>1.10 (0.83, 1.45)</td>
<td>.282</td>
<td>1.17 (0.83, 1.66)</td>
<td>.195</td>
</tr>
<tr>
<td>Household responsibility T2 adjusted for T1</td>
<td>0.99 (0.47, 1.78)</td>
<td>.486</td>
<td>1.01 (0.49, 1.82)</td>
<td>.484</td>
</tr>
<tr>
<td>Married</td>
<td>1.02 (0.53, 1.96)</td>
<td>.481</td>
<td>0.98 (0.47, 2.14)</td>
<td>.488</td>
</tr>
</tbody>
</table>

Continuous variables OR is for 1SD change in predictor.
All CI are bootstrapped.
Adjusted OR includes disease severity (NYLT score), valve procedure during CABG, internal thoracic artery graft, sex, cardiac rehabilitation participation & positive smoking history.
T1= during hospitalization from CABG surgery, T2=1 year post-CABG surgery, NYLT= Risk Score for Predicting Long-Term Mortality After Coronary Artery Bypass Graft Surgery based on the New York State Cardiac Surgery Reporting System. Post-CABG procedure = diagnostic catheterization +/- percutaneous coronary intervention +/- open heart surgery.
Table 3.6 Multiple logistic regression model predicting odds of post-CABG CAD procedure received during 12-year follow-up.

<table>
<thead>
<tr>
<th></th>
<th>1. Simplified Model</th>
<th></th>
<th>2. Oversized Model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>p</td>
<td>OR (95% CI)</td>
<td>p</td>
</tr>
<tr>
<td>Disease severity (NYLT score)</td>
<td>1.08 (0.96, 1.25)</td>
<td>.139</td>
<td>1.07 (0.92, 1.30)</td>
<td>.229</td>
</tr>
<tr>
<td>Sex (female)</td>
<td>0.61 (0.27, 1.23)</td>
<td>.219</td>
<td>0.63 (0.23, 1.40)</td>
<td>.339</td>
</tr>
<tr>
<td>Valve procedure during CABG</td>
<td></td>
<td></td>
<td>1.67 (0.43, 6.83)</td>
<td>.231</td>
</tr>
<tr>
<td>Internal thoracic graft</td>
<td>0.66 (0.24, 1.45)</td>
<td>.195</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiac rehabilitation</td>
<td>1.59 (0.80, 3.79)</td>
<td>.135</td>
<td></td>
<td></td>
</tr>
<tr>
<td>participation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking Hx</td>
<td>1.81 (0.82, 4.58)</td>
<td>.092</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression T1</td>
<td>0.77 (0.42, 1.19)</td>
<td>.162</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression T2</td>
<td>1.91 (1.24, 4.04)</td>
<td>.020</td>
<td>2.12 (0.33, 5.68)</td>
<td>.019</td>
</tr>
<tr>
<td>Perceived social support T1</td>
<td>0.87 (0.54, 1.49)</td>
<td>.311</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived social support T2</td>
<td>1.51 (1.04, 2.69)</td>
<td>.058</td>
<td>1.62 (0.99, 3.57)</td>
<td>.061</td>
</tr>
<tr>
<td>Life function impairment T1</td>
<td>0.99 (0.68, 1.46)</td>
<td>.474</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life function impairment T2</td>
<td>1.53 (1.08, 2.41)</td>
<td>.026</td>
<td>1.52 (1.06, 2.51)</td>
<td>.025</td>
</tr>
<tr>
<td>Household responsibility T1</td>
<td>1.58 (0.61, 4.46)</td>
<td>.176</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household responsibility T2</td>
<td>1.50 (0.96, 2.60)</td>
<td>.067</td>
<td>1.25 (0.58, 3.19)</td>
<td>.311</td>
</tr>
<tr>
<td>Married</td>
<td>2.13 (0.69, 8.82)</td>
<td>.135</td>
<td>3.29 (0.96, 19.98)</td>
<td>.071</td>
</tr>
<tr>
<td>Constant</td>
<td>0.29 (.06, 0.86)</td>
<td>.041</td>
<td>0.15 (0.02, 0.71)</td>
<td>.026</td>
</tr>
<tr>
<td>Hosmer&amp;Lemeshow Test</td>
<td>(\chi^2_{(8)} = 4.223, \ p = .836)</td>
<td></td>
<td>(\chi^2_{(8)} = 5.558, \ p = .697)</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>(\chi^2_{(7)} = 17.634, \ p = .017)</td>
<td></td>
<td>(\chi^2_{(15)} = 25.078, \ p = .049)</td>
<td></td>
</tr>
</tbody>
</table>

Model based on 62 events
CI are bootstrapped
T1=during hospitalization from CABG surgery, T2=1 year post-CABG surgery, NYLT= Risk Score for Predicting Long-Term Mortality After Coronary Artery Bypass Graft Surgery based on the New York State Cardiac Surgery Reporting System, Post-CABG procedure = diagnostic catheterization +/- or percutaneous coronary intervention +/- or open heart surgery.
Figure 3.1 Flow diagram of participants through the study process.

1998-2000
Assessed for eligibility (n=1423)
Enrolled (n=296)

Excluded (n=1,127)
-95M, 47F declined participation
-35 discharged before approached
-950 not meeting inclusion criteria:
  - 104 redo CABG
  - 81 complicated course
  - 5 mental illness/bhvrl disorder
  - 17 deaf/hard of hearing
  - 15 blind/unable to read
  - 78 English language difficulties
  - 41 anxious/dep/hostile
  - 29 confused/ neurological def.
  - 580 males too young

Enrollment

Male participants (n=171)

Male participants (n=137)
Male lost to follow-up (n=34)
  - 23 denied,
  - 6 unable to contact
  - 3 deceased
  - 1 hospitalized/too sick
  - 1 confused.

Female participants (n=125)

T1: In hospital post-CABG

T2: 1-year post-CABG

Male participants
- **T2 analysis (n=132)**
  - Excluded from analysis
    - 34 T1 participants only
    - 2 missing mortality/morbidity
    - 3 <75% of items on analysis questionnaire.

Female participants
- **T2 analysis (n=104)**
  - Excluded from analysis
    - 9 denied
    - 7 unable to contact
    - 1 deceased
    - 1 hospitalized/too sick
    - 2 confused

13-15 years post-CABG
survival analysis

Female analysed
- **T2 analysis (n=99)**
  - Excluded from analysis
    - 21 T1 participants only
    - 5 <75% of items on analysis questionnaire.
Figure 3.2 Interaction between one-year BDI and ISEL in predicting overall survival in post-CABG patients.
Chapter Four: Overall Discussion

4.1 Summary of main findings

This dissertation examines the association between psychosocial variables and long-term outcomes in a sample of male and female CABG recipients. Using data initially collected from 1998-2000 from a single cardiac centre, two separate studies were conducted, with the second building on the first. The focus is on psychosocial variables, sex differences and the interaction between depression and perceived social support and whether these are related to outcomes following CABG surgery. Overall, results from this dissertation support an important role for depression symptoms, social relationships, and life function, in predicting long-term outcomes following CABG surgery, over and above that predicted by factors traditionally used to determine medical risk, such as disease severity, smoking, and cardiac rehabilitation participation.

Chapter one provides an introduction to this dissertation and a review of the literature regarding CAD, CABG surgery and their associations with psychosocial variables. This chapter also briefly discusses long-term post-CABG surgery mortality prediction scores developed using medical variables associated with long-term mortality following CABG surgery (Shahian et al., 2012; Wu et al., 2012). For men and women CAD is the leading cause of mortality and morbidity globally (WHO, 2008, 2009). CABG surgery is a surgical revascularization procedure conducted to correct significant coronary artery stenosis due to CAD. It is conducted to decrease angina pain, increase function and, in some, increase length of life (Hillis et al., 2011). Cardiac disease and CABG surgery outcomes have been associated with depression and social support in previous research (Barth et al., 2010; Blumenthal et al., 2003; Frasure-Smith & Lesperance, 2005; Hawkins et al., 2014; Herlitz et al., 1998; Idler, Boulifard & Contrada, 2012; King & Reis,
Depression, both symptoms and a diagnosis of major depressive disorder, has been the most studied psychosocial variable in the cardiac literature. Depressed mood is related to greater CAD (Lichtman et al., 2009), and poor outcomes following CABG surgery (Blumenthal et al., 2003). Social support, perceived and structural, is also related to better CAD outcomes (Lett et al., 2005; Williams et al., 1992). Being married, a measure of structural support, is associated with decreased mortality following CABG surgery (Idler, Boulifard & Contrada, 2012; King & Reis, 2012). Given the lack of research investigating depression and social variables in combination, this dissertation attempts to fill this gap. As mentioned previously, psychological and social constructs have been measured in many ways. For this dissertation we chose to assess depression symptoms as a continuous measure of depressed mood using the BDI (Beck et al., 1961). We also chose to measure three variables related to interpersonal relationships: Perceived social support (ISEL; Cohen et al., 1985) was used as a measure of functional support, marital status (being married or common-law) as a measure of structural support, and household responsibilities (MRQ; Buxbaum, 1967) was conceptualized as a gender-role variable. Additionally, we investigated life function impairment using the WHYMPI (Kerns et al., 1985). These psychological, social and function variables were investigated as they related to long-term outcomes following CABG surgery with a focus on the buffering role of perceived social support and sex differences.

Chapter two reports an investigation of the adjusted relationship of post-CABG depression symptoms and interpersonal variables with impairment in one-year life function. After adjustment, depression symptoms and socially related factors measured in-hospital following CABG surgery (perceived social support, marital status and household responsibilities), are associated with one-year post-CABG life function, while traditional medical
risk factors are not. Both having greater household responsibilities and a marital partner, at the
time of CABG surgery, were additively associated with reduced one-year life function
impairment. Although we hypothesized greater household responsibilities at baseline may be
associated with reduced one-year life function, especially for women given its association with
greater stress for women (Kendel et al., 2008), it was actually associated with reduced one-year
life function impairment. It is possible that having more household responsibility is indicative of
better baseline functioning and/or is associated with increased impetus for activity post-surgery
which would support rehabilitation. Being married is associated with a 0.5 SD decrease in one-
year life function impairment. Although this indicates a seemingly small 0.6 point increase in life
function, given that mean life function impairment was 1.2 (SD = 1.35) units, this translates into
a moderate effect size in this sample. Further, having a marital partner may provide the
assistance patients indicate they need following surgery (Theobald et al., 2005), allowing
improved functioning in patients despite lingering surgical or cardiac pain. Although people
report varying levels of support from their marital partner, one study supports that people often
receive beneficial invisible support in a marital relationship which they are not aware of and this
promotes adjustment to stressors (Bolger, Zuckerman & Kessler, 2000). In our sample, having a
marital partner may have provided invisible support to those married patients, allowing better
coping following the stress of surgery, which may have led to better life function. Furthermore,
having a marital partner may allow patients to participate in more social and recreational
activities by providing the assistance to attend these activities and may further improve life
function by providing social contact (Uchino, 2006).
All interactions between our psychosocial variables and sex were investigated, but only the interaction between sex and perceived social support, in addition to the interaction between baseline depression symptoms and perceived social support were significant. Although we had hypothesized an overall buffering of the association between depression symptoms and later function by perceived social support, perceived social support only ameliorated the positive association between high baseline depression and life function impairment in women. For men and women, an increase in baseline depression symptoms was related to one-year life function impairment only at average or higher baseline perceived social support. Our model predicts 0.6 SD higher life function impairment (0.8 increase in a score ranging from 0-6) in patients with high depression symptoms compared to those with low depression symptoms at high perceived social support, a moderate effect size (Cohen’s \( d = 0.6 \)). Furthermore, for men either high baseline depression symptoms or low perceived social support led to similarly impaired life function at one year. In women, higher baseline perceived social support is related to better one-year life function at all levels of baseline depression. Perceived social support appears to be more important for women. Women with high versus low baseline perceived social support, at low depression symptoms, are predicted to have a 1.5 unit decrease in life function impairment at one year, a large effect size.

Our findings indicating baseline depression is associated with later life-function are supported by previous research indicating depression at time of CABG surgery is related to later physical impairment (Burg, Benedetto, Rosenberg, et al., 2003; Goyal et al., 2005; Kendel et al., 2010; Lee, 2009). The stronger effect of social support in women in our sample is also supported by prior research which supports a stronger association between perceived social support and later pain and QOL in women recovering from MI (Leifheit-Limson et al., 2010). According to
the Tend and Befriend Theory, put forward by Taylor et al. (2000), social support may play a larger role in women’s stress responses. According to this theory, although men may respond to stress with more typical fight or flight responses, evolutionarily women may have developed a strategy in which they tend to offspring and associate with others in times of danger to protect themselves and their offspring. It is hypothesized that for women fleeing or fighting would not often be adaptive as it might lead to them abandoning or endangering their offspring. This is supported by meta-analysis indicating women engage in more coping by talking to others and themselves, more often seeking out emotional support than men (Tamres, Janicki, & Helgeson, 2002). As perceived social support had a larger association with later function in women and ameliorated the relationship between high depression symptoms and function in women, but not men, our results support that women may rely more heavily on perceived social support than men. It is possible increased later function in women is associated with perceived social support through increased perceptions of safety during the stressful post-CABG recovery period.

This study builds on previous research by investigating the relationship between depression and social variables in how men and women function in their lives one-year following CABG surgery. Although previous research has investigated the association between psychosocial variables and physical function following CABG surgery (Borowicz et al., 2002; Burg, Benedetto, Rosenberg, & Soufer, 2003; Foss-Nieradko, Stepnowska, & Piotrowicz, 2012; Goyal et al., 2005; Karlsson, Berglin, Pettersson, & Larsson, 1999; Kendel et al., 2010) and return to work (Soderman, Lisspers, & Sundin, 2003), this is one of the first studies to investigate life function in CABG patients and important outcomes in women. Overall, perceived social support had stronger associations with later life function in women and ameliorated the association between depression and one-year life function in women, but not men.
Chapter three builds on chapter two by further examining baseline and one-year post-CABG depression symptoms and social variables, in addition to life function (an outcome in chapter two), and finding associations with longer-term outcomes of 13 to 15-year mortality and 12-year CAD procedure recurrence. One-year depression symptoms are related to long-term mortality, but only at average or higher perceived social support. At high perceived social support, a one SD increase in depression symptoms is associated with more than double the hazard of mortality. Additively, one-year post-CABG greater household responsibilities, better life function and being married are all associated with decreased hazard of death. Regarding household responsibility, it was again associated with improved outcomes. Although greater household responsibility may be associated with stress for women (Kendel et al., 2008), our results suggest it is associated with better post-CABG outcomes. This may be due to household responsibilities supporting increased activity following surgery and acting as a form of cardiac rehabilitation. Despite the association of higher household responsibility with stress in women, greater responsibility was not associated with decreased physical function in a prior sample (Kendel et al., 2008). No previous research has investigated household responsibility as a predictor of outcome following CABG surgery. Not having a marital partner is associated with over four times the hazard of mortality. In analyses predicting odds of a CAD related procedure over follow-up, both one-year depression symptoms and life function impairment predict greater odds. Despite some measures of function being related to depression (Kendel et al., 2011; Bruce, Seeman, Merrill, & Blazer, 1994), in this sample both life function and depression symptoms are associated with increased odds of a CAD procedure, indicating their additive role. Although this study used a high proportion of women, and had enough women to be able to investigate sex
differences, no sex differences in the associations between depression and social variables in predicting outcome were seen.

Higher depression symptoms at one-year following surgery were associated with double the hazard of mortality, as has been seen in previous studies (Blumenthal et al., 2003; Peterson et al., 2002). Compared to prior research, in our study we investigated one-year depression symptoms, as a continuous measure, after adjustment for baseline depression symptoms and moderation by perceived social support. In Blumenthal’s (2003) study (N= 817, 27% women, mean age = 61), investigations focused on changes in depression over six months and whether these were significantly associated with increased hazard of mortality compared to patients who were never categorized as depressed. In contrast, our study supports those individuals reporting more symptoms of depression at one-year post-CABG surgery along with average or higher perceived social support are at increased risk of mortality.

An in-hospital measure of depression symptoms following surgery was not associated with long-term hazard of mortality in univariate analyses or after adjustment for one-year measures. It is possible we did not find associations for our baseline measure of depression symptoms as they were completed following surgery and may have been contaminated by the distress of undergoing surgery. Given prior studies measuring depression symptoms following surgery have found relationships with long term hazard of mortality (Connerney, Shapiro, McLaughlin, Bagiella, & Sloan, 2001; Connerney, Sloan, P., Bagiella, & Seckman, 2010; Tully, Baker, & Knight, 2008) this is unlikely. Although one smaller study (N = 100, 19 women, mean age = 63.3 years) with a younger sample and fewer women found that pre-operative but not post-operative depression, measured using the DASS, was associated with 6-month hospital readmission following CABG surgery (Oxlad, Stubberfield, Stuklis, Edwards, & Wade, 2006).
Given the smaller sample size, this may have been due to low power. Further supporting our findings of later measures of depression symptoms being associated with outcome versus measures surrounding surgery, prior research supports psychological treatment initiated at least two months after a cardiac event being associated with improved mortality (Linden, Phillips, & Leclerc, 2007). Later elevated depression symptoms may indicate a more problematic situation. Two studies support depression symptoms measured at six months post-CABG being related to later mortality (Blumenthal et al., 2003; Peterson et al., 2002). It is possible baseline measures are more indicative of the stress of undergoing a cardiac surgery, while one-year measures may better reflect individuals’ adjustment following recovery. Given baseline depression and social variables are related to one-year life function in this sample, and one-year life function is, in turn, associated with mortality and morbidity outcomes, our results may suggest a pathway for longer-term effects of baseline depression and social variables.

It was unexpected that perceived social support was not associated with later mortality or morbidity in this study, and that depression symptoms were only associated with later mortality when perceived social support was average or higher. Previous research investigating outcomes following MI has found a buffering effect of high perceived social support on the association between depression and one-year mortality (Frasure-Smith et al., 2000). This study differed in that they were investigating one-year outcomes in MI patients, had a larger and younger sample (N= 887, 31.5% women, mean age = 59.3 years). They used the BDI, but measured perceived social support with the Perceived Social Support Scale, a scale different from ours. It is unlikely differences in our outcomes are due to the differences in proportions of women, given they had a large number of women, but may be due to differences in patients population (MI versus CABG), goals (our goal of investigating longer-term outcomes may have missed associations of
baseline variables with outcomes up to one-year), measures, and age of sample, as our sample was considerably older given a higher proportion of women.

Previous research has also found an association between social isolation and mortality following CABG surgery (Herlitz et al., 1998). Low perceived social support is also associated with cardiac events (Hedblad, Östergren, Hanson, & Janzon, 1992; Lett et al., 2005; Pedersen, Van Domburg, & Larsen, 2004), higher rates of CAD progression in women (Wang, Mittleman, & Orth-Gomer, 2005) and increased cardiac and all-cause mortality (Barth et al., 2010; Holt-Lunstad, Smith & Layton, 2010; Williams et al., 1992). Those patients (N = 1290, 20% women, mean age = 64 years) responding positively to the statement, “I felt lonely”, prior to CABG, had greater 30-day (RR 2.61, 95% CI [1.15, 5.95]) and five-year adjusted mortality (RR 1.78, 95% CI [1.17, 2.71]) after controlling for medical risk variables (Herlitz et al., 1998). Although, in another study (N = 180, 33.9% women) after adjustment for factors assessed prior to surgery (medical, BDI, STAI, and demographic risk factors), perceived social support, measured with the Social Support Inventory, was not associated with a combined mortality and cardiac hospitalization outcome at five years post-CABG surgery (Cserep et al., 2010). Although it is unclear why perceived social support is not related to mortality as expected given its strong association with overall mortality in meta-analysis (Holt-Lunstad et al., 2010), a number of explanations are tenable. We measured perceived support using the ISEL (Cohen et al., 1985), while a great variety of perceived social support measures have been used in cardiac populations. Possibly, variation in how perceived social support is measured contributed to different findings in our sample. Further, it may be that there is another moderator of perceived social support such as socioeconomic status (Stringhini et al., 2012) or age (Lyyra & Heikkinen, 2006), for which we did not hypothesize an association and might reveal a significant relationship between perceived
social support and outcome. Moreover, this lack of significant finding may be due to the measurement of perceived social support being confounded by greater received support in our sample (Uchino, 2009). Our sample consisted of older and possibly frailer individuals who may be receiving greater assistance due to CAD or receipt of CABG surgery. In our sample, higher perceived social support was related to greater disease severity at baseline ($r = .14, p < .05$) and one year ($r = .17 p < .01$), indicating perceived social support was higher in those who may have had greater disease burden and may have required more assistance. Prior research indicates for older individuals giving support may be more important to health outcomes than receiving support (Thomas, 2010; Uchino, 2009). In Thomas’ (2010) study, investigating the association between various forms of social support psychological well-being ($N = 689, 59\%$ women, mean age = 72 years), total support received became non-significant after including total support given in predicting well-being. Another reason for our lack of findings with perceived social support and mortality may be explained by Uchino’s model (2009). It describes a developmental path in which perceived social support may be acquired in childhood as a characteristic of a person, which may also vary due to circumstances, along with self-esteem, social skills, and feelings of control. In those individuals with high perceived social support, receiving a great deal of support due to chronic illness or frailty may actually lead to greater stress as it impairs their sense of self-esteem and control. This may explain why individuals with higher depression symptoms and average or higher perceived social support exhibited increased hazard of mortality. For those individuals, depression may exacerbate the distress of those with high perceived support receiving more support and possibly losing their independence.

Although previous research finds being married reduces hazard of mortality following CABG surgery (Idler et al., 2012; King & Reis, 2012), no prior study indicates such a large
hazard of mortality or controlled for a large number of psychosocial variables in a single model. Further, King and Reiss (2012) found an association of marital status that was proportional throughout their 15-year follow-up while we did not. This could be due to differences in covariates between models due to a larger number of psychosocial variables. In one study (N = 569, 27.1% women, mean age = 65.3 years), mortality was only measured up to five years indicating a 1.7% increase in adjusted hazard of five-year mortality for unmarried individuals (95% CI [1.08-2.73]; Idler et al., 2012), but the authors found that when health behaviours, such as smoking status, were entered into the model the association of marriage with long-term survival was reduced. We included smoking history and cardiac rehabilitation participation and did not reduce our five year hazard of mortality. Idler et al. (2012) also found that the association between marital status and mortality declined over the five-year follow up, but this was not at a level of significance to disregard proportionality of the association over follow-up. Further, although Idler et al’s study (2012) did investigate depression and social support along with marital status in a single model, they were investigated in separate models along with marital status. Our model indicates a significant effect even after adjusting for depression and other social variables. In King and Reiss’ (2012) study (N=225, 76.9% male, mean age = 60.6 years) married patients were 2.5 (p = .001; 95% CI [1.47, 4.24]) times more likely to survive at any point during 15-year follow-up after CABG surgery. This sample had a smaller number of women than our analysis and a younger sample. Given that marital status may change over time, especially in older individuals who may experience the death of a spouse, it is not surprising we found marriage related to hazard of mortality only over the five-years following follow-up. Finally, both of these studies investigated mortality from the time of CABG surgery and we investigated outcomes only for those individuals surviving to one-year post-CABG surgery. Further neither of
these studies found sex differences in marital status in relation to outcomes, just as we did not, although King and Reiss’s (2012) study did not have enough power to investigate this question. It is also possible that a marital relationship may help to regulate or constrain behaviours, leading to increased healthy behaviours (Lewis & Rook, 1999; Uchino, 2006), although this can depend on the relationship and the behaviours of the partner (S. S. Cohen, 1988). Additionally, as mentioned previously, married patients may benefit from the invisible support provided by their partners without being aware of it (Bolger, Zuckerman & Kessler, 2000).

Although previous research has investigated depression (Blumenthal et al., 2003; Burg, Benedetto, & Soufer, 2003; Connerney et al., 2001; Connerney et al., 2010; Oxlad et al., 2006a; Peterson et al., 2002; Phillips-Bute et al., 2008; Rafanelli et al., 2006; Tully, Baker, & Knight, 2008; Tully, Baker, Turnbull, & Winefield, 2008) and social isolation (Herlitz, 1998; Idler et al., 2012; King & Reis, 2012) in relation to mortality and morbidity following CABG surgery, none have adequately investigated sex differences, or the buffering effect of social support on the association between depression and outcome. Our results support an association between depression symptoms at one-year following CABG surgery with greater morbidity, but only with greater mortality at mean or higher perceived social support. Additionally, our results do not support a buffering effect or main effect of perceived social support in predicting post-CABG mortality or morbidity, but indicate further research regarding perceived versus received support may be warranted in this population.

4.2 Limitations

This dissertation is investigating the long-term outcomes of CABG surgery, but its main limitation is that it is a picture of the long-term outcomes of patients who underwent CABG surgery over a decade ago. Since that time there have been changes in CABG surgery which may
impact short and long-term mortality and morbidity following CABG surgery. Procedures have changed, including increased use of internal mammary artery grafts and increased use of off-pump CABG surgery (Hillis et al., 2011), rates of CABG surgery overall have decreased (Riley et al., 2011) and understanding and management of risk factors has improved (Carroll, Kit, Lacher, Shero, & Mussolino, 2012; Egan, Zhao, & Axon, 2010). Although this study signifies that since 2004 all types of coronary revascularization have been decreasing possibly due to better medical management of the disease and decreased smoking rates. Unfortunately it is impossible to conduct long-term follow-up without this difficulty being encountered. On the other hand these less recent data provide valuable information on the long-term consequences of CABG surgery of many patients living with this condition and the role psychological factors have in their disease trajectory.

In our sample, the majority of patients underwent CABG surgery with radial artery grafts (90.8% radial artery compared to 59.0% with internal mammary artery graft). The fact that CABG surgery is increasingly being conducted with internal mammary artery grafts, which are associated with greater long-term survival possibly due to longer graft patency (Cameron et al., 1996), may indicate the experience of our sample may be different as their long-term survival may be more compromised than patients currently experiencing CABG surgery. Additionally, in our sample, all patients underwent on-pump CABG surgery, while CABG surgery may now more often be conducted without the use of cardiopulmonary bypass (off-pump CABG surgery). Although off-pump CABG surgery may sound more beneficial, and observational trials have shown reduced surgical and post-operative mortality and complications in women (P. P. Brown et al., 2002; Emmert et al., 2010; Puskas, Kilgo, et al., 2007), the use of off-pump CABG surgery is controversial and may even be associated with greater long-term mortality (Moller, Penninga,
Wetterslev, Steinbruchel, & Gluud, 2012). A Cochrane review of 86 trials conducted from 1950-2011 could not show a benefit of off-pump CABG in short or long-term mortality or reduced surgical complications, although it did find increased long-term survival in the group of patients undergoing on-pump surgery (RR = 1.24, p = .04; 95% CI[1.01, 1.53]) (Moller et al., 2012).

Studies investigating women’s outcomes specifically may show that off-pump CABG surgery is more beneficial for women, at least in the short term. In one observational study, adjusted surgical and post-operative mortality was 42% (p = .02) higher in women undergoing on-pump CABG surgery compared to off-pump. Also, women undergoing on-pump CABG had a 42% (p = .03) higher likelihood of respiratory complications (P. P. Brown et al., 2002). A further observational study at a US based academic site revealed from 1997-2005 women undergoing on-pump CABG had higher odds of death (OR = 1.60, p = 0.01), stroke (OR = 1.71, p = 0.007), MI (OR = 2.26, p = 0.008) and combined major adverse cardiac events (OR = 1.71, p < 0.01) compared with men undergoing the same procedure (Puskas, Edwards, et al., 2007).

Complications and mortality for women in this sample who underwent off-pump CABG were similar to men who experienced either on-pump or off-pump CABG surgery. Although these analyses were controlled for medical risk and age, it is unclear if they are influenced by the patients undergoing on-pump CABG surgery being older and having greater risk factors. In more recent, randomized, large-scale trials, very few differences are seen between on and off-pump CABG in cardiac outcomes up to one-year, even in patients over 75 years of age, except for increased hazard of revascularization in the off-pump group (Diegeler et al., 2013; Lamy et al., 2012; Lamy et al., 2013). This includes no differences between men and women undergoing off pump CABG surgery (Lamy et al., 2013). This literature indicates that the fact that our sample
all underwent on-pump surgery may not lead to significant differences in mortality and morbidity due to that factor.

Another possible limitation is the present sample contains patients with both isolated CABG surgery and CABG surgery combined with valve surgery. Including patients who had undergone CABG plus valve surgery may have increased the heterogeneity of the sample (Shahian et al., 2009). We were able to adjust for combined valve surgery in the survival analysis conducted, and found this variable was not related to increased hazard of mortality. We were not able to adjust for this in analyses predicting one-year function as, given our sample-size, this would have compromised power.

Although the goal was to investigate the association of multiple important psychosocial variables with outcomes from CABG surgery, a possible limitation of our research is that we only assessed depression symptoms, despite other psychological variables being associated with both CAD and CABG outcomes. Anger/hostility and anxiety have been associated with development and worsening of CAD (Chida & Steptoe, 2009; Roest et al., 2010). Given that CABG surgery is conducted on patients to correct significant CAD, it is possible that these variables could play a role in outcomes. As well, research is beginning to build a case for anxiety being related to CABG surgery outcomes (Tully, Baker, & Knight, 2008). There are several reasons why we chose not to investigate anxiety and anger constructs in this research. First, given the possible overlap of anger, anxiety and depression symptoms, we thought it might be difficult to investigate these constructs concurrently (Suls & Bunde, 2005) and chose to study depression given strong support for the association of depression with cardiac outcomes. Secondly, given that anger constructs may have greater implications for men’s recovery than women’s (Chida & Steptoe, 2009), anger did not fit with our goal of investigating factors
important to women’s recovery. Finally, we had thought it might be difficult to investigate anxiety surrounding surgery given the high likelihood of justifiable nervousness, or state anxiety, surrounding a stressful cardiac surgery. A similar limitation occurred with social support as we only investigated perceived support and not received support or the match between support wanted and received. Research supports the triggering of negative psychological mechanisms if there is a mismatch between support received and that wanted by the recipient (e.g. feelings of being ineffective in the support recipient) (Bolger & Amarel, 2007; Uchino, 2009). This type of error in our measurement would also decrease the power of our study to find a relationship between social support and outcome.

Two limitations regarding sampling may have impacted this study. First, oversampling of women was conducted to allow for sex comparisons across variables. Although it was considered beneficial to increase the number of women in our study, it is possible this selective recruitment of women may have biased our sample. By not including all men who underwent CABG surgery concurrently with the women, this study design did not allow for consecutive recruitment of all patients undergoing CABG surgery at the time of our sampling. Second, our other exclusion criteria may have biased our sample. By recruiting only patients who were healthy enough post-operatively to participate in the study we are not sampling those who may have been the most sick or the most disabled after surgery. Additionally, for those who denied either participation or continued participation, their denial may be indicative of poorer health. This could all lead to a sample which may be a healthier subset of all of the individuals who underwent CABG surgery at this time. Evaluation of bias was explored in two ways. First, although our sample differed from that which the NYLT distribution frequency score was based on, due to our higher proportion of women who would be expected to have greater comorbidities, our median NYLT
score mirrored the New York State sample median of five (Wu et al., 2012). We also conducted a bootstrapped t-test comparing the mean NYLT score of those baseline participants who did not participate at one-year post-CABG to those who did (t (294) = -0.792, p = .414; 95% CI [-3.30, -0.12]). This revealed no difference in NYLT score between longitudinal participants and baseline-only participants, although we did find a difference in long-term mortality between completers and non-completers. In analysis excluding baseline participants who died within the first year, significantly more non-one-year completers died during follow-up period (61.5% compared to 38.8%, \( \chi^2(1) = 6.243, p = .012 \)), and non-completers had a shorter mean time to death. A further bootstrapped t-test was conducted to compare NYLT scores between one-year participants and those who did not participate at one-year post-CABG due to being deceased, hospitalized, or too confused/sick to participate, not including those we could not contact at one-year post-CABG, (t (281) = -1.655, p = .022; 95% CI [-1.27, 0.71]). Results demonstrated NYLT scores were higher for those unable to participate due to death or disability. Thus nonparticipants in the longitudinal follow-up did not have a greater disease severity at baseline. Additionally, it provided predictive validity for our NYLT score given that those too ill to participate or deceased over the year post-CABG had a higher NYLT score. Further, as our focus was too investigate long-term outcomes from CABG surgery, and medical risk factors are strongly related to mortality, it may be that psychosocial variables are less important in mortality and morbidity outcomes in individuals who are extremely medically ill. Perhaps social support and depression symptoms are more important for those individuals who have the physical capacity to recover and there may come a point when medical illness is so severe that no amount of psychosocial intervention will be an appropriate intervention to alleviate mortality. This type of bias could only serve to reduce the study’s power and reduce the strength of the results. Thus the
results of the present study are representative for individuals who survive CABG surgery, and are moderately physically healthy.

4.3 Strengths

This dissertation adds to the literature investigating functional outcomes post-CABG, which are important for patients’ quality of life and perceived cardiac health (Prince et al., 2007; Salvador-Carulla & Garcia-Gutierrez, 2011). Patients describe their health in terms of how cardiac symptoms impair their ability to function in their lives (Salvador-Carulla & Garcia-Gutierrez, 2011). In addition, we were able to recruit enough women to provide adequate power in order to investigate sex differences in post-CABG outcomes. As it can be difficult recruiting patients to complete lengthy questionnaires during the highly stressful post-CABG recovery period, a sample size of a reasonable magnitude can be difficult to obtain and this study has an adequate sample of men and women. Another strength of this dissertation is that psychosocial variables of particular importance to women were examined at more than one time point. Since it is costly and difficult to follow participants longitudinally, we were appreciative of this opportunity. Further, given the reliable record-keeping of Cardiac Services BC, a strength of this study was the ability to analyze lengthy follow-up data regarding mortality and CAD procedure recurrence.

Previous research has investigated depression as a risk for development of CAD (Frasure-Smith & Lesperance, 2005; Hawkins, Callahan, Stump, & Stewart, 2014; Rugulies, 2002) and subsequent cardiac mortality and morbidity (Leung et al., 2012; Barth, Schumacher, & Herrmann-Lingen, 2004; Frasure-Smith, Lespérance, Juneau, Talajic, & Bourassa, 1999; Leung et al., 2012; Lichtman et al., 2009). Depression has also been associated with long-term mortality and morbidity following CABG surgery (Blumenthal et al., 2003; Burg, Benedetto, & Soufer,
2003; Connerney et al., 2001; Connerney et al., 2010; Cserep et al., 2010; Oxlad et al., 2006a; Peterson et al., 2002; Phillips-Bute et al., 2008; Rafanelli et al., 2006; Tully, Baker, Turnbull, & Winefield, 2008). Very little research has investigated the buffering by perceived social support of the association between depression and cardiac outcomes (Frasure-Smith et al., 2000).

Further, of the studies investigating associations between depression and post-CABG outcomes only one attempted sex specific analyses (Connerney et al., 2001) and they did this without first investigating whether sex moderated this association as recommended. Our study investigated moderation of relationships by sex first and then followed significant interactions with analyses of sex specific associations (Aiken & West, 1991).

4.4 Implications and directions for future research

The results of this dissertation suggest both depression and socially related variables are predictive of outcomes following CABG surgery. One of the main findings from this dissertation is that one-year measures of depression, socially related variables and function were associated with long-term mortality and morbidity outcomes above measures collected at the time of CABG surgery. Prior psychological treatment literature reveals treatment of depression and poor social support immediately after a cardiac event or surgery did not result in decreased mortality over follow-up (Berkman et al., 2003; Linden et al., 2007). One meta-analysis did find improved odds of up to two-year survival following psychological treatment for cardiac populations, but only for those studies initiating treatment two months or longer following a cardiac event, and only in men (Linden et al., 2007). Additionally, ENRICHD, one of the largest psychological intervention studies to date, provided intervention to improve both depression symptoms and social support (within one month of MI) and found no differences in event-free survival between treated and usual care groups (Berkman et al., 2003). In the ENRICHD trial, depression and low social
support both improved spontaneously in the usual care group as has been seen previously for
depression symptoms, especially for those with mild to moderate symptoms (Doering et al.,
2006; Khoueiry et al., 2011; Mitchell et al., 2005; Ravven et al., 2013; Schrader, Cheok,
Hordacre, & Guiver, 2004; Schrader et al., 2006). It is likely that measures of depression and
social support at time of CABG surgery may include a substantial amount of symptom
exacerbation due to the stress of undergoing a cardiac surgery. Our research further supports that
interventions targeting depression may be more likely to reduce long-term mortality in patients
assessed following recovery from CABG surgery. Additionally, given baseline psychosocial
variables were related to one-year life function and one-year life function is associated with later
mortality and morbidity, it is important not to discount depression and social variables assessed
surrounding CABG surgery. Baseline depression and poor social support immediately post-
CABG surgery may be related to longer-term outcomes through their relationship with one-year
life function impairment and further research should investigate this relationship.

Given perceived social support is associated with cardiac mortality (Barth et al., 2010;
Williams et al., 1992), it is surprising that it was not associated with mortality and morbidity
outcomes following CABG surgery in our study. Further research should investigate greater
distinctions regarding perceived and received support in addition to mismatches in support
provision in this population. Received support, which may increase as health deteriorates and
more assistance is required, is not necessarily associated with well-being or mortality while
providing support may be (S. L. Brown, Nesse, Vinokur, & Smith, 2003; Helgeson, 1993;
Thomas, 2010; Uchino, 2009). Given we did not measure provided support, it is possible that
provided support or a mismatch between perceived and received support may be more important
in this group of CABG patients and merits further investigation. Further, given that CABG
patients are often older and may be receiving greater support, further research regarding increases in received support in those who report high received support should be investigated (Uchino, 2009). If high received support is associated with harm to self-esteem and feelings of control in patients undergoing CABG surgery, this could indicate a negative interaction (Cohen, 2004) that could better inform research and treatment, allowing us to better develop social support interventions in many populations.
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APPENDIX A: QUESTIONNAIRE PACKAGE COMPLETED IN-HOSPITAL POST-CABG SURGERY AND ONE-YEAR POST-CABG SURGERY.

SUBJ #: ______________________  DATE: __________________________

Beck Depression Inventory (BDI) excluded due to copyright.

I.S.E.L.

Subject #: _______  Date: __________

Instructions: This scale is made up of a list of statements each of which may or may not be true about you. For each statement, we would like you to circle T if the statement is probably TRUE about you or circle F if the statement is probably FALSE about you.

You may find that some of the statements are neither clearly true nor clearly false. In these cases, try to decide quickly whether “probably TRUE T” or “probably FALSE F” is most descriptive of you. Although some questions will be difficult to answer, it is important that you pick one alternative or the other. Remember to circle only one of the alternatives for each statement.

Please read each item quickly but carefully before responding. Remember that this is not a test and there are no right or wrong answers.

T = Probably TRUE  F = Probably FALSE

T  F  1. I have a hard time keeping pace with my friends.
T  F  2. There are very few people I trust to help solve my problems.
T  F  3. No one I know would throw a birthday party for me.
T  F  4. In general, people don’t have much confidence in me.
T  F  5. Most of my friends are more successful at making changes in their lives than I am.
T  F  6. If for some reason I were put in jail, there is someone I could call who would bail me out.
T  F  7. I have someone who takes pride in my accomplishments.
T  F  8. I feel that I’m on the fringe in my circle of friends.

T  F  9. When I need suggestions for how to deal with a personal problem, I know there is someone I can turn to.

T  F  10. If I were sick and needed someone to drive me to the doctor, I would have trouble finding someone.

T  F  11. If I wanted to go out of town (e.g., to the coast) for the day, I would have a hard time finding someone to go with me.

T  F  12. Most of my friends are more interesting than I am.

T  F  13. If I needed a quick emergency loan of $100, there is someone I could get it from.

T  F  14. There is really no one who can give me objective feedback about how I’m handling my problems.

T  F  15. There is at least one person I know whose advice I really trust.

T  F  16. If I needed some help in moving to a new home, I would have a hard time finding someone to help me.

T  F  17. When I feel lonely, there are several people I could easily call and talk to.

T  F  18. I feel there is no one with whom I can share my most private worries and fears.

T  F  19. There are several different people with whom I enjoy spending time.

T  F  20. There is someone who I feel comfortable going to for advice about sexual problems.

T  F  21. Most people I know don’t enjoy the same things that I do.

T  F  22. If I wanted to have lunch with someone, I could easily find someone to join me.

T  F  23. If I had to go out of town for a few weeks, someone I know would look after my house (the plants, pets, yard, etc.).

T  F  24. If I needed a ride to the airport very early in the morning, I would have a hard time finding anyone to take me.

T  F  25. I don’t often get invited to do things with others.
26. I think that my friends feel that I’m not very good at helping them solve problems.

27. I regularly meet or talk with members of my family or with friends.

28. I am more satisfied with my life than most people are with theirs.

29. If I decide on a Friday afternoon that I would like to go to a movie that evening, I could find someone to go with me.

30. If I had to mail an important letter at the post office by 5:00 and couldn’t make it, there is someone who could do it for me.

31. Most people I know think highly of me.

32. I am able to do things as well as most other people.

33. There is really no one I can trust to give me good financial advice.

34. There is someone I can turn to for advice about handling hassles over household responsibilities.

35. There is no one I could call on if I needed to borrow a car for a few hours.

36. If a family crisis arose, few of my friends would be able to give me good advice about handling it.

37. If I were sick, there would be almost no one I could find to help me with my daily chores.

38. There is someone I could turn to for advice about changing my job or finding a new one.

39. If I got stranded 10 miles out of town, there is someone I could call to come and get me.

40. I am closer to my friends than most other people.
MRQ
SECTION 1

In the following 15 questions, you will be asked to describe who is primarily responsible for some common household activities. Based on the following scale, please rate each activity accordingly.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>primarily me</td>
<td>primarily spouse</td>
<td>about equal</td>
<td>others help</td>
</tr>
</tbody>
</table>

**RATING**

1. Child care decisions _______
2. Disciplining children _______
3. Household tasks (beds, dishes) _______
4. Cooking _______
5. Buying household supplies _______
6. Buying wife’s clothes _______
7. Buying husband’s clothes _______
8. Buying household appliances _______
9. Fixing things around the house _______
10. Paying bills _______
RQ

SECTION 1

In the following 14 questions, you will be asked to describe who is primarily responsible for some common household activities. Please do **NOT** focus on who is *currently* doing these household activities but rather, who would normally carry out these household activities in everyday life (i.e. who was responsible for these activities prior to surgery). Based on the following scale, please rate each activity accordingly.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>primarily me</td>
<td>others (e.g. family, friends, home care, housekeeper, etc.)</td>
<td>myself and others about equally</td>
</tr>
</tbody>
</table>

**RATING**

1. Child care decisions  
2. Disciplining children  
3. Household tasks (beds, dishes)  
4. Cooking  
5. Buying household supplies  
6. Buying clothing  
7. Buying household appliances  
8. Fixing things around the house
9. Paying bills

1. primarily me
2. others (e.g. family, friends, home care, housekeeper, etc.)
3. myself and others about equally

RATING

10. Handling checking account

11. Handling savings account

12. Driving car

13. Source of family income

14. Decisions on family matters

SECTION 2

In the following 14 questions, you will be asked to describe how much you like or dislike doing these household activities. Based on the following scale, please rate each activity accordingly.

1. extremely dislike
2. moderately dislike
3. mildly dislike
4. mildly like
5. moderately like
6. extremely like

RATING

1. Child care decisions
2. Disciplining children

<table>
<thead>
<tr>
<th>RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
</tbody>
</table>

3. Household tasks (beds, dishes)

4. Cooking

5. Buying household supplies

6. Buying clothing

7. Buying household appliances

8. Fixing things around the house

9. Paying bills

10. Handling checking account

11. Handling savings account

12. Driving car

13. Source of family income

171
SECTION 3

In the following 5 questions, you will be asked what social activities you participated in prior to the surgery. In Column A, please indicate whether or not you participated in the following activities.

If you answered “yes” to any of the activities, please indicate in Column B how often you did these activities based on the following scale:

<table>
<thead>
<tr>
<th>Never</th>
<th>Less than Once a Month</th>
<th>Once a Month</th>
<th>Several times A Month</th>
<th>Less than Five Times A Week</th>
<th>Five or More Times A Week</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>COLUMN A (did you participate?)</th>
<th>COLUMN B (how often)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Family gatherings</td>
<td>Yes ☐ No ☐</td>
<td>__________</td>
</tr>
<tr>
<td>2. Recreation</td>
<td>Yes ☐ No ☐</td>
<td>__________</td>
</tr>
<tr>
<td>3. Social gatherings</td>
<td>Yes ☐ No ☐</td>
<td>__________</td>
</tr>
<tr>
<td>4. Hobbies</td>
<td>Yes ☐ No ☐</td>
<td>__________</td>
</tr>
<tr>
<td>5. Organizational activities</td>
<td>Yes ☐ No ☐</td>
<td>__________</td>
</tr>
</tbody>
</table>
SECTION 4

In the following 5 questions, you will be asked what social activities you think you will be able to participate in after the surgery. In Column A, please indicate if you think you will participate in the following activities.

If you answered “yes” to any of the activities, please indicate in Column B how often you think you will be able to participate in these activities based on the following scale:

<table>
<thead>
<tr>
<th>COLUMN B</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once a Month</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than Once a Month</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequent</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Several times A Week</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Several times A Month</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than Five Times A Week</td>
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</tr>
<tr>
<td>Five Times A Week</td>
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<td></td>
</tr>
<tr>
<td>Five or More Times A Week</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>COLUMN A (will you participate?)</th>
<th>COLUMN B (how often)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Family gatherings</td>
<td>Yes ☐ No ☐</td>
<td>____________</td>
</tr>
<tr>
<td>2. Recreation</td>
<td>Yes ☐ No ☐</td>
<td>____________</td>
</tr>
<tr>
<td>3. Social gatherings</td>
<td>Yes ☐ No ☐</td>
<td>____________</td>
</tr>
<tr>
<td>4. Hobbies</td>
<td>Yes ☐ No ☐</td>
<td>____________</td>
</tr>
<tr>
<td>5. Organizational activities</td>
<td>Yes ☐ No ☐</td>
<td>____________</td>
</tr>
</tbody>
</table>
WHYMPI

SECTION 1

In the following 11 questions, you will be asked to describe your pain and how it has affected your life since your surgery. Under each question is a scale to record your answer. Read each question carefully and then circle a number on the scale under that question to indicate how that specific question applies to you since your surgery.

1. Rate the level of your pain at the present moment.

   0 1 2 3 4 5 6
   No pain Very intense pain

2. How supportive or helpful is your spouse (significant other) to you in relation to your pain?

   0 1 2 3 4 5 6
   Not at all supportive Extremely supportive

3. Rate your overall mood during the past week.

   0 1 2 3 4 5 6
   Extremely low mood Extremely high mood

4. On the average, how severe has your pain been during the last week?

   0 1 2 3 4 5 6
   Not at all severe Extremely severe

5. How worried is your spouse (significant other) about you in relation to your pain problem?

   0 1 2 3 4 5 6
   Not at all worried Extremely worried

6. During the past week, how much control do you feel that you have had over your life?

   0 1 2 3 4 5 6
   Not at all in control Extremely in control

7. How much suffering do you experience because of your pain?

   0 1 2 3 4 5 6
   No suffering Extreme suffering

8. How attentive is your spouse (significant other) to your pain problem?

   0 1 2 3 4 5 6
Not at all attentive  Extremely attentive

9. During the past week, how much do you feel that you’ve been able to deal with your problems?

   0  1  2  3  4  5  6
Not at all    Extremely well

10. During the past week how irritable have you been?

    0  1  2  3  4  5  6
Not at all irritable    Extremely irritable

11. During the past week how tense or anxious have you been?

    0  1  2  3  4  5  6
Not at all tense or anxious    Extremely tense or anxious

SECTION 2

In this section, we are interested in knowing how your spouse (or significant other) responds to you when he or she know that you are in pain. On the scale listed below each question, circle a number to indicate how often your spouse (or significant other) has generally responded to you in that particular way when you have experienced pain since your surgery. Please answer all of the 14 questions. Please identify the relationship between you and the person you are thinking of:___________________.

1. Ignores me.

   0  1  2  3  4  5  6
Never    Very often

2. Asks me what he/she can do to help.

   0  1  2  3  4  5  6
Never    Very often

3. Reads to me.

   0  1  2  3  4  5  6
Never    Very often

4. Expresses irritation at me.

   0  1  2  3  4  5  6
Never    Very often

175
5. Takes over my jobs or duties.

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
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<th>4</th>
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<th>6</th>
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<tbody>
<tr>
<td>Never</td>
<td>Very often</td>
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</table>

6. Talks to me about something else to take my mind off the pain.

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<th>1</th>
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<th>6</th>
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</thead>
<tbody>
<tr>
<td>Never</td>
<td>Very often</td>
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</table>

7. Expresses frustration at me.

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<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Very often</td>
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</table>

8. Tries to get me to rest.

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<th>4</th>
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<th>6</th>
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</thead>
<tbody>
<tr>
<td>Never</td>
<td>Very often</td>
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</table>

9. Tries to involve me in some activity.

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<th>3</th>
<th>4</th>
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<th>6</th>
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</thead>
<tbody>
<tr>
<td>Never</td>
<td>Very often</td>
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</table>

10. Expresses anger at me.

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<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Very often</td>
<td></td>
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</table>

11. Gets me some pain medications.

<table>
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<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Very often</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. Encourages me to work on a hobby.

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<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Very often</td>
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</tbody>
</table>

13. Gets me something to eat or drink.

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<tr>
<th>0</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Very often</td>
<td></td>
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</tbody>
</table>

14. Turns on the T.V. to take my mind off my pain.
SECTION 3

In the following 9 questions, you will be asked to describe how your pain has affected your life prior to/before your surgery. Under each question is a scale to record your answer. Read each question carefully and then circle a number on the scale under that question to indicate how that specific question applies to you prior to your surgery.

1. In general, how much does your pain problem interfere with your day to day activities?

No interference 1 2 3 4 5 6 Extreme interference

2. Since the time you developed a pain problem, how much has your pain changed your ability to work?

No change 1 2 3 4 5 6 Extreme change

Check here, if you have retired for reasons other than your pain problem.

3. How much has your pain changed the amount of satisfaction or enjoyment you get from participating in social and recreational activities?

No change 1 2 3 4 5 6 Extreme change

4. How much has your pain changed your ability to participate in recreational and other social activities?

No change 1 2 3 4 5 6 Extreme change

5. How much has your pain changed the amount of satisfaction you get from family-related activities?

No change 1 2 3 4 5 6 Extreme change

6. How much has your pain changed your marriage and other family relationships?

No change 1 2 3 4 5 6 Extreme change

7. How much has your pain changed the amount of satisfaction or enjoyment you get from work?

No change 1 2 3 4 5 6 Extreme change
_____ Check here, if you are not presently working.

8. How much has your pain changed your ability to do household chores?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No change</td>
<td>Extreme change</td>
<td></td>
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</tr>
</tbody>
</table>

9. How much has your pain changed your friendships with people other than your family?

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<tr>
<th></th>
<th>0</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No change</td>
<td>Extreme change</td>
<td></td>
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</tr>
</tbody>
</table>

SECTION 4

Listed below are 18 common daily activities. Based on the following scale, please rate how often you did each of these activities prior to/before your surgery in Column A. In Column B, please rate how often you think you will do each of these activities after your surgery. Please complete all 18 questions.

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
<td>Very often</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>COLUMN A (before surgery)</th>
<th>COLUMN B (after surgery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wash dishes.</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>2. Mow the lawn.</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>3. Go out to eat.</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>4. Play cards or other games.</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>5. Go grocery shopping.</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>6. Work in the garden.</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>7. Go to a movie.</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>COLUMN A (before surgery)</td>
<td>COLUMN B (after surgery)</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>8. Visit friends.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
<tr>
<td>9. Help with the house cleaning.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
<tr>
<td>10. Work on the car.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
<tr>
<td>11. Take a ride in a car.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
<tr>
<td>12. Visit relatives.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
<tr>
<td>13. Prepare a meal.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
<tr>
<td>14. Wash the car.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
<tr>
<td>15. Take a trip.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
<tr>
<td>16. Go to a park or beach.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
<tr>
<td>17. Do a load of laundry.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
<tr>
<td>18. Work on a needed house repair.</td>
<td>_______________</td>
<td>_______________</td>
</tr>
</tbody>
</table>
APPENDIX B: ADDITIONAL QUESTIONNAIRE COMPLETED ONE-YEAR POST-CABG SURGERY.

Coronary Artery Bypass Study

Lifestyle Habits – Patient Follow-Up

1. Since you had your bypass surgery a year ago,
   a) Have you had to return to the hospital for heart problems?  o Yes  o No
   b) Did you have a serious illness or surgery? If yes, please specify:

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

   c) Did you start/participate in a cardiac rehabilitation program?  o Yes
      o No

d) Did you seek or obtain additional information about heart disease?  o Yes
   o No
      If yes, where did you get it from:

      o Family Doctor  o Heart & Stroke Foundation  o TV/Video
      o Cardiologist  o Internet  o Books/magazines
      o Nurse  o Cardiac rehabilitation program  o Other:

   __________________________

   e) Did you encounter a major stress period, like divorce, death of a loved one, etc.? If so, what
      was the event?

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

   __________________________
f) Were there any major changes in your employment/work situation? If yes, please describe:
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

2a) Have you ever regularly smoked tobacco?  o Yes  o No  If yes, how many years? _________

b) If you currently smoke, how many cigarettes per week do you smoke? _____________________

c) Have you ever been a smoker and quit?  o Yes  o No  If yes, when did you quit (month/year)? ______________

3) Have you ever been told that you have high cholesterol?  o Yes  o No

4) Have you ever been told that you have high blood pressure?  o Yes  o No

5) Have you ever been told that you have diabetes?  o Yes  o No

6a) How many times per week do you do an activity specifically for the purpose of exercise?

   By exercise, we mean vigorous activities such as aerobics, jogging, racquet sports, team sports, dance classes or brisk walking; this does not include activities of housework, gardening and yard work.

   b) On average, how many minutes per session do you exercise? _________________ minutes

7) Over the past year, how many drinks per week do you have:

   a) bottles or glasses (12 oz..) of beer/cider _________
b) drinks of hard liquor (1.5 oz.)  __________
c) glasses of wine  __________

8) How tall are you? _______________ in  or  _______________ cm

9) How much do you weigh? _______________ lbs  or  _______________ kg

Thank-you for filling out this questionnaire package. Your help with this research is appreciated.
APPENDIX C: POWER CALCULATIONS

Cohen (J. Cohen, 1988) recommended power = 0.80 (Beta = 0.20) when planning a study to balance between Type I and Type II errors. This implies that a Type I error (accepting the null when it is false in a population) is four times as costly as a type II error (rejecting the null when it is true in a population).

Hierarchical regression analyses predicting FI and Pain at one-year post-CABG:
Statistical power for regression was estimated using tables from Miles and Shevlin (Miles & Shevlin, 2001). For a medium effect size in multivariate regression, adequate power for 20 predictors can be gained with a sample size of N=200, which is below our sample size. Power calculations for interaction will limit the number of interactions included in each analysis. When considering two-way interaction terms, to detect a moderate effect size, it is estimated that 55 participants are required per interaction term (Aiken & West, 1991). A more specific calculation of power for interactions was calculated using IBM SPSS Sample Power 3 (IBM Corporation 2012). This indicated 0.84 power to detect five interactions with small effect sizes in a model already including 9 covariates with a model R-squared of approximately .16 and a small interaction effect size (R-squared change = .05 for the set of interactions).

Power for survival analyses predicting mortality: Using IBM SPSS Sample Power 3 (IBM Corporation 2012) power for survival analysis over 13-15 year follow-up was conducted (with n_{male} = 132 and n_{female} = 99 to allow for removal of participants from analysis due to incomplete questionnaires). This analysis will have power = .80 to detect a hazard ratio of 1.65 between depressed and non-depressed at p < .05, one-tailed. A hazard ratio of 1.5 is considered a moderate effect size in survival analyses (Bedard, Krzyzanowska, Pintilie, & Tannock, 2007). Given that power can be increased or decreased depending on the associations between
covariates and outcome, estimated power can be difficult to compute. In addition to this power calculation a rule of one covariate per ten events was used to determine the optimal number of covariates to include in the analysis (Vittinghoff & McCulloch, 2007). Additionally, given the large number of interactions, which we wanted to investigate, interactions were analysed as a group, but also individually to increase power of detecting significance.