THE EFFECTS OF PRE-OPERATIVE DEPRESSION AND/OR ANXIETY ON LENGTH OF STAY OF CARDIAC SURGICAL PATIENTS

By

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Abstract

Background:

Previous literature has found mixed results concerning the relationship between depression, and anxiety, and length of hospital stay among cardiac surgical patients. Given the high prevalence of these psychiatric illnesses and cardiovascular disease in Canada, a better understanding of the relationship between these variables has the potential to influence medical and psychiatric outcomes for countless individuals.

Objectives:

The objectives of this manuscript style thesis are to (a) describe the prevalence of mild and moderate-to-severe symptoms of depression and anxiety disorders in a sample of cardiac patients (Manuscript 1) and (b) analyze the effects of these symptoms on post-operative length of stay while controlling for potential confounding variables (Manuscript 2).

Methods:

This secondary analysis used data collected from a consecutive series of consenting patients attending Foothills Hospital Pre-operative Assessment Clinic (August 1998-March 2002). Patients completed the Zung Self-Rating Depression and Anxiety scales, and a questionnaire assessing potential confounders. *Manuscript 1:* Prevalence values and 95% intervals were calculated for mild and moderate-to-severe depression and anxiety while logistic regression was used to determine predictors of these conditions. *Manuscript 2:* The relationship between symptoms of depression, anxiety and length of stay was analyzed using multiple linear regression.

Results:

Manuscript 1: We estimated that moderate-to-severe symptoms of depression and anxiety were present in 10.66% and 3.42%, respectively. Mild depression (21.90%) and anxiety (32.89%) were also present. Common predictors of both conditions included sex, general health, and a recent myocardial infarction. Depression was further associated with co-morbid illness, as was type of surgery with anxiety. *Manuscript 2:* Patients with depression experienced a significant increase in length of stay compared to mentally healthy patients. Age, general health, type of surgery and education also predicted hospital stay, while anxiety did not.

Conclusions:

Manuscript 1: The prevalence of depression and anxiety in our sample demonstrates the need to address the burden of psychiatric illness in this population. Predictors of these disorders may assist in determining risk groups that would benefit most from psychiatric testing and interventions. *Manuscript 2:* The elevated length of stay observed among patients with depression supports the implementation of screening and treatment in this population.

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Table of Contents

List of Tables

Chapter 4: Manuscript 1 - The Prevalence of Pre-Operative Depression and Anxiety in Patients Undergoing Elective Cardiac Surgery

Chapter 5: Manuscript 2 - The Effects of Pre-operative Depression and/or Anxiety on Length of Stay in Cardiac Surgical Patients

Appendix A

Appendix B

Appendix C

List of Figures

Chapter 3: Methods

Appendix B

Appendix C

Chapter 1: Introduction

1.1 Purpose and Objectives

This manuscript style thesis will (a) describe the prevalence of mild and moderate-to-severe symptoms of depression and anxiety in a sample of cardiac patients attending a surgical pre-assessment clinic in Alberta, Canada (Manuscript 1) and (b) analyze the effects of depression and anxiety on post-operative length of stay while controlling for potential confounding variables (Manuscript 2). We hypothesize that patients with clinically relevant depression and anxiety (defined according to standardized scale thresholds) will experience a greater length of hospital stay than those without.

1.2 Background and Rationale

Both cardiovascular disease and mental health problems pose a significant burden. Approximately 20% of Canadians are directly affected by a mental disorder during their lifetime[25]. Of these, depression (17%) and anxiety disorders (25%) are among the most prevalent and often co-occur[14]. Up to 85% of individuals with depression have co-morbid symptoms of anxiety, while up to 90% of individuals with an anxiety disorder experience symptoms of depression. Clinical co-morbidity (which occurs when disorders exceed pre-defined clinical thresholds) is also widespread. There is approximately 66% co-occurrence of anxiety in those with clinical depression and 33% of depression in those with clinical anxiety[8]. By the year 2020, depression is predicted to be the second most disabling illness worldwide[20].

Cardiovascular disease is one of the most costly diseases in Canada, one of the leading causes of hospital admissions and mortality, and one of the most common medical co-morbidities in individuals with a psychiatric disorder[11,26]. In 2000, the direct cost of cardiovascular disease

was approximately $7.6 billion in Canada, and the direct cost of heart disease was approximately $1.48 billion[22]. Cardiac patients with co-morbid depression or anxiety have demonstrated elevated morbidity and mortality compared to those without. A better understanding of the prevalence of symptoms of depression and anxiety in patients receiving cardiac care (since these are modifiable) and their impact on hospital use (such as length of stay for cardiac care) may help to improve medical and psychiatric outcomes for a large proportion of the population[3, 7].

1.2.3 Background

Medical and psychiatric conditions often co-occur. For example, the prevalence of depression and anxiety disorders among medical patients is approximately double that of the general population[27]. Previous research has demonstrated point-prevalence values of depression and anxiety ranging between 20 to 30% among general hospital inpatients, with sub-clinical symptoms as high as 40%[6, 12].

In general, individuals with co-morbid physical and psychiatric illness have longer lengths of stay compared to those without co-morbid psychiatric illness. For example, general hospital patients with prolonged hospital stays, ranging from 15 to 40 days, have more severe mental illnesses than those with shorter stays[30]. This association has been demonstrated after four years of follow-up in individuals suffering from obsessive compulsive disorder, depression, psychological distress, anxiety, psychoticism, and hostility[29]. In a review of 26 articles examining the relationship between any psychiatric co-morbidity and length of stay, 80% of the studies demonstrated significant elevations for patients with psychiatric co-morbidities. Depression, delirium and dementia were singled out as the most important contributors[28]. Indeed, more than any other patient group, individuals with depression have consistently shown an increased length of stay compared to those without this condition. Investigations have indicated

an approximate two-fold increase in length of stay for patients with co-morbid depression[16]. Alternatively, studies focusing on anxiety disorders have shown mixed results[6,15].

1.4 Importance of Including Patients with Mild Symptoms

Unlike most previous research this thesis will independently consider patients with mild (but clinically relevant) symptoms of depression and anxiety. At least one study has demonstrated a gradient of risk for adverse psychiatric outcomes, such as hospitalizations or suicide attempts. Mild cases were also the most prevalent among those with psychiatric illness, which elevated the population attributable risk proportion of this group (PARP = 10.8-12.9%) to a value comparable to moderate (7.8-13.7%) and severe cases (10.7-12.2%)[13]. Because the positive predictive value of screening instruments is less than perfect, it has also been suggested that including patients with mild symptoms of depression and anxiety, would increase identification of true cases of these disorders by almost 33%[1].

1.5 The Importance of Length of Stay (LOS) Research

Investigating factors that affect length of stay helps in the understanding of recovery (since longer post-operative duration of stay has been associated with increased morbidity and mortality in a wide variety of patients, including cardiac patients) as well as hospital efficiency and resource use[2, 4, 5, 24]. Owing to rising health care expenses and limited resources, there is much interest in the management and efficient use of hospital expenditures. This is especially true regarding cardiac patients due to the high prevalence and cost associated with cardiovascular disease in Canada[11,26]. All surgical procedures account for approximately 40% of hospital expenditures, and a large portion of these are elective rather than emergency operations[18]. As such, patients undergoing elective cardiac surgery tend to use significant resources. Identification of modifiable factors (such as symptoms of depression or anxiety) that could, if treated, improve post-surgical recovery and reduce length of stay would be highly beneficial.

1.6 Gaps and Limitations of Previous Research

Investigating the prevalence of mild and moderate-to-severe symptoms of depression and anxiety among cardiac surgical patients would contribute to the scarce Canadian research in the area and would assist in clarifying the magnitude of psychiatric problems experienced by this population. Wide discrepancies in depression and anxiety disorder prevalence values have been reported in the literature on account of variations in the sample characteristics, case criteria, the type and quality of psychiatric assessment tools being used, and the types of psychiatric illnesses included in the estimates[19,33]. In addition, definitions of psychiatric conditions have been modified throughout the years, which have decreased comparability across time[34].

There have only been two published studies pertaining to the effects of anxiety on length of stay in cardiac surgical patients. Both studies reported non-significant findings[21,32]. However, sample sizes were small (94 and 119 patients) and were likely underpowered. Research concerning the relationship between depression and length of stay in cardiac patients has also been scarce. Five studies have yielded inconsistent results likely owing to methodological problems such as small sample sizes (ranging from 89 to 416), lack of adjustment for important confounders (most notably severity of illness), as well as differences in the validity, reliability and method of psychiatric illness assessment[10, 16, 27, 30]. Concerning prospective studies in particular, varying periods of exposure assessment between the studies may affect this relationship as symptoms of psychiatric illness can be brief, recurrent, or chronic[9].

1.7 Significance

This analysis will contribute a Canadian perspective to the mental health services literature dealing with the prevalence and length of stay of elective cardiac surgery patients with co-morbid depression and anxiety. We have an opportunity to adjust for a wider array of

potential confounders and prognostic factors than previous studies, and can take into account the timing of psychiatric illness assessment relative to surgery. We will also examine whether mild symptoms are predictive of length of stay. Documentation of the prevalence of pre-operative anxiety and depression and their effects on length of stay in elective cardiac patients may highlight the importance of co-morbid psychiatric conditions, their effects on surgical recovery, and the feasibility of screening using basic self-report scales such as ones used in this research.

1.8 Overview of Thesis

Chapter 2: Literature Review

This chapter reviews current literature surrounding the epidemiology of depression and anxiety, as well as the global disease burden, economic and health impacts and socio-demographic correlates of these disorders. Furthermore, the health and economic consequences of a prolonged hospitalization and the factors associated with a lengthened stay are discussed. The chapter concludes with a review of previous research that has investigated the relationship between depression, anxiety and length of stay in cardiac surgical patients.

Chapter 3: Methods

This chapter outlines the methods used to conduct this study. Specifically, the study design, data collection, measurement tools and methodologies used to analyze our dataset are explained. A note on the ethical considerations of this project is also included in this section.

Chapter 4: Manuscript 1

This chapter includes the first manuscript of this thesis, which describes the prevalence of depression and/or anxiety in our sample of cardiac patients.

Chapter 5: Manuscript 2

Chapter 5 contains manuscript 2, which analyzes the relationship between depression and/or anxiety and length of post-surgical hospital stay.

Chapter 6: Results and Conclusions

This chapter contains a review of key findings, strengths and limitations of this project, a note on our statistical power, suggestions for future investigations, and public health/policy implications of this research.

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Chapter 2: Literature Review

2.1 Epidemiology of Depression and Anxiety Disorders

The Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), defines Major Depressive Disorder (MDD) by the near daily presence of certain symptoms (including enduring depressed mood and loss of interest in daily activities) for at least two weeks. Generalized Anxiety Disorder (GAD) is defined by the presence of specific symptoms (such as feelings of restlessness and trouble concentrating) occurring almost daily, for a minimum of six months. These symptoms must meet specified disability criteria and must not be better accounted for by another psychiatric or medical condition[5].

Lacking biological markers, the gold standard assessment for most psychiatric conditions is a clinical diagnostic interview. Unfortunately, these are typically too expensive and time-intensive to use in epidemiologic research. Further, they do not provide a range of symptom severity so are unable to assess milder (or sub-threshold) symptoms. Self-report scales are a widely used alternative. Frequently used scales for assessing depression in hospitalized patients has been the Hospital Anxiety and Depression Scale, the State-Trait Anxiety Inventory, the Zung Depression and Anxiety Scales, and the Beck Depression Inventory[13, 168, 201, 203, 204].

The prevalence of MDD and GAD vary depending on the measurement instrument used (including variations in thresholds for defining clinically relevant cases), variations in the sample size and characteristics, and the range of disorders included in the estimates[116, 183]. In addition, case criteria have changed over time, further decreasing comparability across studies[194]. For example, general population studies in Canada and the United States, report the one-year prevalence of GAD to range between 1.5% and 3.6%, rising to 8% in primary care samples.

Lifetime prevalence varies between 5.1% and 6.5%[182]. Similarly, the one-year prevalence of MDD Canada and the United States ranges between 2.6% and 6.8%. Two studies conducted in Canada report a prevalence of 4.0%[8, 116, 131, 139, 191]. Lifetime estimates have varied between 4.4% and 25.0%, depending on the age group[8, 18, 86, 191]. A Toronto study conducted in 2000 that used a clinical diagnostic interview reported a lifetime prevalence of 24.4%. The Canadian Community Health Survey conducted by Statistics Canada in 2006 reported a lifetime prevalence of MDD of 10.8%[34,139]. Sub-threshold symptoms of MDD have been reported to range between 16% and 23%[20]. The prevalence of MDD is projected to rise based on various factors including an increasingly aging population and a consequent elevation in chronic medical illnesses[124].

2.2 Onset and Course

GAD generally develops between the ages of 25 and 30 years[27]. This condition is frequently unrecognized in primary care as many of the symptoms are similar to physical conditions. Thus, ten to fifteen years may pass before GAD is diagnosed and treated. The course is generally chronic, with less than 20% of individuals achieving full remission from their symptoms[12]. Similarly, the typical onset of MDD occurs between the ages of 25 and 29[191]. Both GAD and MDD are similar in that symptoms may fluctuate in occurrence and severity. MDD tends to reoccur in approximately 75% of individuals, with approximately 5.4 episodes per lifetime lasting an average of 32.5 weeks. A fifth of individuals will experience chronic symptoms, persisting for a minimum of two years[139].

2.3 Treatment

Only 25% of individuals with GAD will receive treatment[116]. The percentage of individuals with MDD who receive treatment ranges between 30% and 40%[107,165]. The stigma attached to psychiatric illnesses may partly explain the low treatment coverage as fear and embarrassment may prevent people from seeking care. Additionally, clinicians may be less able

to diagnose and treat these conditions due to: reduced levels of comfort and time provided to these individuals, inadequate amount of time to address both psychiatric and physical health problems, confusion resulting from the somatic symptoms of these psychiatric illnesses, and insufficient training regarding the recognition of GAD and MDD[24, 142, 152, 198]. Approximately 34% of GAD and 64% of MDD cases are correctly identified[199]. Despite these low levels of treatment, individuals with psychiatric illness tend to have high levels of health care utilization[32].

2.4 Co-occurrence among GAD and MDD

Nearly 91.3% of individuals with a lifetime generalized anxiety disorder will experience at least one other psychiatric illness during their lifetime[91]. In general, the presence of one anxiety disorder increases the risk of developing another by six-fold[121]. Substantial co-morbidity also exists between GAD and a variety of medical conditions, including pulmonary, cerebrovascular and gastrointestinal diseases[173]. For instance, individuals suffering from either panic disorder or GAD are 5.9 times more likely to experience cardiac illness[68]. Slightly less (76.7%) of individuals with a lifetime depressive disorder will experience at least one other psychiatric illness during their lifetime (OR = 4.3). These co-morbid illnesses most frequently include substance use disorders, GAD, panic disorders, and dysthymia[86]. Furthermore, MDD is associated with several medical conditions, including arthritis, cardiovascular disease and diabetes[124]. MDD and GAD frequently co-occur in 54% to 60% of individuals[136]. Sub-threshold depression is also associated with increased occurrence of GAD[56]. Clustering of risk factors may explain the elevated rates of co-morbidity among these conditions[23, 85].

2.5 Etiology

Genetic epidemiological studies have suggested that the heritable contributions to GAD are 30% to 40% and to MDD are 24% to 31% respectively[69, 173]. Aside from heritability, most of the residual explanations for etiology are derived from individual environmental factors. Specific

theories have proposed that different kinds of stressors occur prior to the onset of psychiatric conditions. In particular, events of loss are associated with depression, while events involving threat are associated with anxiety[52]. Certain medications, chronic stressors and physiological effects of some medical illnesses may also contribute to the development of MDD and GAD[68].

2.6 Health Impact of Depression and Anxiety

In addition to an immense decline in emotional well-being, MDD and GAD are associated with a variety of health problems. First, both conditions are related to the development of a variety of chronic medical illnesses[124, 171]. Secondly, MDD, sub-threshold (mild) depression and GAD are associated with reduced levels of general health[71, 124]. For example, when compared to individuals suffering from angina, arthritis, asthma and diabetes, those with MDD tend to experience the lowest levels of overall health[124]. Lastly, individuals with MDD or GAD tend to experience a greater amount of medically unexplained somatic symptoms[80]. Diminished physical health may be related to certain factors associated with MDD and GAD, such as reduced adherence to treatment, adverse lifestyle factors and increased awareness of symptoms[81, 159]. MDD also predicts mortality[82]. The standardized mortality ratio for clinical depression is 1.7 for natural deaths and 19.7 for suicide[181]. A study concerning individuals who had recently experienced a myocardial infarction determined that depressed patients were four times more likely to pass away within the first six months of surgery than those without depression[55].

2.7 Economic Impact of Depression and Anxiety

In 1990, the estimated cost of depression totalled $44 billion (USD). Of this, 27% were direct costs, 18% were for expenses related to suicide, and 55% were for indirect costs (such as transportation or lost work days). In 2001, this estimate nearly doubled to $83 billion (USD)[64]. Similarly, the total cost of all anxiety disorders amounted to approximately $42 billion (USD,

1990), where 54% was for medical treatment, 31% for psychiatric services, 10% for indirect costs, and 2% for medications[65]. The cost of GAD is greater than that of any other anxiety disorders[71]. Studies conducted in both the United States and Canada have shown that GAD increases workplace costs by reducing productivity (88% of costs) and increasing absenteeism (12% of costs)[65, 93]. A Canadian study conducted in 2004 determined that the average three-month expenditures for GAD-related use of health services and lost work days amounted to $528 (CDN); a four-fold increase from nonclinical individuals (CDN $137)[93]. Depression is another primary contributor to reduced work productivity and is the leading cause of work absenteeism[40, 167]. Reduced output and missed work days resulted in the loss of $6.02 billion (CDN) in 1998[171]. The high prevalence of MDD in the working-age population as well as certain symptoms of the disorder, such as chronic fatigue, social withdrawal, and inability to concentrate, may account for this increase in cost[64].

2.8 Health Services Cost

MDD and GAD are also among the most expensive psychiatric conditions[59, 170]. The presence of GAD is associated with a two fold increase in the use of primary care services compared to those without the condition[93, 154]. Service use rises by over 50% among GAD patients suffering from a co-morbid illness[17]. Potential explanations include the incorrect treatment of unrecognized GAD in medical care[71]. Similarly, MDD is associated with a two-fold increase in health care expenses, which is further elevated by the presence of co-morbid medical illnesses[180]. Medical, pharmaceutical and disability health care costs are approximately 4.2 times greater in individuals with MDD compared to those without this condition[64]. Furthermore, patients with co-morbid congestive heart failure and depression incur 26% to 29% higher costs than those without depression over the course of three years[172]. These increased costs are driven by elevated rates of general medical care rather than psychiatric service use[167]. Symptoms of

depression, such as decreased self-care and increased symptom perception, may assist in explaining this relationship[82].

2.9 Sociodemographic Correlates of Depression and Anxiety Disorder

2.9.1 Sex

Both GAD and MDD occur more frequently in women. For instance, the 1994 annual prevalence of GAD in the United States was 4.3% in women and 2.0% in men. Lifetime prevalence of GAD was 6.6% in women and 3.6% in men[92]. Similarly, MDD and mild (sub-threshold) depression are approximately twice more common in women than men. In Edmonton, the lifetime prevalence of MDD was 12.3% in women and 6.6% in men, in 1996[191]. Many factors may contribute to these relationships, some of which include: a greater genetic contribution to GAD risk in females compared to males, discrepancies pertaining to the regulation of certain biological mechanisms and reproductive hormone cycles, women's enhanced risk of experiencing traumatic events such as sexual abuse, inadequate diagnostic criteria for the assessment of GAD in men, differential self-concepts, and coping styles as women are more likely to distress and ruminate over problems, and a greater social acceptance for the expression of emotions, fear and anxiety in women[3, 114, 128, 164, 190, 202]. This latter point is demonstrated by the finding that men are 50% less likely to seek care for symptoms of GAD and co-morbid disorders[150, 151].

2.9.2 Age

The prevalence of GAD rises with age; peaking at around 45 to 54 years[132, 195]. Various investigations have concluded that the relationship between MDD and age is curvilinear. The prevalence peaks in both younger (18 years-late 30s) and older populations (65+ years), and decline among middle-aged individuals[122, 127]. Young adults may be highly afflicted by MDD due to the substantial changes and uncertainty associated with this age group, while significant

personal and status losses may contribute towards elevated rates in the elderly. Alternatively, middle-aged populations may be at less risk of depression due to the stability associated with this time period, in terms of marriage, employment and financial security[122].

2.9.3 Marital Status

Individuals who are married experience lower prevalence of GAD compared to those who are widowed, divorced or single[121, 129]. It has been suggested that the loss of a relationship acts as a risk factor in the development of anxiety, while the presence of an anxiety disorder enhances the difficulty of beginning and maintaining a relationship[121]. Single or previously married (divorced, widowed or separated) individuals are two to three times more likely to suffer from MDD than those who are married[139]. In general, the widowed have the highest levels of affective disorders, followed by those who are single, and finally by those who are married. Separation confers a greater risk of MDD than divorce[141, 196]. The stress and adjustments associated with a transition from married to single status may elevate the risk of psychiatric illness through alterations in self-concept, routines, financial stability, and social support. The presence of MDD may also increase the difficulty of commencing and maintaining a relationship[141]. The effects of marital status may also be influenced by age[139].

2.9.4 Education

There are mixed findings concerning the relationship between GAD and education[16, 195]. Findings have been inconsistent with regards to depression as well, but have generally indicated that having less than 12 years of schooling is associated with MDD. In fact, a study conducted in Belgium determined that the log odds of having MDD declined by 3% with each educational year[108]. A reduced level of schooling may negatively impact interpersonal and coping skills, thereby enhancing risk of psychiatric illnes[60]. Socioeconomic status, which is partly determined by education, may further explain this relationship through the interaction of the following two

theories: the social causation theory, which posits that the stress and adversity associated with low socioeconomic status increases the risk of MDD, and the social selection theory, which hypothesizes that individuals predisposed to psychiatric illness decline towards or cannot rise from lower social positions[42, 72].

2.9.5 Place of residence

Most studies have failed to find a relationship between GAD and place of residence, however one investigation conducted in Norway did conclude that psychiatric illness (including GAD) was less prevalent in rural compared to urban areas (16.5% vs. 32.8%)[14, 96]. This may have been a selection bias as people with psychiatric illnesses move to cities to be nearer to treatment centres. The prevalence of MDD in urban settings generally exceeds that of rural areas[138]. Accordingly, individuals residing in urban areas are approximately 1.74 times more likely to experience depression than those in rural areas[138]. Increased social isolation, heighted pace of living and elevated stresses associated with urban settings are all factors that may contribute to this relationship[193]. A selection bias may also be present.

2.9.6 Social support

Literature pertaining specifically to GAD and social support is limited however an inverse relationship has been identified[14, 45]. Living alone and reduced social support have been linked to MDD in a variety of patient populations, including those with cardiac disease[18, 54]. The temporality of this relationship is unknown since minimal social support and increased isolation may predict psychiatric illness, whereas psychiatric illness may lead to reduced levels of real or perceived support, through alienation or misconception[54, 70]. Individuals who live alone may be at increased risk for MDD since they have an increased likelihood of engaging in certain risk factors for psychiatric illness, such as smoking or alcohol use[54].

2.9.7 Co-morbid Physical Illness

More so than any other anxiety disorder, GAD occurs in conjunction with other physical and psychiatric illnesses[173]. In fact, individuals with either a panic disorder or GAD are 5.9 times more likely to develop cardiac illness than individuals without these conditions. GAD develops prior to the onset of cardiac illness in 62% of cases[68]. MDD is associated with a variety of chronic medical conditions, one of the most frequent being cardiac illness[73]. Specifically, individuals with MDD are 1.64 times more likely to develop coronary artery disease than those without this condition[156]. The prevalence of MDD is highest in inpatient hospitals (10-14%), followed by primary care services (5%-10%) and finally by community settings (3%-5%)[48, 79, 92, 125, 149]. In addition to the physical symptoms of medical illness, co-morbidities enhance the severity and duration of depressive disorders[15].

Mechanisms that may explain the relationship between these psychiatric conditions and co-morbid physical illnesses include: the development of psychiatric illness due to the stress associated with severe medical diseases, the development of medical illness due to biological changes caused by MDD or GAD, the indirect effects of a third variable, such as certain medications for physical disease that cause GAD or MDD, the shared genetic and environmental risk factors for both physical and psychiatric conditions, such as poor diet, and the increased perception of symptoms in those with psychiatric conditions, which may lead to increased testing and diagnoses[82, 94, 137].

2.9.8 General Health Status

Individuals with GAD report significantly lower levels of general health than those without[71]. A recent investigation demonstrated that patients with GAD were 3.5 times more likely to rate themselves as being at least "continually physically ill" when compared to those without this condition[68]. Both MDD and mild (sub-threshold) depression are associated with

poor general health[77]. A study conducted in the United States reported that MDD was associated with a greater perception of poor health than seven other chronic medical conditions, including angina and coronary artery disease[192]. These findings may relate to the increased focus and perception of somatic symptoms as well as the high rates of co-morbidity in individuals with psychiatric illness[75, 82, 173].

2.9.9 Cigarette Smoking

The elevated levels of smoking have been observed among individuals with an anxiety disorder. Findings form a U.S national survey conducted in 1992 reported the prevalence of current and lifetime smoking in mentally healthy individuals to be 22.5% and 39.1% respectfully. By comparison, 54.6% of people suffering from GAD were current smokers while 54.6% had a lifetime prevalence of smoking. Nicotinic effects that increase feelings of control, calm and ability to manage stress may explain the high levels of smoking in this population[100]. Previous literature has also consistently reported a positive relationship between MDD and smoking. In the same US study, for example, current and lifetime smoking was 44.7% and 60.4% , respectively, in people with MDD[100]. This relationship may be driven by the short-term mood elevating effects of nicotine[135].

2.9.10 Alcohol Use

The excessive consumption of alcohol has been linked to GAD in multiple studies[100, 204]. Overall, individuals with an alcohol use disorders are 3.3 times more likely to experience GAD than those without this disorder[25]. Similarly, individuals with alcohol use disorders are 3.4 times more likely to experience depression than those without this disorder[25, 63, 90]. The depression and anxiety relieving effects of alcohol, biological mechanisms related to excessive alcohol use, and/or an indirect mechanism such as an environmental risk factor, may explain the relationship between substance use and these psychiatric disorders[7, 57, 106, 148].

2.9.11 History of Myocardial Infarction

Anxiety most commonly develops during the pre-operative period, and in some, intensifies following surgery[41]. For others, it diminishes fully or decreases but remains above mentally healthy levels. These feelings have been shown to persist for at least 6 months. In fact, a prospective study found that approximately 10-20% of open-heart surgery patients demonstrated clinical levels of anxiety at least six months following surgery[186]. Difficulty adapting to lifestyle changes following surgery, worry concerning the success of the operation, and a fear of failure may contribute to increased levels of anxiety following a myocardial infarction[44, 66]. Conversely, depression is more commonly reported in the post-operative period[41]. Approximately 25% of patients who experience a myocardial infarction develop depression within three months post-surgery. The severe and traumatic nature of cardiac illness and the associated decline in sense of control following such an event may explain the relationship between depression and a history of myocardial infarction[162].

2.9.12 Previous Surgeries

As a group, anxiety disorders are related to previous surgeries[10]. As mentioned above, a prospective study concluded that approximately 10-20% of patients experienced clinical levels of anxiety at least six months following their open-heart surgery[186]. However, a study by Dew, Roth and Schulberg demonstrated that GAD occurred in less than 1% of cardiac surgical patients one year after surgery and was non-existent by three years post-operation[38].

MDD is one of the most common post-transplant diagnoses with a one-year prevalence of 14% to 25%[38, 118, 144]. This relationship does not exist for mild (sub-threshold) depression[30]. The potential of surgery to act as a stressor, the physical limitations acquired by such an event and the

inability to adapt may contribute to the development of MDD in those who have undergone previous surgeries[37, 155].

2.9.13 Illness Severity

While studies specific to GAD are limited, those pertaining to all anxiety disorders indicate a relationship with physical illness severity. Anxiety is related to various factors that predict both morbidity and mortality, including reduced heart rate variability and baroreflex control of the heart[175, 188]. Findings regarding illness severity and MDD have been mixed. However, depression is positively associated with various measures of cardiac disease severity including NYHA class, Killip class, and heart rate variability[97, 188]. Inconsistent findings may have occurred due to variations in the type and quality of severity measures, the sample characteristics and the ability of patients' to properly perceive the severity of their ailment[101]. A relationship between these variables is biologically plausible since depression is related to a decreased immune function and increased sympathetic activity[95, 97].

2.9.14 Type of Procedure

Both GAD and MDD are associated with increased complexity of surgical procedure and risk of serious complications[30, 61, 186]. This is consistent with literature showing that events of loss (for instance, loss of previous function) are correlated with the development of depression, while events involving threat are associated with anxiety[52].

2.9.15 Wait Time until Surgery

Depression and anxiety disorders are positively correlated with wait time until surgery[179]. Extended periods of delay are a major source of stress and adjustment which may induce fear of illness or death prior to surgery[58].

2.9.16 Cardiac Risk Factors

Anxiety disorders are associated with various cardiac risk factors, such as reduced levels of physical activity, poor diet, and elevated rates of smoking. Furthermore, anxiety disorders are associated with many physiological risk factors, such as elevated nervous system activity[98]. MDD increases the likelihood of coronary heart disease by 1.5 to 2-fold[49, 201]. Depression also has been related to a variety of cardiac risk factors, such as smoking, diabetes, and increased platelet activity[6, 7, 9]. Overall, individuals with co-morbid cardiovascular disease and depression are twice as likely to possess certain cardiac risk factors (ie. obesity and reduced levels of physical activity) than those without depression[83].

2.10 Variations in Length of Stay (LOS) Over Time

Over the years, the LOS for almost all medical and surgical services has been on the decline. In addition to technological advances that are speeding up the process of care, reductions in stay may also be explained by economic incentives to improve efficiency and reduce excess care. In the United States during the 1960s, clinical practice guidelines proposed that an average LOS of three weeks (21 days) was required following a myocardial infarction[60]. A decade later, empirical evidence led to a change in the suggested length of stay, reducing it to a mean of 7 to 10 days in those without complications[1, 74, 120]. In 1995, this was further reduced to less than 6 days in patients without complications[47]. Previous literature has warned however, that a reduction in LOS must not occur in tandem with increased mortality and rehospitalizations[105]. For instance, a study conducted in 1994, determined that 41% of patients readmitted for postoperative complications had experienced a shorter than average LOS for their surgery[117]. There have been limited findings demonstrating that a reduction in LOS will decrease costs without negatively impacting patient outcomes[126].

2.11 Health Impact of LOS in Canada

2.11.1 Morbidity and Mortality

Prolonged LOS predicts increased morbidity and mortality following cardiac surgery[130]. Longer hospital stays are often explained by higher levels of post-operative complications (resulting in greater morbidity), which in turn increases one's risk of mortality. Since these variables share several risk factors and are highly correlated, indexes may be used to predict all three outcomes[178].

2.11.2 Mental Health

Hospitalization generates a variety of psychosocial stresses, which are inevitably affected by increased lengths of stay. Some of these stresses include: absence from work and loss of income for the duration of stay, concern regarding potential adverse reactions to new drugs, the distress of residing in an unfamiliar environment and of leaving a spouse and/or children at home, worry concerning pain or disability occurring due to hospitalization, and seclusion from friends[187].

2.12 Economic Impact of LOS in Canada

Hospital expenses can be measured using complex microcosting methods however these techniques are difficult and are not widely accessible. Consequently, LOS has often been employed as a tool for measuring resource consumption and total cost of care[103, 119]. Longer LOS indicates greater use of resources[78]. The length of hospital stay among surgical patients accounts for approximately 31% of total hospital expenses[111]. An investigation concerning patients who experienced a complication-free myocardial infarction determined that the cost of an additional day in the hospital was $624 (USD). At $105, 629 per year of life saved, the ratio of cost-effectiveness for an additional day was determined to be ineffective. Similarly, a US study

investigating individuals with pneumonia estimated savings of $680 for a one day reduction in stay and $1,408 for a two-day reduction. Savings were largely based on room costs, which accounted for 59% and 72% of expenses. Overall, expenses were highest during the first three days of care and were lowest during the last three days[51].

2.13 Social, Demographic and Behavioural Factors Associated with LOS

2.13.1 Sex

Women are approximately 1.31 to 1.64 times more likely to have a prolonged LOS compared to men[177, 178]. In heart patients, this association may be explained by the older age and increased co-morbid conditions affecting women undergoing cardiac surgery[2]. Furthermore, sex differences in immune system functioning may affect one's ability to recover following surgery, since the efficacy of a woman's system tends to fluctuate during periodic hormone changes[164].

2.13.2 Age

Compared to patients under 65 years old, patients between the ages of 65 and 74 years (OR= 1.89) and those over 70 years (OR= 3.0) are more likely to have a prolonged LOS[177]. A Canadian study conducted in 1994 determined that cardiac surgical patients over the age of 70 remained in the intensive care unit for approximately 7.2 days, while those under the age of 60 experienced an average LOS of two days[178]. Potential explanations for lengthened stay among the elderly include: the increased risk of major and minor complications as well as nosocomial infections due to reduced immune functioning and weakened of organ systems, and the delay of discharge incurred for patients awaiting the availability of a nursing home bed[160, 199]. This latter explanation is the most frequent reason for delay (41%)[11]. Other variables such as reduced income, living alone, and the presence of co-morbidities may also affect this relationship[145]. It

should be noted that increased LOS due to complications and infections is well established[99]. In fact, complications raise mean LOS by 3 to 4-fold[117].

2.13.3 Marital Status

In general, previously married individuals accrue the longest LOS, followed by those who are single, and finally by those who are married[78]. This relationship may be explained by the elevated desire for discharge when returning to a spouse at home, the increased chance of recovery due to the social support provided by a partner and the engagement of riskier behaviours (ie. smoking and alcohol consumption) among those who are not married[76, 185].

2.13.4 Education

The literature surrounding education and LOS is mixed however one investigation of psychiatric patients determined that a decreased level of education and a prolonged LOS have a correlation coefficient of 0.11[4]. One's level of education may be related to the association between a healthy lifestyle and decreased post-operative complications[121]. Educated individuals are less likely to smoke or consume alcohol, and are more likely to exercise and undertake preventive health measures. The tendency for poorly educated individuals to suffer from adverse lifestyle factors may relate to the lack of access or affordability of services and goods required to maintain a healthy lifestyle[147].

2.13.5 Place of Residence (Urban/Rural)

Overall, individuals in urban regions have a prolonged LOS compared to those in rural areas[31, 33]. Urban cardiac patients have a 17% longer LOS and 61% higher costs than patients in rural areas. Approximately 33% to 50% of this discrepancy in cost is due to differences in LOS[33]. The older population as well as the greater amount and complexity of operations performed in urban settings may explain this relationship.

2.13.6 Social Support (Household Size)

Minimal social support and living alone are associated with increased LOS[67, 200]. For instance, patients of hip and knee replacement surgery who reside by themselves are 1.25 times more likely to remain in the hospital for three days longer than those who co-habit with their spouses[73]. This finding may be explained through mechanisms similar to the marital status section.

2.13.7 Co-morbid Physical Illness

Co-morbid physical illness is a primary factor affecting LOS in a variety of patient populations, including cardiac surgical patients[22, 143]. The presence of multiple physical conditions may prolong length of stay by increasing the risk of post-operative complications.

2.13.8 General Health Status

Poor health status predicts a prolonged length of stay. A study conducted using the SF-12 (as a measurement of general health) found that a ten point decline in the Physical Component Score (PCS) increased the likelihood of a prolonged LOS (>14 days) by 33%. No relationship was found between the Mental Component Score (MCS) and length of stay[34]. Weak immune or organ systems may take added time to recover from post-surgical wounds and may be at increased risk of complications and nosocomial infections[160, 199].

2.13.9 Cigarette Smoking

Smoking is associated with a prolonged LOS[28, 177]. A recent investigation of CAGB patients determined that current smokers (OR= 1.02) and past smokers (OR= 1.01) were hospitalized significantly longer than those who did not smoke[143]. The association between

smoking and post-operative complications, impaired wound healing, and weakened immune and cardiovascular function may explain this relationship[19, 50, 55, 163].

2.13.10 Alcohol Use

Individuals who have alcohol in their blood generally experience longer hospital stays[168]. Heavy alcohol use is also related to poor general health and poor lifestyle factors, which in turn are related to a prolonged length of hospital stay[133].

2.13.11 History of Myocardial Infarction

While some investigations have found no relationship between a history of myocardial infarction and length of hospital stay, others have demonstrated that cardiac risk factors such as heart failure are predictors of postoperative morbidity and prolonged LOS[47, 84, 115, 184]. The experience of previous myocardial infarctions may indicate the presence of serious cardiac disease that may require greater lengths of surgical and recovery time.

2.13.12 Previous Surgeries

Previous surgeries are linked to an increased LOS in a variety of patient populations[153]. Having undergone a previous surgery was included in a six-variable risk index used for the prediction of mortality, ICU LOS and postoperative LOS for cardiac surgical patients in Ontario[177]. Additionally, LOS related to previous coronary angioplasty and/or coronary bypass in men[140]. Having undergone previous surgeries may indicate poor general health or a greater severity of underlying disease, which in turn, may explain the increased duration of stay demonstrated among those with prior operations.

2.13.13 Illness Severity

Although findings have been mixed, studies have largely demonstrated that severity of illness is associated with LOS[43, 117, 187]. A previous investigation concerning various health problems, including open heart surgery and myocardial infarctions, concluded that a measure of illness severity (the Computerized Severity Index) doubled their ability to predict LOS[43]. Furthermore, patients with grade 4 left ventricular function (the highest level of severity) are approximately 2.18 times more likely to have a prolonged LOS than those with grade 1 function[178, 179]. Illness severity may increase susceptibility to complications and may lengthen time to recovery due to enhanced complexity of surgery[112]. Alternatively, patients with serious illness may experience early mortality and a subsequent reduction in the average length of stay, which may assist in explaining some of the mixed findings found in the literature.

2.13.14 Type of Procedure

Type of procedure has frequently been associated with LOS[178]. A Canadian study concerning cardiac surgical patients determined that patients undergoing a single valve or a complex valve surgery were respectively, 2.80 and 4.72 times more likely to have an increased LOS compared to those undergoing CABG[177]. Increasing complexity of procedures elevates risk of complications, and thus lengthens LOS[199].

2.13.15 Wait Time until Surgery

Wait time until surgery has not been correlated with LOS. Since surgeries are scheduled using triage systems, patients are allotted dates based on the urgency of their condition. Therefore, increased wait times are not necessarily associated with an increased severity of illness or susceptibility to complications[26].

2.13.16 Cardiac Risk Factors

A study conducted in the Netherlands in 2005 demonstrated that cardiac risk factors are associated with increased LOS. Prior myocardial infarction (+2.88 days), chronic obstructive pulmonary disease (+1.87 days), diabetes (+2.34), renal failure (+2.35 days) and age (+0.14 days) were significantly associated with a longer LOS. Alternatively, medications used to minimize cardiac risk factors, such as statins (-3.15 days) and aspirin (-1.71) were significantly associated with a reduction in LOS[184]. Two composite measures of cardiac risk factors (the Halm score and the RCR Index) have been predictive of both major and minor complications of carotid endarterectomy[146]. Cardiac risk factors may increase LOS by elevating the risk of complications.

2.14 Current Knowledge about the Relationship between Depression, Anxiety and LOS in Cardiac Surgical Patients

2.14.1 Depression and Anxiety among Patients with Cardiovascular Disease

There is some research describing the prevalence of pre-operative anxiety or depression in cardiac patients, but little Canadian literature on this topic. Overall, the prevalence of anxiety and depression in cardiovascular patients varies between 20% and 40%. For example, in one study of cardiac surgical patients 39.6% had trait anxiety (defined as individuals who generally react with greater anxiety than what would seem appropriate), 54.7% had pre-operative state anxiety (defined as general feelings of anxiety that are present in stressful situations, but that subside following the event), and 32% had pre-operative depression[157]. Another study found that approximately 27% of coronary heart disease patients experienced co-morbid depression, and a larger amount suffered from sub-syndromal symptoms of depression[46].

Our literature search identified 17 studies that documented the prevalence of depression in cardiac patients and 7 that studied the prevalence of anxiety or depression. Only four of these

were conducted in Canada, but they shared similar findings with the international studies. Cardiac surgical patients with co-morbid depression and/or anxiety were more likely to be female, older, obese (BMI>40), unemployed, and single. Lacking social support, being a smoker, undergoing major treatments and taking medication with depressive side effects were also identified as predictors of psychiatric illness[39, 46, 110, 113]. Other risk factors included being unmarried, living alone, having a severe disease, having under 8 years of education, being of female, having a family or personal history of chronic illness or psychiatric illness, being of certain ethnicities, and having a low income[29, 161]. These are all factors that may also be associated with an increased length of stay so may function as confounders in our analysis.

2.14.2 Influence of Depression or Anxiety on Post-Operative Length of Stay

Research regarding the post-operative stay of surgical and cardiac patients with co-morbid depression and/or anxiety has yielded inconsistent results. Studies specifically addressing cardiac surgical patients have been sparse and have generally indicated a lack of relationship. One study investigating patients undergoing a coronary artery bypass graft found that those with depression were 1.25 more likely to have a prolonged length of stay, while those with anxiety did not have a significant effect[134]. Another found that patients with depression were 1.22 times more likely to have a prolonged hospital stay. The remainder of the studies did not find an association between these variables. However, these findings should be viewed critically since many of these studies suffered from a variety of methodological problems including: small sample sizes, lack of control for important confounders, and poor diagnostic tools.

Investigations concerning a variety of surgical patients (including cardiac patients) tend to report a positive relationship between both psychiatric conditions and length of stay. Research including general, unspecified surgical patients, has also pointed towards a relationship between these variables. For instance, a prospective study that recruited 278 surgical/medical patients

found a significant, positive correlation between co-morbid depression, anxiety and/or cognitive impairment and length of stay[158]. Similarly, a retrospective study spanning 1999-2001 concerning medical/surgical inpatients with a range of co-morbid psychiatric illnesses (including mood and anxiety disorders) determined that all co-morbid psychiatric illnesses, with the exception of substance use disorders and anxiety disorders in 1999, were correlated with elevated lengths of stay[21]. Additionally, 80% of the 191 studies included in a meta-analysis indicated that adult surgical inpatients (including cardiac patients) benefited from psychosocial interventions. On average, psychiatric symptoms were reduced and length of stay was diminished by 1.5 days[36].

Among the studies addressing cardiac patients in particular, we identified five investigating the relationship between length of stay and depression, one concerning the association between length of stay and anxiety and two addressing the relationship between length of stay and anxiety or depression. None were conducted in Canada (Appendix A, Table 2).

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Chapter 3: Methods

3.1 Study Design

This study is a secondary analysis that used longitudinal data collected from the Foothills Hospital Pre-operative Assessment Clinic in Calgary, Alberta (Stuart H, Ghali W, Co-Investigators). Patients were admitted to this clinical to undergo pre-operative screening prior to elective surgery at Foothills Hospital (a tertiary care hospital equipped with 750 beds). A consecutive series of consenting patients who attended the clinic between August 1998 and March 2002 were invited to participate in the primary investigation (n=1931). The study sample covered all consenting individuals undergoing cardiac surgery at Foothills Hospital, which services a wide geographical area spanning Southern Alberta, Southeastern British Columbia and Southern Saskatchewan. Patients were excluded from study if they were under the age of 18 years, could not provide informed consent, or could not read or complete the questionnaire.

Data were collected using a self-report questionnaire. This was provided to consenting participants, along with an introduction letter, and a Consent Form describing the study and the requirements of participation. The package was given to participants in the waiting room by a research assistant, who remained on hand to answer any questions. Using the hospital number for identification, study patients were then followed through hospital administrative databases for up to 85 days, until the last patient was discharged, died, or transferred.

3.3 Identification of Patients Undergoing Elective Cardiac Surgery

To identify patients who were undergoing elective cardiac surgery (the target group for this investigation) we cross-classified type of surgeon (Cardiac/Thoracic) with type of procedure, to identify cardiac surgeries (see Appendix B, Table 1 for types of surgeries included). We also

reviewed all of the procedures completed by general surgeons to ensure that cardiovascular procedures were not included in this group. This yielded 423 subjects for analysis.

3.2 Measures

Wed used the Zung Self-Rating Depression Scale and the Zung Self-Rating Anxiety Scale to identify clinically relevant symptoms of depression and anxiety[27.28]. These self-report scales were chosen for their simplicity, comparable structure, and extensive use in a variety of populations[3]. Both scales contain positively and negatively worded items in order to minimize response bias, to reduce the patient's ability to discover patterns in their answers and to detect inconsistencies in responses[4].

3.2.1 Depression

Zung's Self Rating Depression Scale (SDS) contains 20 items that measure general affect, psychological symptoms, and physiological symptoms related to depression that have occurred in the past week. There are 11 affective symptoms and nine somatic symptoms. Items are rated on a four-point Likert scale ranging from 'None or a little of the time', 'Some of the time', 'Good part of the time' and 'Most or all of the time' and then summed to yield an overall score ranging from 20-80[29]. Higher values reflect higher levels of depression. Based on the commonly used threshold of 50 to define a clinically relevant case (eg: corresponding to a major depressive disorder), it has been found that the SDS has an alpha of 0.79, a sensitivity of 97% , a specificity of 63%, and a correct classification value of 82%[8, 10, 25, 28, 29,30,] A positive predictive value of 93% in elderly stroke patients has also been found[1]. Additionally, this measure has demonstrated good known-groups validity. It can differentiate those with and without depression, and good concurrent validity, as it correlates well with other measurements of depression[8]. It has out-performed the Beck Depression Inventory and the MMPI-Depression scale in a population of male psychiatric patients[22].

3.2.2 Anxiety

Zung's Self Rating Anxiety Scale (SAS) contains 20 items that evaluate the most frequent symptoms of an anxiety disorder (five affective and fifteen somatic symptoms). It is scored in the same manner as the SDS and ranges from 20-80 with higher scores indicating higher levels of anxiety. Based on the commonly used threshold of 45 to define a clinically relevant case, this scale has been found to have an alpha of 0.85, a sensitivity of 89% , and a specificity of 92%[13, 14, 17]. It correlates well with other measures of anxiety. For instance, the correlation coefficient between the SAS and the Hamilton Anxiety Scale is 0.75[28]. This scale also possesses good discriminant validity as it can differentiate between individuals with a clinical diagnosis of an anxiety disorder and those with other psychiatric illnesses, as well as between patient and non-patient groups[8]. A cut-off of 45 points correctly classifies 89% of individuals with a clinical anxiety disorder and correctly excludes 92% of mentally healthy controls[30].

Although the Zung scales are often used in medical and surgical samples, they include certain somatic symptoms, such as fatigue and troubled eating, which may be a consequence of the patient's medical condition[2]. Since previous research has demonstrated that these somatic symptoms are present in 41% to 81% of mentally healthy patients, these measures may overestimate the prevalence of cases in our study[25]. However, including somatic symptoms increases the sensitivity to common characteristics of depression and anxiety, and it ensures that all aspects of the psychiatric illnesses are considered[10].

3.2.3 Length of Stay

Length of stay data were collected from the Patient Activity and Costs System (PACS) database. PACS is a composite of health care information obtained from hospital records and

gathered by the Health Record Department. Length of stay was defined as the number of partial days or nights in hospital and ranged from 1 to 85 in this sample.

3.2.4 Potential Confounders

Information pertaining to potential confounders and effect modifiers were collected through questionnaires and from the administrative data. Based on the literature, we included socio-demographic factors: sex (male or female), age (continuous variable ranging from 14 to 93), marital status (single, currently married, common law, widowed, separated, and divorced), number of individuals living in one's residence (a proxy for social support; continuous variable ranging from 1 to 8), and education (primary, some high school, high school, some college, college, some university, and university). Surgical risk factors included: self-reported heavy alcohol use (yes or no; as determined by a score of 2 or more on the CAGE alcoholism questionnaire[7]), history of myocardial infarction (yes or no), number of co-morbid discharge diagnoses (a proxy for co-morbidity, ranging from 1-16), number of procedures undertaken (a proxy for surgery complexity, ranging from 1-5), smoking (daily, occasionally, never, and quit), previous surgeries (yes or no), type of surgery (coronary artery bypass, mitral valve replacement or repair, aortic valve replacement or repair, and other), wait time until surgery (a continuous variable ranging from 0 - 748), various cardiac risk factors (age over 70 (yes or no), previous myocardial infarction, previous myocardial infarction in the past six months, angina, suspected critical aortic stenosis, and arrhythmia; categorized as yes, no, and not sure), general health (as determined by the Physical Health Component of the SF-12), and rurality (defined by the second digit (0) in the postal codes[19]). It should be noted that the 'other' types of surgeries included cardiac catheterization, pericardectomy, pericardectomy, open heart surgery, atrial septal defect repair, angioplasty, aortic arch/ascending aortic repair, pericardiocentesis, insertion of artificial pacemaker, subaortic membrane excision, and tricuspid valve replacement. Adjustment for important confounders has often been overlooked in previous studies.

We had also planned to use Detsky's Cardiac Risk Index, however the required information was not available. As an alternative, all available items matching Detsky's criteria were used as independent cardiac risk variables in the analysis. Only six questions of the Physical Health Component of the SF-12 General Health Questionnaire were used as independent physical health predictors to avoid bias with the Mental Health Component, which included items measuring depression and anxiety. Our proxy for co-morbidity (number of concurrent diagnoses) excluded all psychiatric conditions.

3.3 Conceptual Model

Figure 1 describes the conceptual model guiding the length of stay analysis (Manuscript 2). The exposure of interest is the presence of pre-operative depression or anxiety in our sample of elective cardiac surgical patients, while the outcome is length of hospital stay. Potential confounders under consideration include socio-demographic and surgical risk factors that are correlated with both the exposure and outcome, and do not lie on the causal chain.

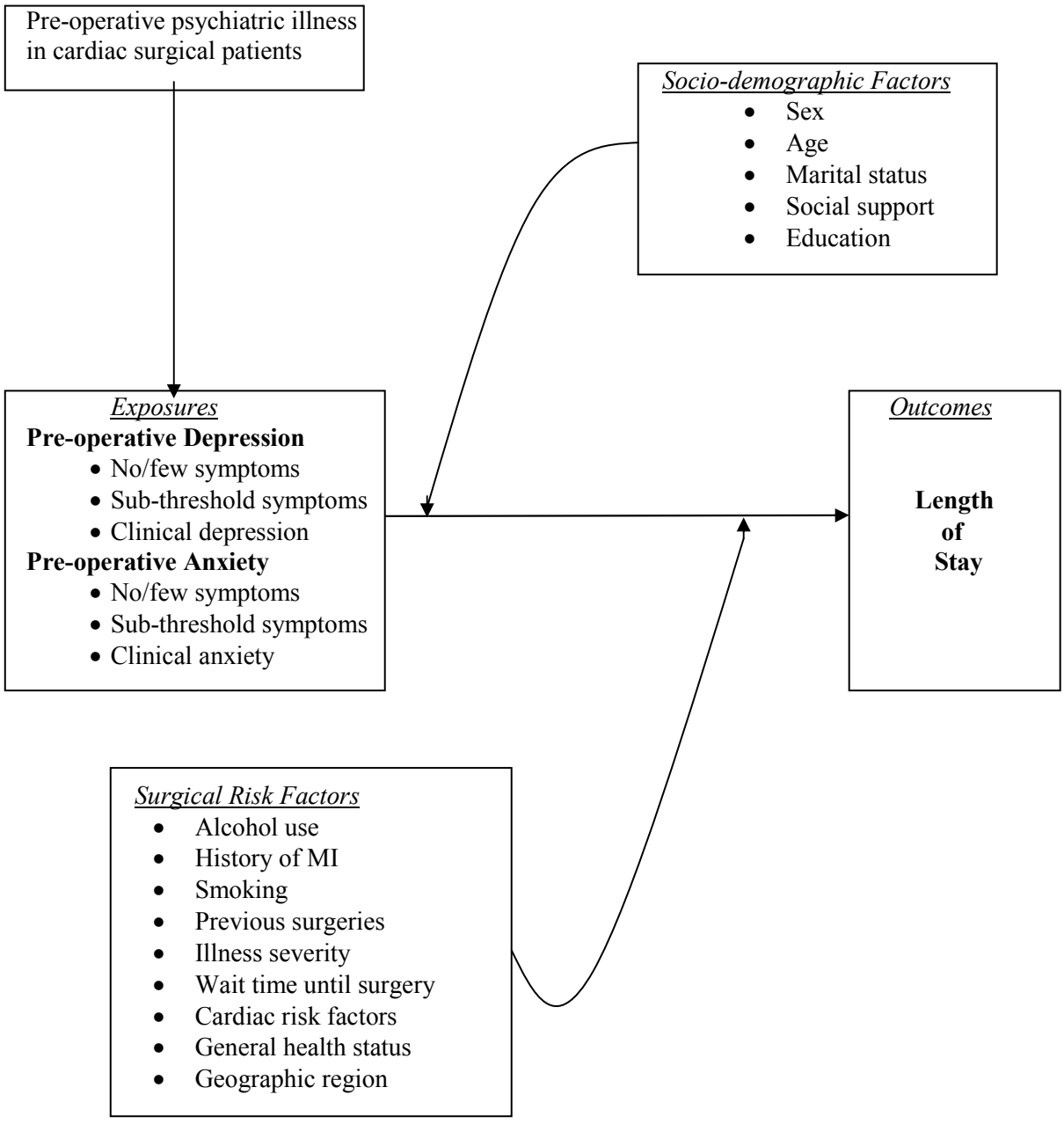

Figure 1. Conceptual Model.

3.4 Data Management

Data were managed and analyzed using SAS (Version 9.0). Prior to any analysis, data were visually inspected to ensure the completeness of the database by examining means, standard deviations, and frequency distributions of all variables.

3.4.1 Recoding

SDS and SAS scales were reverse-scored. For the SDS, these included items 2, 5, 6, 11, 12, 14, 16, 17, 18, and 20 and for the SAS, these included items 5, 9, 13, 17, and 19. A score of 1 corresponded to the lowest level of depressive or anxious symptoms and a score of 4 indicates the highest level. Scores were then summed and converted to index scores, as required to identify cutpoints, by multiplying by 1.25. "Healthy" patients were defined by an SDS score of 20 to 49.9 and SAS scores 20 to 44.9. Only those who met the criteria for both scales were included in this category. Mild symptoms were categorized by an SDS score of 50 to 59.9, and an SAS score ranging between 45 and 59.9. Moderate-to-severe depression (corresponding to a depressive disorder) and anxiety (corresponding to an anxiety disorder) were defined by a score of 60 to 80 on both the SDS and the SAS[15, 18, 27]. Co-morbid moderate to severe depression and anxiety was defined by individuals meeting the criteria for both scales (SDS scores 60 to 80 and SAS score 60 to 80). Co-morbid mild depression and anxiety included individuals who scored in the mild range of both scales (SDS scores 50 to 59.9 and SAS scores 45 to 59.9). We also recoded variables with small cell sizes (cells containing <10) to create reasonably sized categories for analysis. Age was re-coded into 4 groups: 15-29, 30-49, 50-69, 70-83. Number of individuals living in one's residence was similarly recoded to: 1, 2-3, 4-5, 6-8. As was prior operations: yes or no, wait time until surgery (weeks): 1-5, 6 or more, number of procedures: 1-2, 3, 4 5, and number of co-morbidities: 1, 2, 3-4, 5-6, 7-16. Categorical variables (marital status, education, prior

operations, smoking status, alcohol consumption, and cardiac risk factors) were converted into dummy variables for analysis.

3.4.2 Missing Data

We were missing 76 depression values and 43 anxiety values. For records that were at least 80% complete, we used mean imputation to correct for this problem, which assumed items were missing at random[21]. Thirteen subjects were excluded. Five did not respond to any Zung questions and another eight had less than 80% of available responses. Approximately 20% of CAGE data (needed to determine alcohol abuse) was missing. Using another item on the questionnaire, we determined that all but 30 had defined themselves as abstainers. We recoded the CAGE data using this information, resulting in 7.1% of missing values. Listwise deletion was used to exclude missing data from analyses.

3.5 Analyses

We used frequency tables to describe the baseline characteristics of the sample by gender. Formal statistical tests were not performed. We calculated the period (1-week) prevalence estimates of depression and/or anxiety represent the number of individuals reporting symptoms divided by the total population at risk, during the time at which they filled out the Zung questionnaires.

For the first manuscript, we used logistic regression to examine variations in prevalence by socio-demographic and clinical factors. We created two models, one for depression and one for anxiety. All variables were included in the models and backward selection with an exit criterion of $p<=0.15$ was used to identify predictors.

For the second manuscript, we first identified potential confounders in bivariate analyses. For our model, we used linear regression with a log transformation of length of stay to correct for skewness. Backwards regression was used to identify any confounding variables (entry criteria p<=0.15). All potential confounders were placed into the model and were then sequentially deleted. The variable that resulted in the least effect on the main parameter was removed at each step until the cumulative change in parameter estimates reached 15%[5, 16]. Two-way interaction terms were created between all significant variables in the model and the primary exposure variable. Any potential confounding variables that had been excluded from our final model but had a plausible biological relationship with the primary exposure variable were also tested. These were then tested separately by comparing models with and without the interaction term of interest. Those that demonstrated significant p-values (<0.05) were included in our final model. The log transformed outcome was converted into and interpreted as the percent change observed in length of stay among those with depression or anxiety compared to those without such psychiatric illness[23]. Jacknife and studentized residuals, as well as leverage and Cook's D statistics were calculated to assess the influence or leverage of each observation on the overall fit of the model. We assessed collinearity by examining the variance inflation factor (VIF). Any values greater than 10 were cause for concern and were to be centered[6].

3.6 Power

We undertook post hoc power calculations for our prevalence estimates which indicated we could estimate mild depression within 4%, and moderate-to-severe depression within 3.2%. We could estimate mild anxiety within 4% and moderate-to-severe anxiety within 1.8%. A post-hoc power calculation for multiple linear regression was performed using SAS. A sample size of 261 was used (following listwise deletion of regression observations with missing values), along with an R-square value of 0.17 for the full model, and a difference in R-square of 0.055 between

the model with and without the exposure of interest. The total number of predictors was specified as 18 and the number of tested predictors was indicated as 1. This resulted in a power of 98%.

3.9 Ethics Review

Ethics approval for the original study was obtained from the University of Calgary. An expedited review was completed for this secondary analysis, which was granted ethical approval from the Health Sciences Research Ethics Board at Queen's University.

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Chapter 4

The Prevalence of Pre-Operative Depression and Anxiety in Patients Undergoing Elective Cardiac Surgery

Abstract

Objective: Depression and anxiety disorders are commonly associated with cardiovascular disease, with additive effects on morbidity, mortality and costs. This study describes the prevalence of clinically relevant symptoms of depression and anxiety in a sample of elective cardiac patients and identifies socio-clinical predictors. **Methods:** Consenting patients attending Foothills Hospital Pre-operative Assessment Clinic between August 1998 and March 2002 were provided with the Zung Self-Rating Depression and Anxiety scales and a questionnaire assessing potential confounders. Prevalence values and 95% intervals were calculated for depression and anxiety, while logistic regression was used to identify risk factors. **Results:** Moderate to severe symptoms of depression and anxiety were present in 10.66% and 3.42% of patients, respectively, while mild depressive symptoms affected 21.90% and mild anxious symptoms were present in 32.89%. Significant predictors of clinically relevant depression (mild to severe) included sex, general health, the experience of a recent heart attack, and the presence of co-morbid illness. Predictors of clinically relevant anxiety (mild to severe) included sex, general health, the experience of a recent heart attack and the type of upcoming surgery. **Conclusions:** The prevalence of depression and anxiety in our sample (higher than levels in the general population) clearly demonstrates the need to address the burden of psychiatric illness experienced by this population. Predictors of these psychiatric illnesses were consistent with previous research and may assist in determining high risk groups that would benefit most from psychiatric testing and interventions.

Keywords: depression, anxiety, cardiovascular disease;

Introduction

Not only is cardiovascular disease one of the most costly illnesses in Canada, it is also one of the leading causes of hospital admissions and mortality. Furthermore, it is the most common medical co-morbidity in individuals with a psychiatric illness[28,71]. This constitutes a large proportion of individuals as approximately 20% of the Canadian population is directly affected by psychiatric illness during their lifetime[63]. Of these, depression (17%) and anxiety disorders (25%) are among the most prevalent[36]. Previous literature has acknowledged that these psychiatric conditions contribute to increased morbidity, mortality and financial consequences among cardiac patients[8,22,72]. Therefore, insight into the distribution and determinants of psychiatric illness in this population would greatly assist efforts to understand the magnitude of the issue, to improve the quality of life for high risk sub-groups, and to enhance the overall treatment of cardiac illness by tracking and treating these psychiatric symptoms[8].

Depression and anxiety produce considerable distress and expense. The Global Burden of Disease Study projected that depression will be the second most debilitating illness worldwide by the year 2020[54]. When combined with chronic physical illness, depression and anxiety are associated with even further declines in quality adjusted life years[3,49]. Furthermore, the direct and indirect costs of depression and anxiety in Canada account for approximately $14.5 (2001 estimate) and $65 billion (USD, 1994), respectively[21]. Preventive care is essential in reducing this sizable cost. Concerning cardiac patients in particular, a study conducted in Canada determined that patients suffering from co-morbid depression following their first year after cardiac surgery generated approximately 41% greater health care related costs than those without such psychiatric illness[21].

While the association for anxiety is relatively weaker and under-researched, depression is a well-established risk factor for the development and worsening of cardiac illness[24,35]. Cardiac patients suffering from pre-operative depression have a two to four-fold increase in risk of mortality compared to those without such psychiatric illness[5]. Furthermore, they suffer from increased morbidity and recovery time following cardiac surgery as well as the endurance of cardiac symptoms[30,71]. Similarly, it has been reported that individuals with phobic anxiety symptoms experience a four to six-fold increase in risk of cardiac-related mortality and that pre-operative anxiety predicts increased recovery time following surgery[62,79]. Mild levels of depression and anxiety have also been linked to cardiovascular heart disease. Mild depression in particular, increases the risk of cardiac mortality by approximately 6-7 fold and is related to poorer post-surgical outcomes[39,64].

Wide variations in the prevalence of depression and general anxiety disorder have been reported in the literature on account of variations in the sample characteristics, case criteria, the type and quality of psychiatric assessment tools being used, and the types of psychiatric illnesses included in the estimates[49,78]. Furthermore, definitions of psychiatric conditions have been modified throughout the years, which may decrease comparability across time[83]. In Canada, the lifetime prevalence of major depression in individuals aged 25-44 years is 16.9% in women and 10.4% in men, while the one-year prevalence is 6.8% and 4.0% respectively[26]. Mild (sub-clinical), symptoms of major depression have been reported to range between 15% and 23%[7]. Rates are projected to rise based on various factors including an increasingly aging population and a consequent elevation in chronic medical illnesses[54]. Alternatively, the lifetime prevalence of anxiety disorders in individuals aged 25-44 years is 14.7% in women and 11.2% in men and the one-year prevalence is 7.1% and 4.3%, respectively[26]. Within the general populations of Canada and the United States, the one-year prevalence of GAD ranges between 1.5% and 3.6%[26].

Medical and psychiatric conditions often co-occur. For example, the prevalence of depression and anxiety disorders among medical patients is approximately double that of the general population[65]. Studies of general hospital inpatients have demonstrated prevalences ranging from 20% to 33%, with milder sub-threshold symptoms as high as 40%[16,32]. Previous literature pertaining to the prevalence of pre-operative depression in cardiac surgical patients has found values ranging from 12.5% to 47%[9,79]. Anxiety disorders have been found in 20% to 55% of patients[29,41]. The wide variations in prevalence estimates can be explained by the reasons posited above as well as differences in the time at which the pre-operative assessment is taken and the types of surgeries included in the estimates. The prevalence of co-morbid depression and/or anxiety among cardiac patients is much higher for certain surgeries, most notably heart surgery, unstable angina and coronary artery bypass surgery[11,22,62]. Furthermore, prevalence values vary based on their length of measurement (lifetime prevalence or point prevalence). For instance, a past investigation determined that approximately 27.5% of cardiac patients experienced depression at least once in their life prior to their myocardial infarction, whereas only 7.7% experienced depression in the year before the ailment[42]. Limitations of this past research include the lack of Canadian literature on this topic, small sample sizes and the various measures of assessment/sample populations used that led to such wide estimates[47].

Various predictors of depression and anxiety have been identified in the literature. Cardiac surgical patients with co-morbid depression and/or anxiety are more likely to be female, older, obese (BMI>40), unemployed, and single. Lacking social support, smoking, undergoing major treatments and taking medication with depressive side effects have also been identified as predictors of psychiatric illness[17,29,45,46]. Individuals who live alone, are unmarried, in poor health, attained under 8 years of education, experience severe disease, have a family or personal history of chronic or psychiatric illness, are of certain ethnicities, have a prior history of myocardial infarction and are within a low income bracket are also at risk[12,13,24,39,41,67].

This study describes the prevalence of clinically relevant symptoms of depression and anxiety disorders in a sample of cardiac patients attending a surgical pre-assessment clinic in Alberta, Canada, and identifies socio-clinical factors associated with conditions.

Methods

Study Design and Participants:

This study was a secondary analysis that used longitudinal data collected from the Foothills Hospital Pre-operative Assessment Clinic in Calgary, Alberta (Stuart H, Ghali W, Co-Investigators). Patients were admitted to this clinic to undergo pre-operative screening prior to elective surgery at Foothills Hospital (a tertiary care hospital equipped with 750 beds). A consecutive series of patients who attended the clinic between August 1998 and March 2002 were invited to participate in the primary investigation. Of these, this study used a sub-sample of all patients undergoing elective cardiac surgery. Upon arrival to their assessment, a research assistant provided consenting patients with a ten minute questionnaire measuring symptoms of depression and anxiety, as well as socio-demographic and cardiac risk factors. Questionnaires included the Zung Self-Report Depression Scale, the Zung Self-Report Anxiety Scale, and a self-report measure used to gather information on confounders. The study sample covered all consenting individuals undergoing cardiac surgery at Foothills Hospital, which services a wide geographical area spanning Southern Alberta, Southeastern British Columbia and Southern Saskatchewan. Exclusion criteria included individuals under the age of 18 years, those who could not provide informed consent, and those who could not read or complete the questionnaire.

Ethics approval for the original study was obtained from the University of Calgary and the Health Sciences Research Ethics Board at Queen's University.

Measures:

Depression

Zung's Self Rating Depression Scale (SDS) is comprised of 20 questions that measure general affect as well as psychological and physiological symptoms of depression, occurring in the past week. A four-point Likert scale ranging from 'None or a little of the time', 'Some of the time', 'Good part of the time' and 'Most or all of the time' is used to score each question individually, and then these values are summed to yield an overall score spanning 20-80[84]. Based on the commonly used threshold of 50 to define a clinically relevant case, it has been found that the SDS has an alpha of 0.79, a sensitivity of 97% , a specificity of 63%, and a correct classification value of 82%[37,47,87,89]. Additionally, this measure has demonstrated good known-groups validity and good concurrent validity as well as good face and content validity[15,89]. SDS items that indicated greater depressive symptoms with lower numerical scores were reverse-scored to remain consistent with the other items, where a score of 1 corresponds to the lowest level of depressive or anxious symptoms and a score of 4 indicates the highest level. Scores were subsequently summed, converted into SDS index values (the total score was multiplied by 1.25) and categorized. "Healthy" patients, defined as patients free of any level of either depression or anxiety, were represented by SDS scores 20 to 49.9 and SAS scores 20 to 44.9. Only those who met the criteria for both scales were included in this category. As indicated by the literature, mild symptoms of depression were categorized by SDS scores of 50 to 59.9 and moderate to severe depression was defined by SDS scores ranging between 60 to 80[61, 87, 88].

Anxiety

Zung's Self Rating Anxiety Scale (SAS) is comprised of 20 questions that evaluate the most frequent symptoms of an anxiety disorder. It is scored in the same manner as the SDS and ranges from 20-80. Based on the commonly used threshold of 45 to define a clinically relevant

case, this scale has been found to have an alpha of 0.85, a sensitivity of 89%, and a specificity of 92%. It has demonstrated fair concurrent validity and good discriminant validity[50,52,61]. Total scores were summed similarly to the SDS. 'Healthy' patients were those free of depression or anxiety (Zung SDS 0 to 49.9 and Zung SAS 0 to 44.9), while subclinical anxiety was defined by an SAS score ranging between 45 and 59.9 and clinical anxiety was defined by an SAS score of 60 to 80[85, 86]. Co-morbid moderate-to-severe depression and anxiety was defined by SDS and SAS scores 60 to 80, while co-morbid mild depression and anxiety was defined by SDS scores ranging between 50 to 59.9 and SAS scores between 45 to 59.9. The Zung SDS demonstrated an alpha value of 0.84, while the Zung SAS demonstrated an alpha value of 0.82.

Risk Factors

Information pertaining to socio-demographic and cardiac risk factors was collected through questionnaires and computerized hospital administrative data during the initial data collection period.

Statistical Analysis

We used mean imputation to correct for missing data in our depression (missing 76 items) and anxiety (missing 43 items) measures[69]. For the purpose of imputation we required that patients had at least 80% of exposure information completed. Thirteen patients were excluded from this analysis since five did not respond to any Zung questions and 8 had less than 80% of responses available. Missing values were excluded from formal analyses by listwise deletion. Consequently, a total of 305 and 334 observations were included in the regression models used to identify predictors of depression and anxiety, respectively. Because of the limited number of moderate-to-severe cases of depression and anxiety in our sample, all levels of severity were combined (defined as clinically relevant illness) to increase our ability to detect predictors of these psychiatric illnesses. Tabular analysis revealed that the characteristics of individuals with

missing depression and anxiety data were similar to those without missing data. They tended to be older, male, lived in urban areas, were married, had some or completed high school or college education, had no prior operations, were living with 2-3 others, never smoked or quit smoking, were in relatively poor physical health, had multiple procedures and had several co-morbidities (Appendix B, Table 7).

Baseline characteristics of the sample were described by gender, through the use of frequency tables. The prevalence and 95% confidence intervals, stratified by each socio-demographic risk factor, were calculated for those who met the cut-off for mild as well as moderate-to-severe depression and/or anxiety. The point-prevalence estimates of depression and/or anxiety represent the number of individuals reporting symptoms divided by the total population at risk, during the time at which they filled out the Zung questionnaires. Post hoc power calculations yielded precision estimates of approximately 4% for estimates of mild depressive or anxious symptoms, 3.2% for estimates of moderate-to-severe depression and 1.8% for estimates of moderate-to-severe anxiety.

We used logistic regression analysis to identify variations in prevalence by socio-demographic and clinical factors. All socio-demographic and cardiac risk factors were included in the models (age, sex, place of residence, marital status, educational level, number of individuals in house, prior operations, general health, smoking status, wait time until surgery, cardiac risk factors (age over 70, previous heart attack (lifetime), previous heart attack in the last six months, presence of angina, suspected critical stenosis, and presence of heart arrhythmia), number of procedures undertaken during hospital stay, number of concurrent diagnoses (proxy for co-morbid illness), and type of surgery. Backward selection with an exit criterion of $p<=0.15$ was used to identify predictors of depression and anxiety. Two separate models, using outcomes of clinically relevant depression and anxiety (mild, moderate, or severe symptoms) were created.

Predictors were chosen using backwards selection, where variables within the referent 'healthy' group (no clinically relevant symptoms of depression or anxiety) were compared to patients with clinically relevant illness.

Results

Baseline Characteristics

Table 1 reports the sample characteristics of the 423 patients included in the study, stratified by sex. The average age of our sample was 62 years (SD 11.49), with a slightly older male population. The majority of the sample was male, Caucasian, and underwent multiple procedures. About half were undergoing a coronary artery bypass graft. 37 (10.7%) and 13 (3.4%) patients experienced moderate to severe depression and anxiety, respectively, while 76 (21.90%) and 125 (32.89%) experienced mild symptoms of depression and anxiety, respectively. A greater proportion of women experienced psychiatric illness than men.

Table 1: Baseline characteristics of cardiac surgical patients attending Foothills Pre-operative Assessment Clinic, by sex

	Females n= 102	Males n= 321	Total n= 423
	Valid % (n)	Valid % (n)	Valid % (n)
Depression[1]			
▪ "Healthy" (SDS scores 0 to 49.9 and SAS scores 0 to 44.9)" (missing = 64)	32.56 (28)	57.14 (156)	51.25 (184)
▪ Mild depression or anxiety (SDS scores 50 to 59.9 or SAS scores 45 to 59.9)	23.13(16)	13.76 (34)	16.19 (50)
▪ Mild (SDS scores 50 to 59.9)	31.65 (25)	19.03 (51)	21.90 (76)
▪ Moderate to severe (SDS scores 60 to 80)	12.66 (10)	10.07 (27)	10.66 (37)
▪ Missing	(23)	(53)	(76)
Anxiety[2]			
▪ "Healthy" (SDS scores 0 to 49.9 and SAS scores 0 to 44.9)"	32.56 (28)	57.14 (156)	51.25 (184)
▪ Mild depression or anxiety (SDS scores 50 to 59.9 or SAS scores 45 to 59.9)	12.68 (10)	11.78 (73)	12.44 (58)
▪ Mild (SAS scores 45 to 59.9)	46.43 (39)	29.05 (86)	32.89 (125)
▪ Moderate to severe (SAS scores 60 to 80)	8.33 (7)	2.03 (6)	3.42 (13)
▪ Missing	(18)	(48)	(43)
Depression and/or Anxiety[3]			
▪ No clinically relevant symptoms of depression or anxiety	32.56 (28)	57.14 (156)	51.25 (184)
▪ Clinically relevant symptoms of depression or anxiety	61.70 (58)	38.36 (117)	43.86 (175)
Depression (Imputed)[4]			
▪ "Healthy (SDS scores 0 to 49.9 and SAS scores 0 to 44.9)"	35.29 (36)	57.41 (182)	52.03 (218)
▪ Mild (SDS scores 50 to 59.9)	26.73 (27)	21.14 (67)	22.49 (94)
▪ Moderate to severe (SDS scores 60 to 80)	15.84 (16)	9.46 (30)	11.00 (46)
▪ Missing	(1)	(4)	(5)
Anxiety (Imputed)[4]			
▪ "Healthy (SDS scores 0 to 49.9 and SAS scores 0 to 44.9)"	35.29 (36)	57.41 (182)	52.03 (218)
▪ Mild (SDS scores 50 to 59.9)	44.44 (44)	29.30 (92)	32.93 (136)
▪ Moderate to severe (SDS scores 60 to 80)	5.05 (5)	4.46 (14)	4.60 (19)
▪ Missing	(5)	(9)	(10)
Depression and/or Anxiety (Imputed)			
▪ No clinically relevant symptoms of depression or anxiety	35.29 (36)	56.70 (182)	51.54 (218)
▪ Clinically relevant symptoms of depression or anxiety	64.71 (66)	42.06 (135)	47.52 (201)
▪ Missing	(0)	(0)	(0)
Age			
▪ 15-29	1.96 (2)	0.62 (2)	0.95 (4)
▪ 30-49	20.59 (21)	11.21 (36)	13.48 (57)

▪ 50-69	44.12 (45)	59.81 (192)	56.03 (237)
▪ 70-86	33.33 (34)	28.35 (91)	29.55 (125)
▪ Missing	(0)	(0)	(0)
Place of residence			
▪ Rural	14.71 (15)	22.12 (71)	20.33 (86)
▪ Urban	85.29 (87)	77.88 (250)	79.67 (337)
▪ Missing	(0)	(0)	(0)
Marital status[5]			
▪ Never Married	4.08 (4)	4.72 (15)	4.57 (19)
▪ Currently Married/Common Law	65.31 (64)	83.96 (267)	79.57 (331)
▪ Formerly Married	30.61 (30)	11.32 (36)	15.87 (66)
▪ Missing	(4)	(3)	(7)
Education level			
▪ Primary School	6.00 (6)	8.86 (28)	8.17 (34)
▪ Some or completed high school	53.00 (53)	44.30 (140)	46.39 (193)
▪ Some or completed college, trade or technical school	27.00 (27)	26.27 (83)	26.44 (110)
▪ Some university	8.00 (8)	6.33 (20)	6.73 (28)
▪ Completed university	6.00 (6)	14.24 (45)	12.26 (51)
▪ Missing	(2)	(5)	(7)
Household size[6]			
▪ 1	19.39 (19)	11.46 (36)	13.35 (55)
▪ 2-3	66.33 (65)	75.80 (238)	73.54 (303)
▪ 4-5	12.24 (12)	11.46 (36)	11.65 (48)
▪ 6 or more	2.04 (2)	1.27 (4)	1.46 (6)
▪ Missing	(4)	(7)	(11)
Prior operations			
▪ Yes	15.15 (15)	18.97 (59)	18.05 (74)
▪ No	84.85 (84)	81.03 (252)	81.95 (336)
▪ Missing	(3)	(10)	(13)
General Health (SF-12)			
Physical Health Component			
In general, would you say your health is…			
▪ *Excellent*	6.00 (6)	5.13 (16)	5.34 (22)
▪ *Very good*	27.00 (27)	23.08 (72)	24.03 (99)
▪ *Good*	37.00 (37)	48.40 (151)	45.63 (188)
▪ *Fair*	25.00 (25)	18.59 (58)	20.15 (83)
▪ *Poor*	5.00 (5)	4.81 (15)	4.85 (20)
▪ *Missing (n)*	(2)	(9)	(11)
Does your health limit you in moderate activities, such as moving a table or pushing a vacuum cleaner			
▪ *Yes, limited a lot*	55.45 (56)	30.32 (94)	36.50 (150)
▪ *Yes, limited a little*	36.63 (37)	46.77 (145)	44.28 (182)
▪ *Not limited at all*	7.92 (8)	22.90 (71)	19.22 (79)
▪ *Missing*	(1)	(11)	(12)
Does your health limit your ability to climb several flights of stairs?			

▪ *Yes, limited a lot*	72.28 (73)	43.37 (134)	50.49 (207)
▪ *Yes, limited a little*	23.76 (24)	42.72 (132)	38.05 (156)
▪ *Not limited at all*	3.96 (4)	13.92 (43)	11.46 (47)
▪ *Missing*	(1)	(12)	(13)
During the past 4 weeks, with regards to work or other daily activities, have you accomplished less than you would like?			
▪ *Yes*	83.33 (80)	73.42 (221)	75.82 (301)
▪ *No*	16.67 (16)	26.58 (80)	24.18 (96)
▪ *Missing*	(6)	(20)	(26)
During the past 4 weeks, were you limited in the kind of work or other activities that you were able perform?			
▪ *Yes*	82.47 (80)	75.66 (230)	77.31 (310)
▪ *No*	17.53 (17)	24.34 (74)	22.69 (91)
▪ *Missing*	(5)	(17)	(22)
During the past 4 weeks, how much did pain interfere with your normal work?			
▪ *Not at all*	41.24 (40)	32.06 (101)	34.22 (141)
▪ *A little bit*	22.68 (22)	32.70 (103)	30.34 (125)
▪ *Moderately*	14.43 (14)	18.41 (58)	17.48 (72)
▪ *Quite a bit*	17.53 (17)	14.29 (45)	15.05 (62)
▪ *Extremely*	4.12 (4)	2.54 (8)	2.91 (12)
▪ *Missing*	(5)	(6)	(11)
Smoking Status			
▪ Daily	11.22 (11)	9.58 (30)	9.98 (41)
▪ Occasionally	5.10 (5)	1.92 (6)	2.68 (11)
▪ Never smoked	39.80 (39)	23.64 (74)	27.49 (113)
▪ Have quit smoking	43.88 (43)	64.86 (203)	59.85 (246)
▪ Missing	(4)	(8)	(12)
Exit code			
▪ Alive	94.12 (96)	98.75 (317)	97.64 (413)
▪ Dead	5.88 (6)	1.25 (4)	2.36 (10)
▪ Missing	(0)	(0)	(0)
Wait time until surgery			
▪ 0-35 days (1 to 5 weeks)	58.42 (59)	64.80 (208)	63.27 (267)
▪ 36-1106 days (more than 5 weeks)	41.58 (42)	35.20 (113)	36.73 (155)
▪ Missing	(1)	(0)	(1)
Cardiac Risk Factors			
▪ Age>70			
▪ Yes	33.33 (34)	28.35 (91)	29.55 (125)
▪ No	66.67 (68)	71.65 (230)	70.45 (298)
▪ Missing	(0)	(0)	(0)
▪ Prior heart attack			
▪ Yes	14.00 (14)	36.16 (115)	30.86 (129)
▪ No	75.00 (75)	52.20 (166)	57.66 (241)

▪ Not sure	11.00 (11)	11.64 (37)	11.48 (48)
▪ Missing	(2)	(3)	(5)
▪ Heart attack in the last 6 months			
▪ Yes	4.00 (4)	11.29 (36)	9.55 (40)
▪ No	93.00 (93)	78.68 (251)	82.10 (344)
▪ Not sure	3.00 (3)	10.03 (32)	8.35 (35)
▪ Missing	(2)	(2)	(4)
▪ Angina			
▪ Yes	43.75 (42)	55.27 (173)	52.57 (215)
▪ No	44.79 (43)	30.35 (95)	33.74 (138)
▪ Not sure	11.46 (11)	14.38 (45)	13.69 (56)
▪ Missing	(6)	(8)	(14)
▪ Suspected critical Aortic Stenosis?			
▪ Yes	68.32 (69)	38.73 (122)	45.91 (191)
▪ No	26.73 (27)	57.46 (181)	50.00 (208)
▪ Not sure	4.95 (5)	3.81 (12)	4.09 (17)
▪ Missing	(1)	(6)	(7)
▪ Arrhythmia			
▪ Yes	44.33 (43)	20.77 (65)	26.34 (108)
▪ No	37.11 (36)	62.62 (196)	56.59 (232)
▪ Not sure	18.56 (18)	16.61 (52)	17.07 (70)
▪ Missing	(5)	(8)	(13)
Alcohol Consumption[7]			
Cage>2			
▪ *Yes*	3.19 (3)	6.69 (20)	5.85 (23)
▪ *No*	96.81 (55)	93.31 (279)	94.15 (370)
▪ *Missing*	(8)	(22)	(30)
Number of Procedures			
▪ 1-2	2.94 (3)	0.62 (2)	1.18 (5)
▪ 3	17.65 (18)	12.46 (40)	13.71 (58)
▪ 4	20.59 (21)	43.93 (141)	38.30 (162)
▪ 5	58.82 (60)	42.99 (138)	46.81 (198)
▪ Missing	(0)	(0)	(0)
Number of Co-morbidities			
▪ 1	2.94 (3)	2.18 (7)	2.36 (10)
▪ 2	6.86 (7)	2.18 (7)	3.31 (14)
▪ 3-4	18.63 (19)	18.07 (58)	18.20 (77)
▪ 5-6	23.53 (24)	33.33 (107)	30.97 (131)
▪ 7+	48.04 (49)	44.24 (142)	45.15 (191)
▪ Missing	(0)	(0)	(0)
Type of Procedure			
▪ Coronary Artery Bypass Graft (single)	8.82 (9)	21.18 (68)	18.20 (77)
▪ Coronary Artery Bypass Graft (double)	13.73 (14)	35.51 (114)	30.26 (128)
▪ Coronary Artery Bypass Graft (triple or quadruple)	4.90 (5)	10.59 (34)	9.22 (39)
▪ Aortic Valve Replacement or Repair	27.45 (28)	20.25 (65)	21.99 (93)

▪ Mitral Valve Replacement or Repair	29.41 (30)	7.48 (24)	12.77 (54)
▪ Other	15.69 (16)	4.98 (16)	7.57 (32)
▪ Missing	(0)	(0)	(0)

1. Zung Self-Rating Depression Scale (SDS): a self-report questionnaire that evaluates the presence of the most frequent symptoms of a depressive disorder.
2. Zung Self-Rating Anxiety Scale (SAS): a self-report questionnaire comprised of 20 questions that measures the presence of the most frequent symptoms of an anxiety disorder.
3. Clinically relevant symptoms are defined by the presence of mild, moderate or severe depression or anxiety.
4. Depression and anxiety scores were imputed using mean imputation
5. The 'formerly married' category includes: widowed, separated and divorced
6. Household size acts as a proxy for social support in this study.
7. CAGE: An alcohol screening measure. A score over 2 indicates the presence of alcoholism.

Prevalence

Table 2 shows the prevalence of mild depression, mild anxiety, and comorbid mild depression and anxiety stratified by the socio-demographic and cardiac risk factors included in this study. Overall, 21.9% experienced mild depression, 32.89% experienced mild anxiety and 11.7% experienced co-morbid depression and anxiety, respectively. Imputed estimates reported similar findings. Mild disorders were higher in younger age groups, and were more common in females, those who smoked, patients with cardiac risk factors and those in poor general health.

Table 2: Prevalence of mild depression and anxiety by socio-clinical risk factors, using imputed and non-imputed values

Variable (n)	Mild depression[1]		Mild anxiety[1]		Co-morbid mild depression and anxiety[1]	
	Non-imputed[2] n= 76 Valid% (95% C.I)	Mean imputed n = 94 Valid% (95% C.I)	Non-imputed[2] n=125 Valid% (95% C.I)	Mean imputed n=136 Valid% (95% C.I)	Non-imputed[2] n=42 Valid% (95% C.I)	Mean imputed n = 54 Valid% (95% C.I)
Psychiatric Illness						
▪ Yes	21.90 (17.96 – 25.84)	22.49 (18.51 – 26.47)	32.89 (28.41 – 37.37)	32.93 (28.45 – 37.41)	11.70 (8.64 – 14.76)	13.37 (10.13 – 16.61)
▪ No	78.10 (74.16 – 82.04)	77.51 (73.53 – 81.49)	67.11 (62.63 – 71.57)	67.07 (62.60 – 71.55)	88.30 (85.24 – 91.36)	86.63 (83.39 – 89.87)
	Missing (n) = 76	Missing (n) =5	Missing (n) = 43	Missing (n) = 10	Missing (n) = 47	Missing (n) = 4
Age						
▪ 10-29	66.67 (62.18 – 71.16)	50.00 (45.24 – 54.77)	75.00 (70.87 – 79.13)	50.00 (45.24 – 54.77)	33.33 (28.84 – 37.82)	0.00 (0)
▪ 30-49	25.49 (21.34 – 29.64)	28.07 (23.79 – 32.35)	50.94 (46.18 – 55.70)	45.61 (40.86 – 50.36)	17.31 (13.71 – 20.92)	19.30 (15.54 – 23.06)
▪ 50-69	19.12 (15.37 – 22.87)	19.23 (15.47 – 22.99)	29.30 (24.96 – 33.64)	30.17 (25.80 – 34.54)	10.23 (7.34 – 13.12)	12.71 (9.54 – 15.88)
▪ 70-99	24.72 (20.61 – 28.83)	25.20 (21.06 – 29.34)	29.63 (25.28 – 33.98)	31.67 (27.24 – 36.10)	11.32 (8.30 – 14.34)	12.30 (9.17 – 15.43)
	Missing (n) = 76	Missing (n) = 5	Missing (n) = 43	Missing (n) = 10	Missing (n) = 47	Missing (n) = 4
Sex						
▪ Male	19.03 (15.29 – 22.77)	21.14 (17.25 – 25.03)	29.05 (24.72 – 33.38)	29.30 (24.96 – 33.64)	10.17 (7.29 – 13.05)	12.89 (9.70 – 16.08)
▪ Female	31.65 (27.22 – 36.08)	26.73 (22.51 – 30.95)	46.43 (41.68 – 51.18)	44.44 (39.71 – 49.18)	17.28 (13.68 – 20.88)	14.85 (11.46 – 18.24)
	Missing (n) = 76	Missing (n) = 5	Missing (n) = 43	Missing (n) = 10	Missing (n) = 47	Missing (n) = 4
Place of residence						
▪ Rural	25.00 (20.87 – 29.13)	24.42 (20.33 – 28.51)	32.00 (27.56 – 36.45)	31.76 (27.32 – 36.20)	15.07 (11.66 – 18.48)	16.47 (12.94 – 20.01)
▪ Urban	21.20 (17.31 – 25.10)	21.99 (18.04 – 25.94)	33.11 (28.63 – 37.60)	33.23 (28.74 – 37.72)	10.89 (7.92 – 13.86)	12.57 (9.41 – 15.73)
	Missing (n) = 76	Missing (n) = 5	Missing (n) = 43	Missing (n) = 26	Missing (n) = 47	Missing (n) = 26
Marital status						
▪ Never Married	37.50 (32.89 – 42.11)	36.84 (32.24 – 41.44)	47.06 (42.30 – 51.82)	42.11 (37.41 – 46.82)	18.75 (15.03 – 22.47)	26.32 (22.12 – 30.52)
▪ Married/Common Law	18.82 (15.10 – 22.55)	20.36 (16.52 – 24.20)	30.39 (26.01 – 34.77)	31.08 (26.67 – 35.49)	10.30 (7.40 – 13.20)	12.16 (9.05 – 15.28)
▪ Formerly Married[3]	29.82 (25.46 – 34.18)	27.27 (23.03 – 31.51)	40.74 (36.06 – 45.42)	37.10 (32.50 – 41.70)	14.55 (11.19 – 17.91)	13.64 (10.37 – 16.91)

	Missing (n) = 79	Missing (n) = 9	Missing (n) = 46	Missing (n) = 17	Missing (n) = 51	Missing (n) = 9
Education level						
▪ Primary School	30.77 (26.37 – 35.17)	26.47 (22.27 – 30.67)	36.67 (32.08 – 41.26)	50.00 (45.24 – 54.77)	20.00 (16.19 – 23.81)	23.53 (19.49 – 27.57)
▪ High school	21.79 (17.86 – 25.72)	19.90 (16.10 – 23.71)	35.06 (30.51 – 39.61)	31.94 (27.50 – 36.38)	10.53 (76.05 – 13.5)	11.40 (8.37 – 14.43)
▪ College, trade or technical school[4]	20.00 (16.19 – 23.81)	23.64 (19.59 – 27.69)	31.31 (26.89 – 35.73)	32.38 (27.92 – 36.84)	10.00 (7.14 – 12.86)	11.01 (8.03 – 13.99)
▪ University	19.40 (15.63 – 23.17)	22.78 (18.78 – 26.78)	26.67 (22.46 – 30.88)	26.32 (22.12 – 30.52)	11.11 (8.12 – 14.11)	15.38 (11.94 – 18.82)
	Missing (n) = 79	Missing (n) = 9	Missing (n) = 45	Missing (n) = 17	Missing (n) = 50	Missing (n) = 9
Number of people in the house[5]						
▪ 1	32.61 (28.14 – 37.08)	27.27 (23.03 – 31.51)	44.19 (39.46 – 48.92)	39.62 (34.96 – 44.28)	17.39 (13.78 – 21.00)	16.36 (12.84 – 19.89)
▪ 2-3	21.05 (17.17 – 24.94)	21.93 (17.99 – 25.87)	29.75 (25.39 – 34.11)	30.87 (26.47 – 35.27)	11.31 (8.29 – 14.33)	13.58 (10.32 – 16.85)
▪ 4-5	12.20 (9.08 – 15.32)	18.75 (15.03 – 22.47)	40.00 (35.33 – 44.67)	34.78 (30.24 – 39.32)	6.98 (4.55 – 9.41)	8.51 (5.85 – 11.17)
▪ 6 or more	20.00 (16.19 – 23.81)	16.67 (13.12 – 20.22)	50.00 (45.24 – 54.77)	33.33 (28.84 – 37.82)	20.00 (16.19 – 23.81)	16.67 (13.12 – 20.22)
	Missing (n) = 84	Missing (n) = 13	Missing (n) = 50	Missing (n) = 20	Missing (n) = 55	Missing (n) = 13
Prior operations						
▪ Yes	19.35 (15.59 – 23.12)	22.97 (18.96 – 26.98)	35.71 (31.14 – 40.28)	33.80 (29.29 – 38.31)	7.58 (5.06 – 10.10)	12.16 (9.05 – 15.28)
▪ No	22.22 (18.26 – 26.18)	22.16 (18.20 – 26.12)	32.01 (27.56 – 36.46)	32.52 (28.06 – 36.98)	12.54 (9.38 – 15.70)	13.77 (10.49 – 17.05)
	Missing (n) = 82	Missing (n) = 15	Missing (n) = 50	Missing (n) = 23	Missing (n) = 54	Missing (n) = 15
General Health (SF-12) <u>Physical Health Component</u> In general, would you say your health is…						
▪ *Excellent*	5.56 (3.38 – 7.74)	4.55 (2.56 – 6.54)	31.58 (27.15 – 36.01)	22.73 (18.74 – 26.72)	5.00 (2.92 – 7.08)	0.00 (0)
▪ *Very good*	16.47 (12.94 – 20.01)	16.16 (12.65 – 19.67)	17.89 (14.24 – 21.54)	21.21 (17.31 – 25.11)	7.29 (4.81 – 9.77)	9.09 (6.35 – 11.83)
▪ *Good*	19.75 (15.96 – 23.54)	20.32 (16.49 – 24.16)	30.77 (26.37 – 35.17)	30.65 (26.26 – 35.04)	9.36 (6.58 – 12.14)	9.09 (6.35 – 11.83)
▪ *Fair*	29.69 (25.34 – 34.04)	30.49 (26.10 – 34.88)	48.61 (43.85 – 53.37)	47.37 (42.61 – 52.13)	16.92 (13.35 – 20.49)	20.73 (16.87 – 24.59)
▪ *Poor*	50.00 (45.24 – 54.77)	55.00 (50.26 – 59.74)	66.67 (62.18 – 71.16)	63.16 (58.56 – 67.76)	38.89 (34.24 – 43.54)	50.00 (45.24 – 54.77)
▪	Missing (n) = 81	Missing (n) = 13	Missing (n) = 50	Missing (n) = 21	Missing (n) = 53	Missing (n) = 13
Does your health limit you in moderate						

activities, such as moving a table or pushing a vacuum cleaner						
▪ *Yes, limited a lot*	38.02 (33.39 – 42.65)	36.00 (31.43 – 40.57)	48.15 (43.39 – 52.91)	46.53 (41.78 – 51.28)	20.00 (16.19 – 23.81)	22.00 (18.05 – 25.95)
▪ *Yes, limited a little*	16.78 (13.22 – 20.34)	18.78 (15.06 – 22.50)	29.63 (25.28 – 33.98)	28.09 (23.81 – 32.37)	9.20 (6.45 – 11.95)	10.56 (7.63 – 13.49)
▪ *Not limited at all*	7.04 (4.60 – 9.48)	7.59 (5.07 – 10.11)	14.47 (11.12 – 17.82)	18.99 (15.25 – 22.73)	4.00 (2.13 – 5.87)	5.06 (2.97 – 7.15)
	Missing (n) = 82	Missing (n) = 13	Missing (n) = 50	Missing (n) = 22	Missing (n) = 55	Missing (n) = 14
Does your health limit your ability to climb several flights of stairs?						
▪ *Yes, limited a lot*	32.14 (27.69 – 36.59)	32.52 (28.06 – 36.98)	46.20 (41.45 – 50.95)	42.21 (37.50 – 46.92)	18.08 (14.41 – 21.75)	19.02 (15.28 – 22.76)
▪ *Yes, limited a little*	12.12 (9.01 – 15.23)	12.90 (9.71 – 16.09)	19.72 (15.93 – 23.51)	24.68 (20.57 – 28.79)	5.44 (3.28 – 7.60)	7.69 (5.15 – 10.23)
▪ *Not limited at all*	10.00 (7.14 – 12.86)	10.64 (7.70 – 13.58)	24.44 (20.35 – 28.54)	23.40 (19.37 – 27.43)	6.98 (4.55 – 9.41)	8.51 (5.85 – 11.17)
	Missing (n) = 83	Missing (n) = 15	Missing (n) = 52	Missing (n) = 23	Missing (n)= 56	Missing (n) = 15
During the past 4 weeks, with regards to work or other daily activities, have you accomplished less than you would like?						
▪ *Yes*	27.87 (23.60 – 32.14)	28.33 (24.04 – 32.62)	38.24 (33.61 – 42.87)	38.49 (33.85 – 43.13)	14.66 (11.29 – 18.03)	17.06 (13.48 – 20.65)
▪ *No*	8.05 (5.46 – 10.64)	8.33 (5.70 – 10.96)	20.00 (16.19 – 23.81)	19.79 (15.99 – 23.59)	4.44 (2.48 – 6.40)	4.17 (2.27 – 6.08)
	Missing (n) = 92	Missing (n) = 27	Missing (n) = 61	Missing (n) = 36	Missing (n) = 67	Missing = 28
During the past 4 weeks, were you limited in the kind of work or other activities that you were able perform?						
▪ *Yes*	25.10 (20.97 – 29.23)	25.65 (21.49 – 29.81)	36.88 (32.28 – 41.48)	35.67 (31.11 – 40.24)	13.77 (10.49 – 17.05)	15.26 (11.83 – 18.69)
▪ *No*	10.71 (7.76 – 13.66)	10.99 (8.01 – 13.97)	20.73 (16.87 – 24.59)	23.08 (19.07 – 27.10)	5.88 (3.64 – 8.12)	6.59 (4.23 – 8.95)
	Missing (n) = 88	Missing (n) = 24	Missing (n) = 59	Missing (n) = 32	Missing (n) = 62	Missing (n) = 24
During the past 4 weeks, how much did pain						

interfere with your normal work?						
▪ *Not at all*	16.24 (12.73 – 19.76)	15.60 (12.14 – 19.06)	22.83 (18.83 – 26.83)	25.36 (21.21 – 29.51)	8.66 (5.98 – 11.34)	9.93 (7.08 – 12.78)
▪ *A little bit*	21.50 (17.59 – 25.42)	20.80 (16.93 – 24.67)	24.35 (20.26 – 28.44)	29.03 (24.70 – 33.36)	9.24 (6.48 – 12.00)	11.20 (8.19 – 14.21)
▪ *Moderately*	23.64 (19.59 – 27.69)	30.00 (25.63 – 34.37)	41.94 (37.24 – 46.64)	36.62 (32.03 – 41.21)	11.86 (8.78 – 14.94)	15.49 (12.04 – 18.94)
▪ *Quite a bit*	34.62 (30.09 – 39.15)	35.48 (30.92 – 40.04)	56.90 (52.18 – 61.62)	52.63 (47.87 – 57.39)	22.22 (18.26 – 26.18)	22.95 (18.94 – 26.96)
▪ *Extremely*	18.18 (14.51 – 21.86)	16.67 (13.12 – 20.22)	63.64 (59.06 – 68.22)	33.33 (28.84 – 37.82)	18.18 (14.51 – 21.86)	16.67 (13.12 – 20.22)
	Missing (n) = 81	Missing (n) = 13	Missing (n) = 50	Missing (n) = 21	Missing (n) = 53	Missing (n) = 13
Smoking Status						
▪ Daily	30.30 (25.92 – 34.68)	29.27 (24.93 – 33.61)	48.57 (43.81 – 53.33)	43.24 (38.52 – 47.96)	14.29 (10.96 – 17.63)	17.50 (13.88 – 21.12)
▪ Occasionally	30.00 (25.63 – 34.37)	27.27 (23.03 – 31.51)	54.55 (49.81 – 59.30)	54.55 (49.81 – 59.30)	30.00 (25.63 – 34.37)	27.27 (23.03 – 31.51)
▪ Never	23.60 (19.55 – 27.65)	23.21 (19.19 – 27.23)	32.71 (28.24 – 37.18)	32.74 (28.27 – 37.21)	12.00 (8.90 – 15.10)	13.27 (10.04 – 16.50)
▪ Quit	20.10 (16.28 – 23.92)	21.22 (17.32 – 25.12)	30.00 (25.63 – 34.37)	30.00 (25.63 – 34.37)	10.76 (7.81 – 13.71)	12.65 (9.48 – 15.82)
	Missing (n) = 82	Missing (n) = 14	Missing (n) = 50	Missing (n) = 22	Missing (n) = 55	Missing (n) = 14
Wait time until surgery						
▪ 1 to 5 weeks	23.85 (19.79 – 27.91)	23.95 (19.88 – 28.02)	34.84 (30.30 – 39.38)	34.10 (29.58 – 38.62)	12.97 (9.77 – 16.17)	14.77 (11.39 – 18.15)
▪ 6 weeks or more	17.97 (14.31 – 21.63)	19.48 (15.71 – 23.25)	29.41 (25.07 – 33.75)	31.13 (26.72 – 35.54)	9.49 (6.70 – 12.28)	11.04 (8.05 – 14.03)
	Missing (n) = 77	Missing (n) = 6	Missing (n) = 43	Missing (n) = 11	Missing (n) = 47	Missing (n) = 5
Cardiac Risk Factors						
▪ Age>70						
▪ Yes	24.72 (20.61 – 28.83)	25.20 (21.06 – 29.34)	29.63 (25.28 – 33.98)	31.67 (27.24 – 36.10)	11.32 (8.30 – 14.34)	12.30 (9.17 – 15.43)
▪ No	20.93 (17.05 – 24.81)	21.36 (17.45 – 25.27)	34.19 (29.67 – 38.71)	33.45 (28.95 – 37.95)	11.85 (8.77 – 14.93)	13.80 (10.51 – 17.09)
	Missing (n) = 76	Missing (n) = 5	Missing (n) = 43	Missing (n) = 10	Missing (n) = 47	Missing (n) = 4
▪ Prior heart attack						
▪ Yes	23.36 (19.33 – 27.39)	25.78 (21.61 – 29.94)	33.33 (28.84 – 37.82)	35.71 (31.14 – 40.28)	10.83 (7.87 – 13.79)	15.63 (12.17 – 19.09)
▪ No	18.23 (14.55 – 21.91)	18.67 (14.96 – 22.38)	30.56 (26.17 – 34.95)	29.66 (25.31 – 34.01)	10.19 (7.31 – 13.07)	10.79 (7.83 – 13.75)
▪ Not sure	34.29 (29.77 – 38.81)	29.79 (25.43 – 34.15)	41.03 (36.34 – 45.72)	36.96 (32.36 – 41.56)	18.42 (14.73 – 22.11)	17.02 (13.44 – 20.60)
	Missing (n) = 78	Missing (n) = 7	Missing (n) = 45	Missing (n) = 15	Missing (n) = 49	Missing (n) = 7
▪ Heart attack in the last 6 months						
▪ Yes	22.86 (18.86 – 26.86)	27.50 (23.25 – 31.76)	55.00 (50.26 – 59.74)	50.00 (45.24 – 54.77)	18.42 (14.73 – 22.11)	20.00 (16.19 – 23.81)

▪ No	19.37 (15.60 – 23.14)	20.12 (16.30 – 23.94)	28.66 (24.35 – 32.97)	29.29 (24.95 – 33.63)	9.45 (6.66 – 12.24)	11.37 (8.34 – 14.40)
▪ Not sure	48.15 (43.39 – 52.91)	41.18 (36.49 – 45.87)	46.88 (42.12 – 51.64)	48.48 (43.72 – 53.24)	26.67 (22.46 – 30.88)	26.47 (22.27 – 30.67)
	Missing (n) = 77	Missing (n) = 6	Missing (n) = 44	Missing (n) = 14	Missing (n) = 48	Missing (n) = 5
▪ Angina						
▪ Yes	21.31 (17.41 – 25.21)	23.00 (18.99 – 27.01)	33.67 (29.17 – 38.17)	32.54 (28.08 – 37.01)	11.46 (8.42 – 14.50)	13.55 (10.29 – 16.81)
▪ No	15.00 (11.60 – 18.40)	15.94 (12.45 – 19.43)	26.77 (22.55 – 30.99)	28.68 (24.37 – 32.99)	6.11 (3.83 – 8.39)	7.97 (5.39 – 10.55)
▪ Not sure	40.00 (35.33 – 44.67)	33.93 (29.42 – 38.44)	40.00 (35.33 – 44.67)	39.29 (34.64 – 43.94)	23.40 (19.37 – 27.44)	23.21 (19.19 – 27.23)
	Missing (n) = 80	Missing (n) = 16	Missing (n) = 50	Missing (n) = 22	Missing (n) = 53	Missing (n) = 15
▪ Suspected critical Aortic Stenosis						
▪ Yes	24.50 (20.40 – 28.60)	24.74 (20.63 – 28.85)	38.24 (33.61 – 42.87)	35.14 (30.59 – 39.69)	14.97 (11.57 – 18.37)	14.21 (10.88 – 17.54)
▪ No (1586)	19.77 (15.98 – 23.57)	20.29 (16.46 – 24.12)	28.95 (24.63 – 33.27)	31.22 (26.80 – 35.64)	8.90 (6.19 – 11.61)	12.56 (9.40 – 15.72)
▪ Not sure (53)	20.00 (38.29 – 42.67)	23.53 (19.49 – 27.57)	25.00 (20.87 – 29.13)	23.53 (19.49 – 27.57)	7.14 (4.69 – 9.59)	11.76 (8.69 – 14.83)
	Missing (n) = 80	Missing (n) = 9	Missing (n) = 47	Missing (n) = 16	Missing (n) = 51	Missing (n) = 9
▪ Arrhythmia						
▪ Yes	31.11 (15.98 – 23.57)	32.41 (27.95 – 36.87)	49.47 (44.71 – 54.24)	45.63 (40.88 – 50.38)	18.95 (15.22 – 22.69)	19.44 (15.67 – 23.21)
▪ No	16.75 (13.19 – 20.31)	17.75 (14.11 – 21.39)	24.77 (20.66 – 28.88)	27.51 (23.25 – 31.77)	7.34 (4.85 – 9.83)	10.39 (7.48 – 13.30)
▪ Not sure	21.15 (17.26 – 25.04)	20.29 (16.46 – 24.12)	32.20 (27.75 – 36.65)	26.47 (22.27 – 30.67)	12.73 (9.55 – 15.91)	11.59 (8.54 – 14.64)
	Missing (n) = 84	Missing (n) = 15	Missing (n) = 51	Missing (n) = 23	Missing (n) = 55	Missing (n) = 15
Alcohol Consumption[6]						
Cage>2						
▪ *Yes*	22.22 (18.26 – 26.18)	21.74 (17.81 – 25.67)	26.32 (22.12 – 30.51)	27.27 (23.03 – 31.51)	10.53 (7.60 – 13.46)	13.04 (9.83 – 16.25)
▪ *No*	21.36 (17.45 – 25.27)	19.56 (15.78 – 23.34)	32.35 (27.89 – 36.81)	29.85 (25.49 – 34.21)	10.71 (7.76 – 13.66)	11.07 (8.08 – 14.06)
	Missing (n) = 64	Missing (n) = 129	Missing (n) = 64	Missing (n) = 133	Missing (n) = 68	Missing (n) = 129
Number of procedures						
▪ 1-2	0.00 (0)	0.00 (0)	50.00 (45.24 – 54.77)	40.00 (35.33 – 44.67)	0.00 (0)	0.00 (0)
▪ 3	18.75 (15.03 – 22.47)	18.97 (15.23 – 22.71)	32.63 (28.16 – 37.10)	35.19 (30.64 – 39.74)	12.24 (9.12 – 15.36)	14.04 (10.73 – 17.35)
▪ 4	18.18 (14.51 – 21.86)	18.75 (15.03 – 22.47)	27.33 (23.08 – 31.58)	28.48 (24.18 – 32.78)	9.15 (6.40 – 11.90)	10.00 (7.14 – 12.86)
▪ 5	26.97 (22.74 – 31.20)	27.18 (22.94 – 31.42)	36.72 (32.13 – 41.31)	35.71 (31.14 – 40.28)	14.12 (10.80 – 17.44)	16.24 (12.73 – 19.76)
	Missing (n) = 76	Missing (n) = 5	Missing (n) = 43	Missing (n) = 10	Missing (n) = 47	Missing (n) = 4
Number of						

co-morbidities						
▪ 1	33.33 (28.84 – 37.82)	30.00 (25.63 – 34.37)	40.00 (35.33 – 44.67)	30.00 (25.63 – 34.37)	11.11 (8.12 – 14.11)	10.00 (7.14 – 12.86)
▪ 2	8.33 (5.70 – 10.96)	7.14 (4.69 – 9.59)	50.00 (45.24 – 54.77)	50.00 (45.24 – 54.77)	7.69 (5.15 – 10.23)	7.14 (4.69 – 9.59)
▪ 3-4	23.88 (19.82 – 27.94)	22.37 (18.40 – 26.34)	30.88 (26.48 – 35.28)	28.95 (24.63 – 33.27)	11.59 (8.54 – 14.64)	10.53 (7.60 – 13.46)
▪ 5-6	13.46 (10.21 – 16.71)	17.05 (13.47 – 20.63)	26.09 (21.91 – 30.28)	25.20 (21.06 – 29.34)	8.77 (6.07 – 11.47)	10.08 (7.21 – 12.95)
▪ 7+	27.10 (22.86 – 31.34)	26.98 (22.75 – 31.21)	36.42 (31.83 – 41.01)	38.71 (34.07 – 43.35)	14.04 (10.73 – 17.35)	17.37 (13.76 – 20.98)
Missing	Missing (n) = 76	Missing (n) = 5	Missing (n) = 43	Missing (n) = 10	Missing (n) = 47	Missing (n) = 4
Type of Procedure						
▪ Coronary Artery Bypass Graft (single)	14.06 (10.75 – 17.37)	20.00 (16.19 – 23.81)	32.86 (28.38 – 37.34)	30.67 (26.28 – 35.06)	10.14 (7.26 – 13.02)	10.67 (7.73 – 13.61)
▪ Coronary Artery Bypass Graft (double)	25.69 (21.53 – 29.85)	26.77 (22.55 – 30.99)	28.45 (24.15 – 32.75)	30.71 (26.31 – 35.11)	12.28 (9.15 – 15.401)	15.63 (12.17 – 19.09)
▪ Coronary Artery Bypass Graft (triple or quadruple)	17.65 (14.02 – 21.28)	15.79 (12.32 – 19.27)	22.22 (18.26 – 26.18)	29.73 (25.37 – 34.09)	2.63 (1.11 – 4.16)	7.89 (5.32 – 10.46)
▪ Aortic Valve Replacement or Repair	23.29 (19.26 – 27.32)	20.65 (16.79 – 24.51)	37.21 (32.60 – 41.82)	36.26 (31.68 – 40.84)	16.87 (13.30 – 20.44)	17.20 (13.60 – 20.80)
▪ Mitral Valve Replacement or Repair	22.50 (18.52 – 26.48)	24.07 (19.99 – 28.14)	41.86 (37.16 – 46.56)	34.62 (30.09 – 39.15)	11.90 (8.81 – 14.99)	11.32 (8.30 – 14.34)
▪ Other	25.93 (21.75 – 30.11) Missing (n) = 76	21.88 (17.94 – 25.82) Missing (n) = 5	37.93 (33.31 – 42.55) Missing (n) = 43	38.71 (34.07 – 43.35) Missing (n) = 10	10.00 (7.14 – 12.86) Missing (n) = 47	9.38 (6.60 – 12.16) Missing (n) = 4

1. Mild depression was defined by a Zung SDS index score ranging between 50 and 59.9; mild anxiety was defined by a Zung SAS index score ranging between 45and 59.9; co-morbid depression and anxiety was defined by a Zung SDS score between 50 and 59.0 and a Zung SAS score between 45 and 59.9.
2. Missing values for depression questionnaire = 76; missing values for anxiety questionnaire = 43; missing values for co-morbid illness = 47
3. The 'formerly married' category includes: widowed, separated and divorced
4. This category includes individuals who completed some or all of their education.
5. Household size acts as a proxy for social support in this study.
6. CAGE: An alcohol screening measure. A score over 2 indicates the presence of alcoholism.

Table 3 reports the prevalence of moderate-to-severe symptoms of depression and/or anxiety, stratified by socio-demographic and cardiac risk factors. Overall, 10.7%, of our sample reported moderate-to-severe depression, 3.4% reported moderate-to-severe anxiety and 2.1% indicated co-morbid moderate-to-severe depression and anxiety. Imputed estimates reported similar results. The presence of these symptoms was highest among those aged 30-49 years old, females, smokers, and those in poor general health. Experiencing a prior heart attack, angina and arrhythmia were most common among those with depressive symptoms, while angina, critical aortic stenosis and the experience of a previous heart attack were most common among those with anxiety.

Table 3: Prevalence of moderate-to-severe depression and anxiety by socio-clinical risk factors, using imputed and non-imputed data

Variable (n)	Moderate to severe depression[1]		Moderate to severe anxiety[1]		Co-morbid moderate to severe depression and anxiety[1]	
	Non-imputed[2] n =37 Valid% (95% C.I)	Mean imputed n=46 Valid% (95% C.I)	Non-imputed[2] n = 13 Valid% (95% C.I)	Mean imputed n=19 Valid% (95% C.I)	Non-imputed[2] n = 8 Valid% (95% C.I)	Mean imputed n=13 Valid% (95% C.I)
Psychiatric Illness						
▪ Yes	10.66 (7.75 – 13.57)	11.00 (8.05 – 13.95)	3.42 (1.71 – 5.13)	4.60 (2.62 – 6.58)	2.05 (0.71 – 3.39)	3.37 (1.67 – 5.07)
▪ No	89.34 (86.43 – 92.25)	89.00 (86.05 – 91.95)	96.58 (94.87 – 98.29)	95.40 (93.43 – 97.38)	97.95 (96.61 – 99.29)	96.63 (94.93 – 98.33)
	Missing (n) = 23	Missing (n) = 5	Missing (n) = 10	Missing (n) = 24	Missing (n) = 32	Missing (n) = 7
Age						
▪ 10-29	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
▪ 30-49	13.73 (10.49 – 16.98)	14.04 (10.76 – 17.32)	3.77 (1.97 – 5.57)	8.77 (6.10 – 11.44)	0.00 (0)	7.02 (4.61 – 9.43)
▪ 50-69	9.80 (7.00 – 12.60)	9.83 (7.02 – 12.64)	3.26 (1.59 – 4.93)	3.88 (2.06 – 5.70)	2.69 (1.16 – 4.22)	3.43 (1.71 – 5.15)
▪ 70-99	11.24 (8.26 – 14.22)	12.20 (9.11 – 15.29)	3.70 (1.92 – 5.48)	4.17 (2.29 – 6.06)	1.82 (0.56 – 3.08)	1.64 (0.44 – 2.84)
	Missing (n) = 76	Missing (n) = 5	Missing (n) = 43	Missing (n) = 10	Missing (n) = 32	Missing (n) = 7
Sex						
▪ Male	10.07 (7.23 – 12.91)	9.46 (6.70 – 12.22)	2.03 (0.70 – 3.36)	4.46 (2.51 – 6.41)	1.33 (0.25 – 2.41)	3.15 (1.50 – 4.80)
▪ Female	12.66 (9.52 – 15.80)	15.84 (12.40 – 19.28)	8.33 (5.72 – 10.94)	5.05 (2.99 – 7.12)	4.44 (2.50 – 6.38)	4.04 (2.18 – 5.90)
	Missing (n) = 76	Missing (n) = 5	Missing (n) = 43	Missing (n) = 10	Missing (n) = 32	Missing (n) = 7
Place of residence						
▪ Rural	7.81 (5.28 – 10.34)	8.14 (5.56 – 10.72)	0.00 (0)	4.71 (2.71 – 6.71)	2.56 (1.07 – 4.05)	2.33 (0.91 – 3.75)
▪ Urban	11.31 (8.32 – 14.30)	11.75 (8.71 – 14.79)	4.26 (2.36 – 6.16)	4.57 (2.60 – 6.54)	0.00 (0)	3.64 (1.87 – 5.41)
	Missing (n) = 76	Missing (n) = 5	Missing (n) = 10	Missing (n) = 43	Missing (n) = 140	Missing (n) = 7
Marital status[3]						
▪ Never Married	6.25 (3.97 – 8.53)	10.53 (7.64 – 13.42)	0.00 (0)	15.79 (12.35 – 19.23)	0.00 (0)	10.53 (7.64 – 13.42)
▪ Married/Common Law	8.86 (6.18 – 11.54)	9.12 (6.41 – 11.84)	2.29 (0.88 – 3.70)	3.38 (1.68 – 5.08)	1.29 (0.23 – 2.35)	2.44 (0.99 – 3.89)
▪ Formerly Married	19.30 (15.58 – 23.02)	18.18 (14.54 – 21.82)	9.26 (6.53 – 11.99)	6.45 (4.13 – 8.77)	6.56 (4.23 – 8.89)	4.84 (2.81 – 6.86)
	Missing (n) = 79	Missing (n) = 9	Missing (n) = 46	Missing (n) = 17	Missing (n) = 34	Missing (n) = 14
Education level [4]						

▪ Primary School	11.54 (8.53 – 14.55)	11.76 (8.72 – 14.80)	3.33 (1.64 – 5.02)	0.00 (0)	0.00 (0.56 – 1.46)	0.00 (0)
▪ High school	9.62 (6.84 – 12.40)	10.99 (8.04 – 13.94)	3.45 (1.73 – 5.17)	5.24 (3.14 – 7.34)	1.65 (0.45 – 2.85)	4.71 (2.71 – 6.71)
▪ College, trade or technical school	13.68 (10.44 – 16.92)	13.64 (10.40 – 16.88)	3.03 (1.41 – 4.65)	2.86 (1.29 – 4.43)	2.94 (1.35 – 4.53)	1.87 (0.59 – 3.15)
▪ University	7.46 (4.98 – 9.94)	9.21 (6.48 – 11.94)	4.00 (2.15 – 5.85)	3.95 (2.11 – 5.79)	2.67 (1.15 – 4.19)	3.95 (2.11 – 5.79)
	Missing (n) = 79	Missing (n) = 9	Missing (n) = 45	Missing (n) = 17	Missing (n) = 34	Missing (n) = 14
Number of people in the house[5]						
▪ 1	15.22 (11.83 – 18.61)	16.36 (12.87 – 19.85)	2.33 (0.91 – 3.75)	7.55 (5.06 – 10.04)	2.08 (0.73 – 3.43)	5.66 (3.48 – 7.83)
▪ 2-3	8.50 (5.87 – 11.13)	8.64 (5.99 – 11.29)	2.51 (1.03 – 3.99)	3.36 (16.61 – 5.06)	1.41 (0.30 – 2.52)	2.33 (0.91 – 3.75)
▪ 4-5	14.63 (11.30 – 17.96)	16.67 (13.16 – 20.19)	4.44 (2.50 – 6.38)	4.35 (2.43 – 6.27)	2.22 (0.83 – 3.61)	4.26 (2.36 – 6.16)
▪ 6 or more	20.00 (16.23 – 23.77)	16.67 (13.16 – 20.19)	0.00 (0)	16.67 (13.16 – 20.19)	0.00 (0)	16.67 (13.16 – 20.19)
	Missing (n) = 84	Missing (n) = 13	Missing (n) = 50	Missing (n) = 20	Missing (n) = 40	Missing (n) = 17
Prior operations						
▪ Yes	12.90 (9.74 – 16.06)	13.51 (10.29 – 16.73)	4.29 (2.38 – 6.20)	4.23 (2.33 – 6.13)	2.86 (1.29 – 4.43)	4.17 (2.28 – 6.06)
▪ No	10.04 (7.21 – 12.87)	10.48 (7.59 – 13.37)	3.30 (1.62 – 4.98)	4.26 (2.36 – 6.16)	1.92 (0.63 – 3.21)	3.32 (1.63 – 5.01)
	Missing (n) = 82	Missing (n) = 15	Missing (n) = 50	Missing (n) = 23	Missing (n) = 40	Missing (n) = 20
General Health (SF-12) <u>Physical Health Component</u> In general, would you say your health is…						
▪ *Excellent*	11.11 (8.15 – 14.07)	9.09 (6.38 – 11.80)	0.00 (0)	13.64 (10.40 – 16.88)	0.00 (0)	9.09 (6.37 – 11.80)
▪ *Very good*	5.88 (3.66 – 8.10)	8.08 (5.51 – 10.65)	1.05 (0.089 – 2.01)	2.02 (0.69 – 3.35)	1.03 (0.078 – 1.98)	2.02 (0.69 – 3.35)
▪ *Good*	6.37 (4.07 – 8.67)	5.88 (3.66 – 8.10)	1.78 (0.53 – 3.03)	3.23 (1.56 – 4.90)	0.56 (0.14 – 1.26)	1.07 ((0.078 – 1.98)
▪ *Fair*	23.44 (19.45 – 27.44)	23.17 (19.19 – 27.15)	9.72 (6.93 – 12.51)	5.26 (3.15 – 7.37)	6.85 (4.47 – 9.23)	5.13 (3.05 – 7.21)
▪ *Poor*	27.78 (23.56 – 32.00)	25.00 (20.92 – 29.08)	5.56 (3.20 – 7.72)	15.79 (12.35 – 19.23)	5.56 (3.40 – 7.72)	15.79 (12.35 – 19.23)
▪	Missing (n) = 81	Missing (n) = 13	Missing (n) = 50	Missing (n) = 21	Missing (n) = 38	Missing (n) = 18
Does your health limit you in moderate activities, such as moving a table or pushing a						

vacuum cleaner ▪ *Yes, limited a lot* ▪ *Yes, limited a little* ▪ *Not limited at all*	16.53 (13.03 – 20.03) 8.72 (6.06 – 11.38) 4.23 (2.33 – 6.13) Missing (n) = 82	17.33 (13.76 – 20.90) 8.29 (5.69 – 10.89) 5.06 (2.99 – 7.13) Missing (n) = 13	7.41 (4.94 – 9.88) 1.85 (0.58 – 3.12) 0.00 (0) Missing (n) = 50	6.25 (3.97 – 8.53) 5.06 (2.99 – 7.13) 1.27 (0.21 – 2.33) Missing (n) = 22	4.32 (2.40 – 6.24) 1.20 (0.17 – 2.23) 0.00 (0) Missing (n) = 40	4.86 (2.83 – 6.89) 3.31 (1.62 – 5.00) 1.27 (0.21 – 2.33) Missing (n) = 19
Does your health limit your ability to climb several flights of stairs? ▪ *Yes, limited a lot* ▪ *Yes, limited a little* ▪ *Not limited at all*	14.29 (10.99 – 17.59) 7.58 (5.08 – 10.08) 7.50 (5.02 – 9.98) Missing (n) = 83	15.05 (11.68 – 18.42) 7.10 (4.68 – 9.52) 8.51 (5.88 – 11.14) Missing (n) = 15	5.43 (3.29 – 7.57) 2.11 (0.75 – 3.47) 0.00 (0) Missing (n) = 52	6.03 (3.79 – 8.27) 2.60 (1.10 – 4.10) 4.26 (2.36 – 6.16) Missing (n) = 23	3.17 (1.52 – 4.82) 1.35 (0.26 – 2.44) 0.00 (0) Missing (n) = 41	4.46 (2.51 – 6.41) 1.95 (0.65 – 3.25) 4.26 (2.36 – 6.16) Missing (n) = 20
During the past 4 weeks, with regards to work or other daily activities, have you accomplished less than you would like? ▪ *Yes* ▪ *No*	12.70 (9.56 – 15.84) 3.45 (1.73 – 5.17) Missing (n) = 92	12.33 (9.23 – 15.43) 4.17 (2.28 – 6.06) Missing (n) = 27	4.04 (2.18 – 5.90) 1.11 (0.12 – 2.10) Missing (n) = 61	4.47 (2.52 – 6.42) 2.08 (0.73 – 3.43) Missing (n) = 36	2.83 (1.27 – 4.39) 0.00 (0) Missing (n) = 49	3.06 (1.44 – 4.68) 2.08 (0.73 – 3.43) Missing (n) = 33
During the past 4 weeks, were you limited in the kind of work or other activities that you were able perform? ▪ *Yes* ▪ *No*	12.75 (9.60 – 15.90) 4.76 (2.75 – 6.77) Missing (n) = 88	12.66 (9.52 – 15.80) 4.40 (2.47 – 6.33) Missing (n) = 24	3.90 (2.07 – 5.73) 1.22 (0.18 – 2.26) Missing (n) = 59	5.33 (3.21 – 7.45) 2.20 (0.82 – 3.58) Missing (n) = 32	2.43 (0.98 – 3.88) 1.15 (0.14 – 2.16) Missing (n) = 48	3.63 (1.87 – 5.39) 2.20 (0.82 – 3.58) Missing (n) = 29
During the past 4 weeks, how much did pain interfere with your normal work?						

▪ *Not at all*	5.13 (3.05 – 7.21)	6.38 (4.08 – 8.68)	2.36 (0.93 – 3.79)	2.17 (0.80 – 3.54)	2.26 (0.86 – 3.66)	1.44 (0.32 – 2.56)
▪ *A little bit*	5.61 (3.44 – 7.78)	6.40 (4.09 – 8.71)	0.87 (0.0057 – 1.75)	4.03 (2.18 – 5.88)	0.00 (0)	1.61 (0.42 – 2.80)
▪ *Moderately*	12.73 (9.59 – 15.87)	12.86 (9.70 – 16.02)	3.23 (1.56 – 4.90)	4.23 (2.33 – 6.13)	0.00 (0)	2.78 (1.23 – 4.33)
▪ *Quite a bit*	25.00 (20.92 – 29.08)	24.19 (20.15 – 28.23)	10.34 (7.47 – 13.21)	7.02 (4.61 – 9.43)	6.90 (4.51 – 9.29)	6.90 (4.51 – 9.29)
Extremely	45.45 (40.76 – 50.15)	41.67 (37.02 – 46.32)	9.09 (6.38 – 11.80)	33.33 (28.89 – 37.78)	9.09 (6.38 – 11.80)	33.33 (28.89 – 37.78)
	Missing (n) = 81	Missing (n) = 13	Missing (n) = 50	Missing (n) = 21	Missing (n) = 39	Missing (n) = 18
Smoking Status						
▪ Daily	27.27 (23.07 – 31.47)	26.83 (22.65 – 31.01)	14.29 (10.99 – 17.59)	13.51 (10.29 – 16.73)	8.11 (5.54 – 10.68)	10.53 (7.64 – 13.42)
▪ Occasionally	10.00 (7.17 – 12.83)	9.09 (6.38 – 11.80)	9.09 (6.38 – 11.80)	9.09 (6.38 – 11.80)	9.09 (6.38 – 11.80)	9.09 (6.38 – 11.80)
▪ Never	4.49 (2.54 – 6.44)	4.46 (2.51 – 6.41)	0.00 (0)	0.88 (0.0072 – 1.76)	0.00 (0)	0.88 (0.0072 – 17.61)
▪ Quit	10.53 (7.64 – 13.42)	11.43 (8.43 – 14.43)	3.18 (1.53 – 4.83)	5.00 (2.94 – 7.06)	1.78 (0.53 – 3.03)	3.31 (1.62 – 5.00)
	Missing (n) = 82	Missing (n) = 14	Missing (n) = 50	Missing (n) = 22	Missing (n) = 40	Missing (n) = 19
Wait time until surgery						
▪ 1 to 5 weeks	9.63 (6.85 – 12.41)	10.27 (7.41 – 13.13)	2.46 (1.00 – 3.92)	4.21 (2.32 – 6.10)	1.59 (0.41 – 2.77)	3.42 (1.71 – 5.13)
▪ 6 weeks or more	12.50 (9.38 – 15.62)	12.34 (9.24 – 15.44)	5.15 (3.06 – 7.23)	5.30 (3.19 – 7.41)	2.88 (1.30 – 4.46)	3.29 (1.61 – 4.97)
	Missing (n) = 77	Missing = 6	Missing (n) = 43	Missing (n) = 11	Missing (n) = 33	Missing (n) = 8
Cardiac Risk Factors[6]						
▪ Age>70						
▪ Yes	11.24 (8.26 – 14.22)	12.20 (9.11 – 15.29)	3.70 (1.92 – 5.48)	4.17 (2.28 – 6.06)	1.82 (0.56 – 3.08)	1.64 (0.44 – 2.84)
▪ No	10.47 (7.58 – 13.36)	10.51 (7.62 – 13.40)	3.31 (1.62 – 5.00)	4.78 (2.77 – 6.79)	2.14 (0.78 – 3.50)	4.08 (2.21 – 5.95)
	Missing (n) = 76	Missing (n) = 5	Missing (n) = 43	Missing (n) = 10	Missing (n) = 32	Missing (n) = 7
▪ Prior heart attack						
▪ Yes	13.08 (9.90 – 16.26)	12.50 (9.38 – 15.62)	3.25 (1.58 – 4.92)	3.17 (1.52 – 4.82)	1.63 (0.44 – 2.82)	1.57 (0.40 – 2.74)
▪ No	8.87 (6.19 – 11.55)	9.54 (6.77 – 12.31)	3.24 (1.57 – 4.91)	4.66 (2.67 – 6.65)	2.22 (0.83 – 3.61)	4.22 (2.32 – 6.12)
▪ Not sure	14.29 (10.99 – 17.59)	14.89 (11.53 – 18.25)	5.13 (3.05 – 7.21)	8.70 (6.04 – 11.36)	2.44 (0.99 – 3.89)	4.26 (2.36 – 6.16)
	Missing (n) = 78	Missing (n) = 7	Missing (n) = 45	Missing (n) = 15	Missing (n) = 34	Missing (n) = 12
▪ Heart attack in the last 6 months						
▪ Yes	25.71 (21.59 – 29.83)	22.50 (18.56 – 26.44)	5.00 (2.94 – 7.06)	5.26 (3.15 – 7.37)	6.25 (3.97 – 8.53)	5.26 (3.15 – 7.37)
▪ No	8.80 (6.13 – 11.47)	9.62 (6.84 – 12.40)	2.93 (1.34 – 4.52)	4.73 (2.73 – 6.73)	1.57 (0.40 – 2.74)	3.53 (1.79 – 5.27)
▪ Not sure	11.11 (8.15 – 14.07)	11.76 (8.72 – 14.80)	6.25 (3.97 – 8.53)	3.03 (1.41 – 4.65)	3.23 (1.56 – 4.90)	0.00 (0)
	Missing (n) = 77	Missing (n) = 6	Missing (n) = 44	Missing (n) = 14	Missing (n) = 33	Missing (n) = 11

▪ Angina						
▪ Yes	12.02 (8.95 – 15.09)	10.80 (7.87 – 13.73)	2.55 (1.06 – 4.04)	3.83 (2.02 – 5.64)	2.46 (1.00 – 3.92)	2.38 (0.94 – 3.82)
▪ No	10.00 (7.17 – 12.83)	10.14 (7.29 – 12.99)	3.15 (1.50 – 4.80)	4.41 (2.47 – 6.35)	2.26 (0.86 – 3.66)	4.38 (2.45 – 6.31)
▪ Not sure	5.00 (2.94 – 7.06)	8.93 (6.24 – 11.62)	6.00 (3.76 – 8.24)	5.36 (3.24 – 7.48)	0.00 (0)	1.79 (0.54 – 3.04)
	Missing (n) = 80	Missing (n) = 16	Missing (n) = 50	Missing (n) = 22	Missing (n) = 38	Missing (n) = 20
▪ Suspected critical Aortic Stenosis						
▪ Yes	11.26 (8.28 – 14.24)	12.11 (9.03 – 15.19)	4.71 (2.71 – 6.71)	4.32 (2.40 – 6.24)	2.29 (0.88 – 3.70)	3.23 (1.56 – 4.90)
▪ No	10.17 (7.32 – 13.02)	10.14 (7.29 – 12.99)	1.58 (0.40 – 2.76)	4.88 (2.85 – 6.91)	1.03 (0.078 – 1.98)	3.38 (1.68 – 5.08)
▪ Not sure	6.67 (4.32 – 9.02)	5.88 (3.66 – 8.10)	6.25 (3.97 – 8.53)	5.88 (3.66 – 8.10)	5.88 (3.66 – 8.10)	5.88 (3.66 – 8.10)
	Missing (n) = 80	Missing (n) = 9	Missing (n) = 47	Missing (n) = 16	Missing (n) = 36	Missing (n) = 13
▪ Arrhythmia						
▪ Yes	17.78 (14.17 – 21.39)	16.67 (13.16 – 20.19)	6.32 (4.03 – 8.61)	7.77 (5.25 – 10.29)	5.00 (2.94 – 7.06)	4.85 (2.82 – 6.88)
▪ No	5.58 (3.42 – 7.75)	6.93 (4.54 – 9.32)	1.83 (0.57 – 3.09)	2.18 (0.80 – 3.56)	0.45 (0.018 – 1.08)	2.16 (0.79 – 3.53)
▪ Not sure	15.38 (11.98 – 18.78)	14.49 (11.17 – 17.81)	5.08 (3.01 – 7.15)	8.82 (6.15 – 11.49)	3.28 (1.60 – 4.96)	5.80 (3.60 – 8.00)
	Missing (n) = 84	Missing (n) = 15	Missing (n) = 51	Missing (n) = 23	Missing (n) = 41	Missing (n) = 20
Alcohol Consumption Cage>2						
▪ *Yes*	11.11 (8.15 – 14.07)	8.70 (6.04 – 11.36)	5.26 (3.15 – 7.37)	4.55 (2.58 – 6.52)	5.00 (2.94 – 7.06)	4.55 (2.58 – 6.52)
▪ *No*	11.00 (8.05 – 13.95)	9.59 (6.81 – 12.37)	3.53 (1.79 – 5.27)	4.85 (2.82 – 6.88)	2.01 (0.69 – 3.33)	2.95 (1.35 – 4.55)
	Missing (n) = 96	Missing (n) = 129	Missing (n) = 64	Missing (n) = 133	Missing (n) = 55	Missing (n) = 130
Number of procedures						
▪ 1-2	25.00 (20.92 – 29.08)	20.00 (16.23 – 23.77)	25.00 (20.92 – 29.08)	40.00 (35.38 – 44.62)	25.00 (20.92 – 29.08)	20.00 (16.23 – 23.77)
▪ 3	14.58 (11.25 – 17.91)	15.52 (12.11 – 18.94)	8.16 (5.58 – 10.74)	9.26 (6.53 – 11.99)	5.88 (3.66 – 8.10)	7.14 (4.71 – 9.57)
▪ 4	7.69 (5.18 – 10.20)	7.50 (5.02 – 9.98)	2.67 (1.15 – 4.19)	2.53 (1.05 – 4.01)	1.92 (0.63 – 3.21)	1.89 (0.61 – 3.17)
▪ 5	11.84 (8.79 – 14.89)	12.31 (9.21 – 15.41)	2.26 (0.86 – 3.66)	4.08 (2.21 – 5.95)	0.56 (0.01 – 1.26)	3.06 (1.44 – 4.68)
	Missing (n) = 76	Missing (n) = 5	Missing (n) = 43	Missing (n) = 10	Missing (n) = 32	Missing (n) = 7
Number of co-morbidities						
▪ 1	0.00 (0)	0.00 (0)	10.00 (7.17 – 12.83)	10.00 (7.17 – 12.83)	0.00 (0)	0.00 (0)
▪ 2	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
▪ 3-4	7.46 (4.98 – 9.94)	7.89 (5.35 – 10.43)	2.94 (1.35 – 4.53)	3.95 (2.11 – 5.79)	1.43 (0.31 – 2.55)	3.90 (2.07 – 5.73)

▪ 5-6 ▪ 7+	8.65 (6.00 – 11.30) 14.84 (11.49 – 18.19) Missing (n) = 76	10.08 (7.24 – 12.92) 14.29 (10.99 – 17.59) Missing (n) = 5	2.61 (1.11 – 4.11) 4.05 (2.19 – 5.91) Missing (n) = 43	4.72 (2.72 – 6.72) 4.84 (2.82 – 6.86) Missing (n) = 10	1.67 (0.46 – 2.88) 2.82 (1.26 – 4.38) Missing (n) = 32	3.13 (1.49 – 4.77) 3.74 (1.95 – 5.53) Missing (n) = 7
Type of Procedure						
▪ Coronary Artery Bypass Graft (single)	9.38 (6.63 – 12.13)	8.00 (5.44 – 10.56)	1.43 (0.31 – 2.55)	2.67 (1.15 – 4.19)	1.39 (0.29 – 2.49)	1.32 (0.24 – 2.40)
▪ Coronary Artery Bypass Graft (double)	9.17 (6.45 – 11.89)	9.45 (6.69 – 12.21)	0.86 (0.01 – 1.73)	4.72 (2.72 – 6.72)	0.84 (0.020 – 1.70)	2.36 (0.93 – 3.79)
▪ Coronary Artery Bypass Graft (triple or quadruple)	11.76 (8.72 – 14.80)	10.53 (7.64 – 13.42)	5.56 (4.00 – 7.72)	5.41 (3.28 – 7.54)	5.41 (3.28 – 7.54)	5.41 (3.28 – 7.54)
▪ Aortic Valve Replacement / Repair	10.96 (8.01 – 13.91)	10.87 (7.93 – 13.81)	3.49 (1.76 – 5.22)	2.20 (0.82 – 3.58)	2.30 (0.89 – 3.71)	2.20 (0.82 - 3.58)
▪ Mitral Valve Replacement /Repair	12.50 (9.38 – 15.62)	14.81 (11.46 – 18.16)	2.33 (0.91 – 3.75)	3.85 (2.04 – 5.66)	0.00 (0)	3.77 (1.97 – 5.57)
▪ Other	14.81 (11.46 – 18.16) Missing (n) = 76	18.75 (15.07 – 22.43) Missing (n) = 5	17.24 (13.68 – 20.80) Missing (n) = 43	16.13 (12.66 – 19.60) Missing (n) = 10	7.14 (4.71 – 9.57) Missing (n) = 32	12.50 (9.38 – 15.62) Missing (n) = 7

1. Moderate to severe depression was defined by a Zung SDS score of 60 and above; anxiety was defined by a Zung SAS score of 60 and above; co-morbid depression and anxiety was defined by a Zung SDS and SAS score of at least 60.
2. Missing values for depression questionnaire = 76; missing values for anxiety questionnaire = 43; missing values for co-morbid illness = 47
3. The 'formerly married' category includes: widowed, separated and divorced
4. This category includes individuals who completed some or all of their education.
5. Household size acts as a proxy for social support in this study.
6. CAGE: An alcohol screening measure. A score over 2 indicates the presence of alcoholism.

Table 4 displays the mean Zung scores (indexed) of our sample, stratified by sex. An average score of 45.5 and 42.7 was observed for the Zung Self-Rating Depression and Anxiety Scale, respectively. Women scored slightly higher than men in both scales. Imputed estimates were similar and were within one standard deviation of the original values (Table 5).

Table 4: Means and standard deviations of the Zung Self-Rating Depression and Anxiety Scale scores, by sex

	Women		Men		Total	
	Mean	SD	Mean	SD	Mean	SD
Zung SDS (n=347)	48.58	10.41	44.53	10.08	45.45	10.28
Zung SAS (n= 380)	45.44	10.11	41.24	8.50	42.17	9.04

Zung SDS = Zung's Self-Rating Depression Scale; Zung SAS = Zung's Self-Rating Anxiety Scale; SD = standard deviation

Table 5: Means and standard deviations of the Zung Self-Rating Depression and Anxiety Scale scores, by sex, using imputed data

	Women		Men		Total	
	Mean	SD	Mean	SD	Mean	SD
Zung SDS (n= 1908)	46.00	10.23	45.63	10.04	45.72	10.08
Zung SAS (n= 1907)	42.90	9.25	42.48	9.27	42.59	9.26

Zung SDS = Zung's Self-Rating Depression Scale; Zung SAS = Zung's Self-Rating Anxiety Scale; SD = standard deviation

Risk Factors

Table 6 reports the findings of the logistic regression examining socio-demographic factors associated with clinically relevant (mild, moderate or severe) depression in our sample. Females, patients who had experienced a myocardial infarction in the previous six months, those with poor self-rated general health, and those with major self-rated physical limitations had greater odds of experiencing clinically relevant depression. Conversely, those with two co-morbid illnesses experienced decreased odds of clinically relevant depression. It should be noted that certain confidence limits are quite wide, likely reflecting small sample sizes in those groups.

Table 6: Summary of the logistic regression used to assess predictors of clinically relevant depression

Odds Ratio Estimates		
Variable	**Clinically Relevant Depression**	
	Point Estimate (95% Confidence Interval)	**p-value***
Sex		
▪ Male	baseline	
▪ Female	**1.88 (1.00 - 3.54)**	**0.049**
General Health		
In general, would you say your health is…		
▪ *Excellent*	baseline	
▪ *Very good*	1.48 (0.34 - 6.39)	0.60
▪ *Good*	1.25 (0.31 - 5.121)	0.60
▪ *Fair*	3.03 (0.69 - 13.37)	0.14
▪ *Poor*	**4.28 (2.5 - 18.36)**	**0.0037**
Does your health limit you in moderate activities, such as moving a table or pushing a vacuum cleaner		
▪ *Yes, limited a lot*	**6.44 (2.61 - 15.90)**	**<.0001**
▪ *Yes, limited a little*	2.02 (0.83 - 4.97)	0.12
▪ *Not limited at all*	baseline	
Presence of Cardiac Risk Factors		
▪ Heart attack in the last 6 months	**2.79 (1.413 - 5.517)**	**0.0031**
Number of co-morbidities		
▪ 1	baseline	
▪ 2	**0.047 (0.003 - 0.74)**	**0.029**
▪ 3-4	0.46 (0.091 - 2.29)	0.34
▪ 5-6	0.31 (0.063 - 1.51)	0.15
▪ 7+	0.64 (0.14 - 3.05)	0.58

**Exclusion criteria: p = 0.15
Ns = not significant

Table 7 displays the results of the logistic regression which examined socio-demographic factors associated with clinically relevant anxiety. Females, patients who had experienced a myocardial infarction in the previous six months, those with self-rated poor general health, patients with self-rated physical limitations and those who underwent certain types of operations (ie. insertion of an artificial pacemaker and an atrial septal defect repair; categorized under the 'other' category) had an increased odds of experiencing clinically relevant anxiety. It should be noted that certain confidence limits are quite wide, likely reflecting small sample sizes in those groups.

Table 7: Summary of the logistic regression used to assess predictors of clinically relevant anxiety

Odds Ratio Estimates		
Variable	**Clinically Relevant Anxiety**	
	Point Estimate (95% Confidence Interval)	**p-value***
Sex		
▪ Male	baseline	
▪ Female	**2.14 (1.14 - 4.03)**	**0.018**
General Health		
In general, would you say your health is…		
▪ *Excellent*	baseline	
▪ *Very good*	0.52 (0.151 - 1.792)	0.30
▪ *Good*	1.01 (0.32 - 3.26)	0.98
▪ *Fair*	2.86 (0.84 - 9.69)	0.092
▪ *Poor*	**5.91 (1.17 - 29.89)**	**0.032**
Does your health limit you in moderate activities, such as moving a table or pushing a vacuum cleaner		
▪ *Yes, limited a lot*	**5.42 (2.36 - 12.45)**	**<.0001**
▪ *Yes, limited a little*	**2.98 (1.32 - 6.759)**	**0.0088**
▪ *Not limited at all*	baseline	
Presence of Cardiac Risk Factors		
Heart attack in the last 6 months	**3.31 (1.73 - 6.31)**	**0.0003**
Type of Surgery		
▪ Coronary Artery Bypass Graft (single)	baseline	
▪ Coronary Artery Bypass Graft (double)	0.82(0.39 - 1.73)	0.5975
▪ Coronary Artery Bypass Graft (triple or quadruple)	0.92(0.33 - 2.55)	0.8728
▪ Aortic Valve Replacement or Repair	6.48(0.68 - 3.25)	0.3271
▪ Mitral Valve Replacement or Repair	1.94 (0.75 - 5.05)	0.1751
▪ Other	**4.50 (1.48 - 13.65)**	**0.0080**

**Exclusion criteria: p = 0.15

Discussion

The point prevalence of moderate to severe depression (10.7%) and anxiety (3.4%) in our sample are lower than the majority of estimates describing the prevalence of these psychiatric conditions among cardiac patients (which range between 12.5% to 40%), yet remain slightly above those reported in the general Canadian population[58,59,77]. There were some studies that reported findings similar to our own; for instance, one investigation found that 7.7% of cardiac patients experienced major depression one year prior to their myocardial infarction[42]. Furthermore, one of the few studies focusing on outpatient samples, such as our sample, found the prevalence of depression to be 9.3% in cardiac patients[18]. The prevalence of mild symptoms was highly consistent with the literature, as this figure has ranged around 15% to 26%[10].

The slightly greater proportion of mild anxiety compared to mild depression reported in our study was expected since anxiety is often the dominant feeling prior to surgery (it may be further elevated by state anxiety attributable to the impending surgery), while depression is most common following the procedure[19,70]. The reversal may be true for moderate to severe symptoms since this level of severity may more closely approximate clinical levels of psychiatric illness. Severe to moderate depression may be higher in our sample since clinical depression is more predominant in this age group (clinical anxiety peaks at age 45, whereas depression declines in middle age, but peaks in younger and older populations)[53,83].

The low prevalence of moderate-to-severe symptoms may be explained by this study's focus on elective cardiac surgeries, which range in severity. Elective surgeries are by nature less complex and life-threatening than emergency operations. Complicated procedures or those associated with greater risk have a stronger association with pre-operative anxious and depressive

symptoms[79]. Previous literature has most commonly pertained to emergency procedures or very serious elective surgeries, and has thus reported high rates of psychiatric illness. Ours on the other hand, included a variety of surgeries, ranging in severity (Appendix B, Table 1). Furthermore, individuals suffering from depression or anxiety may be less likely to comply with recommendations of elective cardiac surgery and may be less likely to be referred to such surgery due to the attribution of somatic symptoms to their psychiatric illness[32,33]. As well, our sample is composed of a predominantly older, male population who are less likely to experience severe depression/anxiety and less likely to report symptoms of psychiatric illness[48,53, 83].

Our use of the Zung scales may have led to lower estimates than reported in the literature. For example, studies using the Beck Depression Inventory have indicated that 41.4% of a sample cardiac patients experienced depression, while the Diagnostic Interview Schedule indicated that the only 15.1% of the same sample suffered from the psychiatric illness[43]. One explanation for this discrepancy is the inclusion of varying levels of somatic symptoms and the lack of validation of these questionnaires in medically ill populations[70]. Though the Zung scales have not been used in cardiac patients, they have demonstrated good reliability and validity across a variety of patient populations. They also allow for the collection of subclinical information (which cannot be obtained by the gold standard of clinical diagnostic interviews)[52,61,87]. The brevity of these measures also allowed us to attain a large sample size, as their ease of completion may have increased consent.

Significant predictors of depression and anxiety found in this study were consistent with the literature. Because symptoms of these psychiatric illnesses are associated post-surgical morbidity and mortality, a better understanding of these variables may help identify high risk groups that require added care[6,8,86]. Predictors of clinically relevant depression included sex, general health, the experience of a recent myocardial infarction, and the presence of co-morbid

illness. Sex, general health, the experience of a recent myocardial infaction and the type of surgery acted as predictors for clinically relevant anxiety in this population.

Research has consistently demonstrated an increased risk of depression and anxiety in women, and has posited several explanations for this relationship[82,84]. Some of these include: a greater social acceptance of the expression of emotions, fear and anxiety in women and discrepancies in the regulation of certain biological mechanisms and reproductive hormone cycles[1, 55,81].

Poor health is frequently associated with depression and anxiety, likely due to the increased focus on and perception of somatic symptoms and the high rates of co-morbidity in individuals with psychiatric illness[34,68].

Depression is typically related to the development or the presence of multiple physical ailments (which is a measure of illness severity)[26,33]. The protective effect of having two co-morbidities in this study may relate to the lifestyle improvements one makes after being diagnosed with multiple health problems. It is possible that the presence of two co-morbidities increases the likelihood of making an adapting lifestyle change that may protect one from experiencing depression (more so than one), while the presence of more co-morbidities inhibits the ability to do so. This hypothesis is supported by the findings that 68% of patients with a myocardial infarction or breast cancer report a positive healthy lifestyle change following their illness[60]. It is also possible that our small sample size disorted the relationship between these variables.

Certain cardiac operations, perhaps those associated with greater risk or lifestyle change (such as the implantation of a pacemaker and an atrial septal defect repair), may have enhanced

the likelihood of anxiety in our sample due to fear of death, lifestyle change, or physical limitation following surgery[79].

As demonstrated in the literature, several cardiac risk factors were associated with both depression and anxiety[39,44]. This is not surprising since anxiety disorders and depression share many risk factors with cardiovascular disease, such as reduced levels of physical activity, poor diet, and elevated rates of smoking[40]. Furthermore, anxiety disorders are associated with many physiological risk factors, such as elevated nervous system activity, while depression has been linked to increased platelet activity[38,39].

Relationship between Depression/Anxiety and Cardiovascular Disease

Numerous factors may drive the relationship between depression and cardiac illness. To a lesser degree, these factors also serve to explain the weaker association between cardiac problems and anxiety. Depression and anxiety are associated with poor treatment adherence to lifestyle changes and medication as well as adverse lifestyle factors related to cardiac illness, such as smoking, alcohol consumption and lack of physical activity. Furthermore, depression has been linked to various ailments, such as diabetes and obesity, that are proven risk factors for coronary artery disease[2,43,73]. Increased platelet activity, dysregulation of the hypothalamic pituitary adrenal axis and the autonomic nervous system, and increased inflammation are also risk factors of cardiac illness that are associated with depression[38].

Strengths and Limitations

An advantage to this study is its inclusion of symptoms of mild depressive and anxiety as they allow for a more in-depth view of psychiatric illness in this population. They also allow for an enhanced ability to capture symptoms of psychiatric illness, as they tend to fluctuate over time, and ultimately increase the validity of diagnostic groupings. In fact, the inclusion of mild cases

has said to increase the coverage of true cases by nearly 33%[4]. As well, we collected standardized data for multiple socio-demographic risk factors that were examined as potential predictors of psychiatric illness. Finally, we have the ability to contribute to the limited Canadian research in this area.

A main limitation of this study is the magnitude of missing depression and anxiety data. A number of respondents did not provide complete information for the Zung Self-Rating Depression Scale (18% missing) and the Zung Self-Rating Anxiety Scale (10% missing). We compared findings with and without imputed values. Imputed prevalence estimates of depression and/or anxiety were similar and mean Zung scores were quite comparable. A limitation of this procedure is that it assumes values are missing at random. If there was a systematic bias, imputation would not have corrected for this.

Volunteer bias may have affected the data as patients who consented to our study may have been inherently different than those who refused. For instance, a previous investigation determined that volunteers tended to be more highly educated, less likely to smoke, and more interested in health issues than those who do not volunteer[76]. Since these characteristics are related to depression and/or anxiety this selection bias had the potential to affect our findings.

While the conclusions of this study are generalizable to a wide geographical range of individuals (as this was the only cardiac surgical centre in the health region), it is not be generalizable to those undergoing non-elective cardiac surgery.

We were unable to calculate the participation rate in our study due to lack of information concerning the refusal rate. However, patients with severe psychiatric disorders may have been

more likely to have refused due to the stigma attached to psychiatric illnesses. If this is so, then we would have underestimated the prevalence of depression and anxiety in our sample.

Finally, the reliability of PACS database and discharge hospital records, used to obtain information concerning socio-demographic risk factors and length of stay, is unclear as they may have contained coding errors, misdiagnoses, or missing information. However, these data were used to support hospital funding and monitor expenses, so extensive resources were used to ensure their ongoing accuracy.

Clinical Importance

This investigation assists in highlighting the magnitude of depression and/or anxiety experienced in elective cardiac surgical patients. Although our estimates were lower than previous studies, they still exceed those of community samples and most certainly represent a significant concern. Addressing this issue and treating co-morbid depression and/or anxiety in cardiac patients will not only improve the quality of life for these individuals, but will substantially improve the overall treatment of cardiac illness since pre-operative symptoms strongly predict ongoing post-operative psychiatric illness and morbidity[79]. In fact, pre- and post-operative depression has been found to increase morbidity six months and five years following coronary artery bypass graft surgery, while post-operative depression has been found to increase mortality one month following cardiac surgery and to hinder prevention efforts following a myocardial infarction[6,8,86]. Consequently, understanding the distribution and determinants of depression and anxiety in this population could allow for targeted interventions towards those in most need, which could enhance post-operative recovery and survival and reduce hospital expenses. As an added benefit, such targeted interventions could allow for treatment of depression and anxiety within these populations, which could greatly enhance the quality of life among these patients. Since depression and anxiety are associated with reduced levels of general

health, the development of a variety of chronic physical illnesses, financial consequences in terms of increased hospital expenses and lost-work days, severe emotional pain and debilitating stigma, any means by which support can be provided would improve cirmcumstances for those in need of psychiatric care.

The overall medical and socioeconomic burden of mild anxiety or depression is even greater than moderate to severe levels due to their higher prevalence and relationship to cardiac outcomes[31,39]. Consequently, it is extremely important that these states are acknowledged and treated in clinical settings as well.

Future investigations are required to assist in clarifying the prevalence of anxiety and depression among cardiac patients, and to further assess the relationship between these psychiatric disorders and cardiac illness. A greater number of large scale studies using clinical diagnostic interviews would be instrumental in narrowing the wide range of prevalence estimates of depression and anxiety seen in this population. Assessments of the effectiveness of targeted screening and treatment, in terms of cost-saving and quality of life, would also be beneficial.

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Chapter 5

The Effects of Pre-operative Depression and Anxiety on Length of Stay in Cardiac Surgical Patients

Abstract

Objective: The relationship between depression and/or anxiety and length of hospital stay (an indicator of hospital resource use, morbidity and mortality) has been inconsistent. The limited previous research in this area has been conducted outside of Canada and suffers from a variety of methodological limitations. This study analyzed the effects of depression and anxiety on post-operative length of stay while controlling for potential confounding variables. **Methods:** Consenting elective cardiac patients attending Foothills Hospital Pre-operative Assessment Clinic between August 1998 and March 2002 completed the Zung Self-Rating Depression and Anxiety scales to measure symptoms of these psychiatric conditions and a questionnaire assessing potential confounders. Multiple linear regression with a log adjustment for length of stay (which was skewed) was used to examine the relationship between clinically relevant depression or anxiety and length of stay. **Results:** The presence of clinically relevant depression increased length of stay by 15.4% compared to those without clinically relevant depression or anxiety. Age, educational attainment, general health, and type of surgery also predicted length of stay. **Conclusions:** The increase in duration of stay observed among patients with depression supports the implementation of screening and treatment of these psychiatric disorders in this population. Further research is required regarding the effects of these psychiatric illnesses on post-surgical stay in cardiac patients.

Keywords: depression, anxiety, LOS (length of stay), cardiovascular disease;

LOS = length of stay

Introduction

Cardiovascular disease is one of the most costly illnesses in Canada and is a primary cause of hospital admission and mortality. The excessive danger and burden associated with this disease suggest that increased attention to high risk sub-groups would be highly beneficial. Since cardiovascular disease is the most common medical co-morbidity in individuals with a psychiatric illness, and since these individuals suffer from a high rate of co-morbidity, an important high risk group includes those affected by psychiatric illness[40]. This constitutes a wide proportion of individuals as approximately 20% of the Canadian population is directly affected by psychiatric illness during their lifetime[66]. Of these, depression (17%) and anxiety disorders (25%) are among the most prevalent[43].

Previous literature has acknowledged that depression and anxiety contribute to increased morbidity, mortality and financial consequences among cardiac patients[13,29,84]. For instance, a Canadian study determined that patients suffering from co-morbid depression following their first year after cardiac surgery generated approximately 41% greater health care related costs than those without such psychiatric illness[30]. While the association for anxiety is relatively weaker and under-researched, depression is a well-established risk factor for the development and worsening of cardiac illness[31,42]. Cardiac patients with co-morbid pre-surgical depression are two to four times more likely to pass away compared to patients without such psychiatric illness[8]. These individuals also experience increased post-operative morbidity and recovery time, and suffer from enduring cardiac symptoms[39,83]. Similarly, it has been reported that patients with co-morbid phobic anxiety symptoms experience a four to six-fold increase in risk of cardiac-related mortality, and that pre-operative anxiety is associated with prolonged post-operative recovery time[66,89]. Subclinical depression and anxiety have also been linked to cardiovascular heart disease[48,69]. Subclinical depression increases the risk of cardiac mortality by approximately 6-7 fold, and is related to poorer post-surgical outcomes[4,28].

Understanding the factors that drive length of stay is an essential aspect of health care optimization. Investigating influences on post-operative length of stay can help indicate health care resource use, hospital efficiency, and can be a proxy measure for recovery from illness[18,64]. In fact, longer post-operative duration of stay has been associated with increased morbidity and mortality in a wide variety of patients, including cardiac patients[9,17]. Given an association between depression and/or anxiety and length of stay, treatment of patients' psychiatric illnesses would not only reduce the mortality, morbidity and economic consequences of cardiac surgery, but the treatment of both the physical and mental conditions could greatly improve the quality of life of these individuals.

Previous literature pertaining to the prevalence of pre-operative depression and anxiety in cardiac surgical patients has found values ranging from 12.5% to 47% and 20% to 55%, respectively[16,38,51,89]. Subclinical levels of depression and anxiety consistently range around 20%[5,15].

Research regarding the post-operative stay of cardiac patients with co-morbid depression or anxiety has yielded inconsistent results. The few studies addressing this patient population have generally indicated a lack of relationship among those with co-morbid anxiety, and have been inconsistent regarding those with co-morbid depression. Two investigations involving cardiac surgical patients found that those with depression were approximately 1.2 times more likely to have a prolonged length of stay, while the remaining three did not find an association between these variables. However, these findings should be viewed critically since many of these studies suffered from a variety of methodological problems including: small sample sizes, lack of control for important confounders, and differences in the validity, reliability and method of psychiatric illness assessment[10, 17, 30,63].

Investigations concerning a variety of surgical patients (including cardiac patients) tend to report a positive relationship between both psychiatric conditions and length of stay. Research including general, unspecified surgical patients, has also pointed towards a relationship between these variables. For instance, a prospective study that recruited 278 surgical/medical patients found a significant, positive correlation between co-morbid depression, anxiety and/or cognitive impairment and length of stay[75]. Similarly, a retrospective study spanning 1999-2001 concerning medical/surgical inpatients with a range of co-morbid psychiatric illnesses (including mood and anxiety disorders) determined that all co-morbid psychiatric illnesses, with the exception of substance use disorders and anxiety disorders (at baseline) were correlated with elevated lengths of stay[22]. It is important to monitor these relationships over time as changes may take place based on improvements in surgical procedures or alterations in policies regarding hospital stay.

This study analyzed the association between pre-operative symptoms of depression and anxiety and length of hospital stay in a sample of elective cardiac patients attending a surgical pre-assessment clinic in Alberta, Canada. We hypothesized that patients with comorbid depression and anxiety would have a higher length of stay.

Methods

Study Design and Participants:

This study is a secondary analysis that used longitudinal data collected from the Foothills Hospital Pre-operative Assessment Clinic in Calgary, Alberta (Stuart H, Ghali W, Co-Investigators). Patients were admitted to this clinic to undergo pre-operative screening prior to elective surgery at Foothills Hospital (a tertiary care hospital equipped with 750 beds). A consecutive series of patients who attended the clinic between August 1998 and March 2002 were

invited to participate in the primary investigation. Of these, a sub-sample of all patients undergoing elective cardiac surgery was used in this study.

Upon arrival to their assessment, a research assistant provided consenting patients with a ten minute questionnaire measuring symptoms of depression and anxiety, as well as socio-demographic and cardiac risk factors. Questionnaires included the Zung Self-Report Depression Scale, the Zung Self-Report Anxiety Scale, and a self-report measure used to gather information on confounders. The outcome of interest, length of stay, was assessed by following patients for up to 85 days through administrative databases until discharge, death, or transfer. The study sample covered all consenting individuals undergoing cardiac surgery at Foothills Hospital, which services a wide geographical area spanning Southern Alberta, Southeastern British Columbia and Southern Saskatchewan. Exclusion criteria included individuals under the age of 18 years, those who could not provide informed consent, and those who could not read or complete the questionnaire.

Ethics approval for the original study was obtained from the University of Calgary and the Health Sciences Research Ethics Board at Queen's University.

Depression/Anxiety Measures:

We used Zung's self-rated depression and anxiety scales to identify clinically relevant symptoms. Zung's Self Rating Depression Scale (SDS) is comprised of 20 questions that measure general affect as well as psychological and physiological symptoms related to depression that have occurred in the past week. A four-point Likert scale ranging from 'None or a little of the time', 'Some of the time', 'Good part of the time' and 'Most or all of the time' is used to score each question individually, and then these values are summed to yield an overall score spanning 20-80[90]. Based on the recommended threshold of 50 to define a clinically relevant case, it has been found that the SDS has an alpha of 0.79, a sensitivity of 97% , a specificity of 63%, and a correct classification value of 82%[45,54,94,95]. Additionally, this measure has demonstrated

good known-groups validity and good concurrent validity as well as good face and content validity[19,95]. SDS items that indicated greater depressive symptoms with lower numerical scores were reverse-scored to remain consistent with the other items, where a score of 1 corresponds to the lowest level of depressive or anxious symptoms and a score of 4 indicates the highest level. Scores were subsequently summed, converted into SDS index values (the total score is multiplied by 1.25), and categorized.

Zung's Self Rating Anxiety Scale (SAS) is comprised of 20 questions that evaluate the most frequent symptoms of an anxiety disorder. It is scored in the same manner as the SDS and ranges from 20-80. Based on the commonly used threshold of 45 to define a clinically relevant case, this scale has been found to have an alpha of 0.85, a sensitivity of 89% , and a specificity of 92%[57,58,65]. It has demonstrated fair concurrent validity and good discriminant validity. Total scores were scored similarly to the SDS.

Consistent with previous literature identifying cut-points for clinically relevant symptoms, we defined 'healthy' patients as those free of depression or anxiety, based on a Zung SDS score of 20 to 49.9 and a Zung SAS score of 20 to 44.9[65]. Patients scoring with an SDS index score above 50 and those with a SAS score above 45 were categorized as having clinically relevant depression and anxiety, respectively.

Length of Stay

Length of stay was collected from the Patient Activity and Costs System (PACS) database. PACS is a composite of health care information obtained from hospital records and gathered by the Health Record Department. The database contains information concerning admission and discharge dates, which were used to calculate length of stay. Length of stay was defined as the number of partial days or nights in hospital and ranged from 1 to 85 in this sample.

Potential Confounders/Effect Modifiers

Information pertaining to potential confounders and effect modifiers was collected using questionnaires and the PACS database. Socio-demographic factors relating to both the exposures and outcome of interest included: sex, age, marital status, living arrangements (a proxy for social support), geographic region of residence, and education. Surgical risk factors relating to both variables included: history of myocardial infarction, smoking status, previous surgeries, co-morbid illness, wait time until surgery, various cardiac risk factors (age over 70, previous myocardial infarction, previous myocardial infarction in the past six months, angina, suspected critical aortic stenosis, and arrhythmia), number of procedures, type of surgery, and general health. Adjustment for important confounders has often been overlooked in previous studies.

Alcohol consumption was measured by the CAGE Alcohol Screening Questionnaire[25]. We originally planned to use a version of Detsky's Cardiac Risk Index to identify the presence of cardiac risk factors however all of the required information was not available. As an alternative, all items matching Detsky's criteria were used as independent cardiac risk variables in the analysis[23]. Furthermore, only the Physical Health Component of the SF-12 was used in this study, to avoid any bias associated with the inclusion of the Mental Health Component (as it would measure similar constructs as our primary exposure variable and may subsequently bias our estimates towards the null). These six questions were used as independent physical health variables in the analysis. It should be noted that our proxy for co-morbid illness (number of concurrent diagnoses) excludes all psychiatric conditions.

Data Management and Analysis

All data management and analysis was performed using SAS (version 9.0). Depression and anxiety scores were missing for 76 and 43 items respectively. We used mean imputation to correct for missing values, assuming they were missing at random, and examined both imputed and non-imputed results[81]. However, since response bias is often associated with these types of self-report psychiatric assessments, un-imputed estimates are presented in this paper[22]. Missing values present in all other explanatory variables were excluded from regression analyses by listwise deletion, giving 261 observations for analysis. Prior to any analysis, data were visually inspected to ensure the completeness of the database by examining means, standard deviations, and frequency distributions of all variables.

We first identified potential confounders in bivariate analyses. For our model, we used linear regression with a log transformation of length of stay to correct for skewness. (Appendix B, see figure 1 for distribution of outcome variable). Backwards regression was used to identify any confounding variables (entry criteria $p<=0.15$)[19]. All potential confounders were placed into the model and were then sequentially deleted. The variable that resulted in the least effect on the main parameter was removed at each step until the cumulative change in parameter estimates reached 15%[12,19]. Two-way interaction terms were created between all significant variables in the model and the primary exposure variable. Any potential confounding variables that had been excluded from our final model but had a plausible biological relationship with the primary exposure variable were also tested. These were then tested separately by comparing models with and without the interaction term of interest. Those that demonstrated significant p-values (<0.05) were included in our final model. Jacknife and student residuals, as well as leverage and Cook's D statistics were calculated to assess the influence or leverage of each observation on the overall fit of the model. We assessed collinearity by examining the variance inflation factor (VIF). We

also evaluated a Cox's proportional hazards model but found that the data violated its key assumption of proportional hazards [49,77].

Results

Baseline Characteristics

Baseline characteristics of this sample are described elsewhere (Manuscript 1). The average age of our sample was 62 years (SD 11.5), with a slightly older male population. The majority of the sample was composed of males, was of Caucasian ethnicity, and underwent multiple procedures. About half were undergoing a coronary artery bypass graft. 37 (10.7%) and 13 (3.4%) patients experienced moderate to severe depression and anxiety, respectively, while 76 (21.9%) and 125 (32.9%) experienced mild symptoms of depression and anxiety, respectively. A greater proportion of women experienced clinically relevant psychiatric illness than men.

Table 1 displays the mean Zung index scores of our sample, stratified by sex. An average score of 45.5 and 42.2 was observed for the Zung Self-Rating Depression and Anxiety Scale, respectively. Women scored slightly higher than men in both scales. Imputed estimates were similar and were within one standard deviation of the original values (Table 2).

Table 4: Means and standard deviations of the Zung Self-Rating Depression and Anxiety Scale scores, by sex

	Women		**Men**		**Total**	
	Mean	SD	Mean	SD	Mean	SD
Zung SDS (n=347)	48.58	10.41	44.53	10.08	45.45	10.28
Zung SAS (n= 380)	45.44	10.11	41.24	8.50	42.17	9.04

Zung SDS = Zung's Self-Rating Depression Scale; Zung SAS = Zung's Self-Rating Anxiety Scale; SD = standard deviation

Table 5: Means and standard deviations of the Zung Self-Rating Depression and Anxiety Scale scores, by sex, using imputed data

	Women		Men		Total	
	Mean	SD	Mean	SD	Mean	SD
Zung SDS (n= 1908)	46.00	10.23	45.63	10.04	45.72	10.08
Zung SAS (n= 1907)	42.90	9.25	42.48	9.27	42.59	9.26

Zung SDS = Zung's Self-Rating Depression Scale; Zung SAS = Zung's Self-Rating Anxiety Scale; SD = standard deviation

Table 3 reports the average length of stay by each covariate. Individuals with missing depression or anxiety scores experienced similar periods of stay when stratified by each covariate. Those with missing depression data had an average stay of 9.52 days (SD 7.82), while those with missing anxiety data had an average stay of 10.11 (SD 9.62). In the bivariate analyses, length of stay was independently associated with clinically relevant depression, sex, educational attainment, living arrangement (proxy for social support), age over 70, the presence of suspected critical aortic stenosis, number of procedures, co-morbid illness, type of surgeries, poor physical health (specifically physical limitations due to health and the experience of pain).

Table 3: Average length of stay of cardiac surgical patients attending Foothills Pre-operative Assessment Clinic, by all covariates (n= 423)

	Average Length of Days in Hospital (SD)
Depression[1]	
▪ "Healthy" (SDS scores 0 to 49.9 and SAS scores 0 to 44.9)" (missing = 64)	9.51 (8.98)
▪ Mild (SDS scores 50 to 59.9)	8.31 (7.52)
▪ Moderate to severe (SDS scores 60 to 80)	9.84 (4.82)
▪ Missing	9.52 (7.82)
Anxiety[2]	
▪ "Healthy" (SDS scores 0 to 49.9 and SAS scores 0 to 44.9)"	9.51 (8.98)
▪ Mild (SAS scores 45 to 59.9)	8.99 (7.83)
▪ Moderate to severe (SAS scores 60 to 80)	12.46 (12.20)
▪ Missing	10.11 (9.62)
Depression and/or Anxiety[3]	
▪ No clinically relevant symptoms of depression or anxiety	7.89 (6.91)
▪ Clinically relevant symptoms of depression or anxiety	9.34 (8.23)
▪ Missing	8.87 (5.22)
Depression (Imputed) [4]	
▪ "Healthy (SDS scores 0 to 49.9 and SAS scores 0 to 44.9)"	8.58 (6.95)
▪ Mild (SDS scores 50 to 59.9)	8.77 (10.33)
▪ Moderate to severe (SDS scores 60 to 80)	10.70 (9.85)
▪ Missing	9.54 (5.96)
Anxiety (Imputed) [4]	-
▪ "Healthy (SDS scores 0 to 49.9 and SAS scores 0 to 44.9)"	8.58 (6.95)
▪ Mild (SDS scores 50 to 59.9)	8.75 (8.78)
▪ Moderate to severe (SDS scores 60 to 80)	11.89 (10.67)
▪ Missing	9.30 (6.21)
Depression and/or Anxiety (Imputed) [4]	-
▪ No clinically relevant symptoms of depression or anxiety	7.85 (3.39)
▪ Clinically relevant symptoms of depression or anxiety	8.73 (8.04)
▪ Missing	9.54 (5.96)
Age	
▪ 15-29 (n = 4)	4.25 (2.36)
▪ 30-49 (n = 57)	7.58 (6.52)
▪ 50-69 (n = 237)	8.11 (5.65)
▪ 70-83 (n = 125)	10.6 (11.09)
▪ Missing (n=0)	-
Sex	
▪ Male (n = 321)	8.35 (7.83)
▪ Female (n = 102)	9.95 (7.73)
▪ Missing (n=0)	-
Place of residence	
▪ Rural (n = 86)	8.65 (7.41)

▪ Urban (n = 337)	8.759 (7.94)
▪ Missing (n = 0)	-
Marital status[5]	
▪ Never Married (n = 19)	7.11 (3.30)
▪ Currently Married/Common Law (n = 331)	8.69 (8.29)
▪ Formerly Married (n = 66)	9.075 (6.30)
▪ Missing (n = 7)	12.14 (6.59)
Education level	
▪ Primary School (n = 34)	11.32 (13.59)
▪ Some to complete high school (n = 193)	8.90 (7.25)
▪ Some to complete college, trade or technical school (n = 110)	7.48 (4.07)
▪ Completed university (n = 79)	8.71 (9.57)
▪ Missing (n = 7)	11.71 (6.70)
Number of people in the house[6]	
▪ 1 (n = 55)	8.76 (3.89)
▪ 2-3 (n = 303)	8.815 (8.10)
▪ 4-5 (n = 48)	6.69 (2.69)
▪ 6 or more (n = 6)	7.33 (3.39)
▪ Missing (n = 11)	16.18 (19.98)
Prior operations	
▪ Yes (n = 74)	8.14 (6.13)
▪ No (n = 336)	8.91 (8.28)
▪ Missing (n = 13)	7.77 (2.71)
General Health (SF-12)	
Physical Health Component	
In general, would you say your health is…	
▪ *Excellent*	7.59 (4.64)
▪ *Very good*	8.38 (6.63)
▪ *Good*	8.92 (9.80)
▪ *Fair*	8.84 (4.85)
▪ *Poor*	9.65 (7.06)
▪ *Missing*	8.54 (4.30)
Does your health limit you in moderate activities, such as moving a table or pushing a vacuum cleaner	
▪ *Yes, limited a lot*	9.55 (8.04)
▪ *Yes, limited a little*	8.31 (6.76)
▪ *Not limited at all*	7.99 (9.76)
▪ *Missing*	9.83 (5.59)
Does your health limit your ability to climb several flights of stairs?	
▪ *Yes, limited a lot*	9.90 (9.64)
▪ *Yes, limited a little*	7.96 (5.94)
▪ *Not limited at all*	6.70 (2.95)
▪ *Missing*	6.76 (2.17)
During the past 4 weeks, with regards to work or other daily activities, have you accomplished less than you would like?	
▪ *Yes*	8.86 (7.57)
▪ *No*	8.42 (9.06)

▪ *Missing*	8.42 (5.76)
During the past 4 weeks, were you limited in the kind of work or other activities that you were able perform?	
▪ *Yes*	8.42 (6.12)
▪ *No*	9.15 (10.85)
▪ *Missing*	11.45 (12.87)
During the past 4 weeks, how much did pain interfere with your normal work?	
▪ *Not at all*	8.64 (8.97)
▪ *A little bit*	7.93 (5.21)
▪ *Moderately*	8.89 (6.60)
▪ *Quite a bit*	10.48 (11.02)
▪ *Extremely*	9.33 (5.97)
▪ *Missing*	7.54 (1.80)
Smoking Status	
▪ Daily (n = 41)	7.12 (3.47)
▪ Occasionally (n = 11)	6.82 (1.78)
▪ Never smoked (n = 113)	9.04 (7.83)
▪ Have quit smoking (n = 246)	8.97 (8.59)
▪ Missing (n = 12)	8.5 (4.72)
Exit code	
▪ Alive (n = 413)	8.60 (7.42)
▪ Dead (n = 10)	14.4 (17.72)
▪ Missing (n=0)	
Wait time until surgery	
▪ 0-35 days (1 to 5 weeks) (n = 267)	9.26 (9.15)
▪ 36-1106 days (more than 5 weeks) (n = 155)	7.85 (4.69)
▪ Missing (n = 1)	5.00 (-)
Cardiac Risk Factors	
▪ Age>70	
▪ Yes (n = 125)	10.6 (11.09)
▪ No (n = 298)	7.96 (5.80)
▪ Missing[6] (n = 0)	-
▪ Prior heart attack	
▪ Yes (n = 129)	8.26 (7.92)
▪ No (n = 241)	8.78 (7.15)
▪ Not sure (n = 48)	9.73 (10.77)
▪ Missing (n = 5)	9.6 (2.70)
▪ Heart attack in the last 6 months	
▪ Yes (n = 40)	8.73 (9.62)
▪ No (n = 344)	8.78 (7.62)
▪ Not sure (n = 35)	8.51 (8.12)
▪ Missing (n = 4)	7.00 (4.55)
▪ Angina	
▪ Yes (n = 279)	7.28 (5.47)
▪ No (n = 1344)	5.17 (5.81)

▪ Not sure (n = 142)	7.60 (10.11)
▪ Missing (n = 44)	7.16 (5.08)
▪ Suspected critical Aortic Stenosis	
▪ Yes (n = 215)	8.02 (5.12)
▪ No (n = 138)	9.10 (7.90)
▪ Not sure (n = 56)	10.61 (14.19)
▪ Missing (n = 14)	8.50 (4.88)
▪ Arrhythmia	
▪ Yes (n = 108)	9.07 (5.50)
▪ No (n = 232)	8.57 (8.50)
▪ Not sure (n = 70)	8.73 (9.10)
▪ Missing (n = 13)	8.92 (4.25)
Alcohol Consumption	
Cage>2	
▪ *Yes* (n=23)	7.09 (1.98)
▪ *No* (n=370)	8.80 (7.84)
▪ *Missing* (n=30)	9.23 (10.25)
Number of procedures	
▪ 1-2 (n=418)	6.80 (5.76)
▪ 3 (n=58)	6.39 (1.90)
▪ 4 (n=162)	6.90 (2.52)
▪ 5 (n=198)	10.97 (10.71)
▪ Missing	-
Number of co-morbidities	
▪ 1 (n=10)	5.1 (1.37)
▪ 2 (n=14)	5.35 (1.73)
▪ 3-4 (n=77)	6.44 (1.74)
▪ 5-6 (n=131)	6.74 (2.41)
▪ 7+ (n=191)	11.46 (10.80)
▪ Missing	-
Type of Procedure	
▪ Coronary Artery Bypass Graft (single) (n=77)	8.11 (7.66)
▪ Coronary Artery Bypass Graft (double) (n=128)	7.24 (2.94)
▪ Coronary Artery Bypass Graft (triple or quadruple) (n=39)	9.02 (8.38)
▪ Aortic Valve Replacement or Repair (n=93)	9.39 (6.92)
▪ Mitral Valve Replacement or Repair (n=54)	11.53 (10.27)
▪ Other (n=32)	9.21 (14.85)
Overall LOS total	8.74 (7.83)

LOS = length of stay

1. Zung Self-Rating Depression Scale (SDS): a self-report questionnaire that evaluates the presence of the most frequent symptoms of a depressive disorder.
2. Zung Self-Rating Anxiety Scale (SAS): a self-report questionnaire comprised of 20 questions that measures the presence of the most frequent symptoms of an anxiety disorder.
3. Clinically relevant symptoms are defined by those experiencing mild, moderate or severe symptoms.
4. Depression and anxiety scores were imputed using mean imputation
5. The 'formerly married' category includes: widowed, separated and divorced
6. Household size acts as a proxy for social support in this study.

Backwards selection identified clinically relevant depression, age, sex, area of residence (urban or rural), educational attainment, general health (specifically, those who experienced limitation with regards to physical activity or those who were limited in their ability to accomplish daily), smoking, the experience of a previous heart attack, alcoholism and type of surgery, as predictors of length of stay. All other predictors (including clinically relevant anxiety) were not significant and were thus dropped from the model. Two-way interaction terms were created between all significant variables in the model and the primary exposure variable. Any potential confounding variables that had been excluded from our final model but had a plausible biological relationship with the primary exposure variable were also tested (i.e. living arrangements, physical health items, and the presence of co-morbid illness). Significant effect modifiers ($p>0.05$) were included in the final model (Table 4).

Regression diagnostics (Appendix C) showed the model was an adequate fit for the data. The R-squared value showed that the final model explained approximately 17.17% of the observed variation in length of stay.

Table 4: Summary of the multiple linear regression used to assess the relationship between depression, anxiety and length of stay

Variable	Parameter Estimate	Transformed estimate: Percent Change ($100*(e^B-1)$)	P-value
▪ **Clinically relevant depression**	0.14	15.36	0.021
▪ **Age**	0.011	1.12	<.0001
Sex			
▪ Male	baseline		
▪ Female	0.13		0.074
Education			
▪ Primary School	baseline		
▪ High School	-0.16		0.17
▪ College	-0.26	-22.69	0.035
▪ University	-0.10		0.43
General Health			
Does your health limit your ability to climb several flights of stairs?			
▪ Limited a lot	0.31	36.17	0.0021
▪ Limited a little	0.17		0.090
▪ Not limited at all	baseline		
During the past 4 weeks, with regards to work or other daily activities, have you accomplished less than you would like?			
▪ Yes	-0.12		0.068
▪ No	baseline		
Smoking Status			
▪ Daily/Occasionally	-0.090		0.36
▪ Quit	-0.010		0.88
▪ Never Smoked	baseline		
Cardiac Risk Factors			
▪ Previous heart attack	0.039		0.53
Alcohol use			
Cage over 2	-0.064		0.60
Type of Surgery			
▪ Coronary Artery Bypass Graft (single)	baseline		
▪ Coronary Artery Bypass Graft (double)	-0.073		0.36
▪ Coronary Artery Bypass Graft (triple or quadruple)	0.019		0.86
▪ Aortic Valve Replacement or Repair	0.083		0.34
▪ Mitral Valve Replacement or Repair	0.30	35. 60	0.0059
▪ Other	-0.23		0.069

1. Clinically relevant: defined by the presence of mild, moderate or severe symptoms of depression

The presence of clinically relevant depression increased length of stay by 15.36% compared the stay of mentally healthy patients. Age, educational attainment, physical health, and type of surgery also predicted duration of stay (Table 4). Non-significant variables included in the table are those that induced at least a ten percent change when removed from the final model, and thus were also deemed confounders. No significant effect modifiers were identified. A sensitivity analysis excluding all individuals who passed away or had been transferred produced very similar results (ie. clinically depressed group experienced a 15.60% increase in length of stay). Another sensitivity analysis was performed among those with a diagnosis of depression or anxiety on their hospital discharge record. This also conveyed similar results (percent change of 16.62%).

Discussion

Summary of Results

This study was conducted to determine the effect of pre-operative depression and anxiety on length of stay in a sample of elective cardiac surgical patients. Using multiple linear regression (with a log transformation to correct for skewness in length of stay), we found that clinically relevant depression increased length of stay by approximately 15% when compared with mentally health patients. Age, physical health, and type of surgery also predicted an increase in stay, while educational attainment predicted a reduced duration of stay.

These results must be regarded in the context of the following biases that had the potential to affect our findings:

Selection bias

Volunteer bias may have affected the data as patients who consented to our study may have been inherently different than those who refused. For instance, a previous investigation determined that volunteers tended to be more highly educated, less likely to smoke, and more interested in health issues than those who do not volunteer[87]. Since these characteristics are related to depression, anxiety as well as length of stay, this selection bias has the potential to affect our findings. However these variables are differentially and well distributed in our dataset. Furthermore, the prevalence of daily smoking reported in our sample (17.96 %) is comparable to that of Alberta's general population in 2004 (20.0%); as is the level of educational attainment (most notably the proportion that completed college and university)[92,96].

Although this study was prospective in nature and was therefore subject to loss to follow-up bias, we used a hospital administrative database to collect outcome information which minimized the chance of this bias affecting our results.

Information bias

The low specificity of the Zung Self Rating Depression scale (63%) may have lead to systematic exposure misclassification as this measure may incorrectly identify healthy individuals as having clinically relevant symptoms. However, since these scales have been widely validated in medical populations and since psychiatric illness is often under-reported, we remain confident in our estimates[62].

Social desirability bias may have led to lower estimates of psychiatric symptoms, since the debilitating stigma attached to psychiatric illnesses may have decrease the likelihood of truthful reporting[22].

Confounding

This study adjusted for a wider array of confounders that have often been overlooked in previous research. However, we were missing information regarding co-morbid psychiatric

illnesses and socioeconomic status. While socioeconomic status may have been partially accounted for by educational attainment, the neglect of these potential confounders may have distorted the true relationship between these depression and length of stay. It was also difficult for us to tell whether patients were receiving treatment for a diagnosed depression or anxiety disorder at the time of their surgery, since this information was not present in the database or included on the questionnaire. This would have biased our results toward the null and, in the case of anxiety, may have accounted for our null finding. By virtue of sharing many 'cardiac-like' symptoms, anxiety disorders may have been more likely to be diagnosed and treated than depression as physicians would want to rule this out as a possible explanation for symptoms.

However, our findings are similar to studies focusing on general medical inpatients which have indicated an approximate two-fold increase in stay among those with depression[32,43]. Previous research has demonstrated mixed findings among those with co-morbid anxiety disorders[61]. However, the few studies specific to cardiac patients have reported inconsistent results concerning depression and insignificant findings among those with anxiety disorders[20]. Mixed findings may be a result of variations in sample sizes and characteristics, types of diagnostic measurements being used, potential confounders being assessed, and types of outcomes under investigation.

A variety of factors relating to psychiatric illness may explain the overall increase in duration of stay among individuals with symptoms of depression. Patients with depression experience a greater number of post-surgical complications, which inevitably prolongs their stay[50]. These complications could be driven by differences in symptom reporting. Comorbid psychiatric symptoms may increase the subjective feeling of physical distress, which may increase the perceived severity of the complications[41]. As well, since depression commonly share symptoms with physical diseases, the presence of a mental illness may hinder or confuse the

correct treatment. This may result in increased testing and a subsequent increased length of stay. Another explanation put forth in the literature pertains to the differences in perspective held by individuals with and without depression or anxiety. Mentally healthy individuals may be more optimistic and thus may encounter less stress related problems and may be better able to focus on their recovery[2]. Alternatively, individuals suffering from psychiatric illnesses may be more likely to have a more accurate and pessimistic view of their illness which may subsequently reduce their medical and psychiatric treatment compliance[80]. Another possible explanation of this relationship pertains to the consequences of psychiatric comorbidity, such as physiological effects, poor lifestyle behaviours, poor adherence to treatment, and inadequate self care regiments. These may delay worsen general health, increase severity of disease, and ultimately prolong length of stay[28,80]. Lastly, depression impedes the immune system, which may delay post-surgical wound healing and recovery[46].

Due to the older age of our sample, there may be concern that delays of discharge occurring for patients awaiting the availability of a nursing home bed may have affected the relationship in this study[76]. However, the highest number of transfers occurred among those aged 70-99, which may be attributable to transfers for those awaiting nursing home beds.

As consistently demonstrated in the literature, poor general health, age, and type of surgery predicted an increase in stay. Mitral valve surgery is among the most severe operations in our study, and therefore it is not surprising that this operation predicts a prolonged length of stay. Educational status predicted a reduction in stay, possibly because it acts as a proxy for socio-economic status (which has previously been associated with length of stay). As well those with a higher education are more likely to engage in healthier lifestyles[68].

Strengths and Limitations:

Few of the previous investigations have considered the timing of psychiatric symptoms in relation to surgery. Therefore, the pre-operative assessment of our sample and the prospective nature of this study are important for establishing the temporality. We can be sure that the psychiatric depression and anxiety pre-dated the surgical intervention. In addition, outcome data were obtained from a comprehensive administrative database which minimizes the loss of patients to follow-up. Another strength of this study is its inclusion of mild cases, since the addition of such cases increases the correct classification of psychiatric illness by 33%[2]. Furthermore, the effects of subclinical depression and anxiety are not often included such research, despite their widespread prevalence and association with adverse surgical outcomes[9,13].

Although time and space constraints prevented use of the gold standard exposure measurement (clinical diagnostic interviews), the measures employed in our study have been widely validated. Furthermore, these self-report questionnaires provided us with information pertaining to sub-threshold symptoms, allowing us to assess a wider range of symptoms of psychiatric depression and anxiety. This would not have been possible with a clinical diagnostic interview. The brevity of these measures also allowed us to attain a large sample size. We also collected standardized data for a variety of important potential confounders and effect modifiers that were often overlooked in previous research.

With respect to limitations, a number of respondents did not provide complete data for our exposure measures. For example, 18% of the surveys provide incomplete depression data and 10% provided incomplete anxiety data. Previous research conducted on this study population examined several imputation approaches to deal with the missing data and this allowed us to explore the impact of the missing data on the precision of our analyses assuming the data were missing at random—an assumption that is difficult to test[81].

While the conclusions of this study are generalizable to a wide geographical range of individuals within Canada (as this was the only cardiac surgical centre in the health region), they may not be generalizable to those undergoing non-elective cardiac surgery.

We were unable to calculate the participation rate in our study due to lack of information concerning the refusal rate. However, patients with severe psychiatric disorders may have been more likely to have refused due to the stigma attached to psychiatric illnesses. If this is so, then we would have underestimated the prevalence of depression and anxiety in our sample.

Our inclusion of mild anxiety may have included state anxiety (since mild symptoms are often indicative of a transient psychiatric state, rather than trait anxiety alone (defined as individuals who to react with greater anxiety than what would seem appropriate)[42]. Differing effects among the two states may have biased our findings towards the null and subsequently resulted in a non-significant finding.

Two potential confounders, co-morbid psychiatric disorders and socioeconomic status, were not addressed in this study[24]. Missing confounders could potentially distort the true effect observed between depression, anxiety and length of hospital stay. However, because our study takes many other confounders into account, it is possible that some of the missing confounders may be partially accounted for by correlations with other variables. For instance, education level was assessed, which minimizes any effects associated with not adjusting for socioeconomic status. Undertaking a full diagnostic work up would not have been feasible due to the time constraints of this investigation and lengthier questionnaires would likely have decreased participation rates. Despite missing these two covariates, this investigation covers a wide range of confounders that have not been previously assessed in similar investigations.

The reliability of PACS database and discharge hospital records is unclear as they may have contained coding errors, misdiagnoses, or missing information. However, these data were used to support hospital funding and monitor expenses, so extensive resources were used to ensure

We were unable to control for post-operative depression which may have affected our findings since depressive symptoms developed following surgery are associated with poorer post-surgical outcomes[35]. This would bias our results to the null. However, many cases of post-surgical depression develop from pre-operative illness, so it is likely that only few individuals developed depression who were not already accounted for[10].

Clinical Importance

The results of this study highlight the need for further research concerning the effects of anxiety and depression on length of stay and the importance of these psychiatric conditions in cardiac patients. Addressing depression in cardiac patients would not only improve patients' quality of life and risk of mortality, but could improve hospital efficiency and resource use. Because these conditions are generally under-diagnosed, brief self-report questionnaires, such as the Zung Self-Rating Depression and Anxiety Scales, could be used to identify clinically relevant symptoms among incoming cardiac patients. In fact, a number of clinical guidelines, released by the American College of Cardiology and the American Heart Association, suggest that cardiac patients be screened for depression[85]. This would be especially useful for elective cardiac surgical patients, since they generally experience substantial wait times prior to surgery. These waiting periods provide plenty of time for psychological interventions and collaborative care to improve quality of life and overall health, which would ultimately reduce the risk of complications and facilitate a fast post-operative recovery[32,71].

There have been few studies assessing the treatment of depression on cardiac outcomes. The two largest trials concerning depression, the Enhancing Recovery in Coronary Heart Disease Patients (ENRICHD) trial and the Sertraline Antidepressant Heart Attack Randomized Trial (SADHART), both found a small decrease in depressive states, and thus, no change in cardiac outcomes[6]. One study however, that assessed the impact of including a psychosocial intervention to cardiovascular rehabilitation, found that such interventions reduced cardiac mortality by a further 41%, morbidity by 46% and generally improved quality of life. Furthermore, patients who received the intervention fared better with regards to intermediate biological risk factors (such as heart rate and cholesterol level)[53]. The treatment of anxiety disorders also results in cardiovascular benefits as selective serotonin reuptake inhibitors, used to treat depression and anxiety have demonstrated a cardio-protective effect[21].

Since pre-operative depressive symptoms strongly predict ongoing post-operative psychiatric illness and morbidity, screening and treating depression in cardiac patients improve recovery[89]. In fact, pre- and post-operative depression has been found to increase morbidity six months and five years following coronary artery bypass graft surgery, while post-operative depression has been found to increase mortality one month following cardiac surgery and to hinder prevention efforts following a myocardial infarction[10, 12, 93]. Depressive states are highly prevalent in cardiac patients, so treatment in this population would benefit a substantial number of individuals[73].

An added benefit to such treatment would be an improvement in the quality of life for cardiac patients affected by psychiatric illness. Depression may become chronic and debilitating, if not adequately treated, and negatively impact quality of life, functional abilities, and adherence to healthy lifestyles[70,71,92]. For instance, The Global Burden of Disease study, conducted by the World Health Organization in 2002 demonstrated that depression contributed to 4.5% of global DALYs, thereby ranking it as the fourth largest cause of lost DALYs that year. This elevated

burden is attributed to the high prevalence, immense decline of functioning, and early onset of depression. The stigma attached to psychiatric illnesses serves to exacerbate this burden. This same study projected that depression will be the most debilitating illness, worldwide, by the year 2020[56]. Furthermore, depression is a stronger indicator of quality of life, symptom severity, and physical limitation than many physical risk factors of heart disease (such as left ventricular function). Despite that, physical risk factors are routinely assessed whereas depression is not[94]. The treatment and identification of patients with these co-morbid conditions would enable targeted interventions towards this high risk group.

One of the primary factors driving wait lists for cardiac surgery in Canada is a restricted supply of ICU resources. Weeks or months may pass before patients undergo their required surgery. Individuals with longer stays tend to "block" beds and use a great amount of resources, inevitably leading to the cancellation or postponement of surgeries for others on the waitlist[60]. Predicting LOS may increase the efficiency of resource use by altering the method of scheduling. Individuals at risk of a longer LOS can be scheduled towards the end of the week to maximize the use of hospital beds during the weekend, when the operating rooms are not in use. Alternatively, patients with a minimal risk of a long LOS may be scheduled prior to those at increased risk[88]. These solutions may only be implemented among individuals with equivalent need of surgery[61,88].

In conclusion, this study demonstrates the impact of depression and anxiety on length of post-operative stay in cardiac patients and the potential benefit of screening and psychiatric interventions in this population. Further large-scale studies are required to demonstrate consistency and confidence in this finding. Future research should ensure the inclusion of psychiatric co-morbidities (to assess its potential confounding effects), as well as the consideration of readmissions to identify individuals who may have been discharged too early.

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Chapter 6: Conclusions

6.1 Summary of Key Findings

This chapter provides a brief overview and discussion of the strengths and limitations of this thesis. More detailed discussion can be found in the manuscripts contained in Chapters 4 and 5. This thesis described the prevalence of clinically relevant anxiety and depression in a series of patients undergoing elective cardiac surgery, identified socio-demographic and clinical predictors of depression and anxiety, and assessed the impact of pre-operative depression and/or anxiety on length of hospital stay.

Manuscript 1 described the prevalence as well as the socio-demographic and clinical predictors of depression and/or anxiety within our sample. Summed Zung Self-Rating Depression Scale (SDS) scores revealed that 10.66% (7.75 – 13.57) were met the criteria for a clinical illness. Similarly, the totalled Zung Self-Rating Anxiety Scale (SAS) scores indicated that 3.43% (1.71 – 5.13) had clinically relevant illness. Co-morbid clinical illness was present in 2.05% (0.71 – 3.39) of patients. Predictors of clinically relevant depression included sex, general health, the experience of a recent myocardial infarction, and the presence of co-morbid illness. Sex, general health, the experience of a recent myocardial infarction and the type of surgery acted as predictors for clinically relevant anxiety in this population.

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The self-report nature of the Zung questionnaires resulted in considerable missing exposure data. Specifically, 76 (17.97%) Zung SDS questionnaires and 43 (10.17%) Zung SAS questionnaires were incomplete (Appendix B, Tables 2 and 3). Non-response was most common for the following SDS items: '*I have crying spells or I feel like it'* (missing 4.02% (n=17)), 'I e*njoy looking at, talking to, and being with attractive women/men'* (missing 5.91% (n= 25)), and *'My heart beats faster than usual'* (missing 3.78% (n=16)). The SAS most frequently lacked

information concerning the following items: '*I have fainting spells or feel like it'* (missing 3.16% (n= 61)), 'I *can breathe in and out easily'* (missing 3.31% (n= 14)), and *'I feel calm and can sit still easily'* (missing 3.07% (n = 13)). The use of mean imputation to replace missing Zung values slightly altered our prevalence estimates, however these estimates were not used since imputation makes the assumption that values were missing at random. Using these estimates may have led to uncertain results due to potential for non-response bias in this population, caused by the stigma attached to psychiatric illness[5]. We also calculated prevalence with the effects of somatic items (which may be indicative of cardiac illness) removed from the Zung questionnaires and, as expected, found that our estimates decreased. Administering the Zung scales in an interview format may reduce missing values in further research.

Despite these limitations, our findings were consistent with previous literature. Females, patients who had experienced a recent myocardial, those with poor self-rated general health, and those with major self-rated physical limitations had greater odds of experiencing clinically relevant depression. Conversely, having two co-morbid illnesses acted as a protective factor against depression.

Predictors of clinical anxiety were also in agreement with previous research. Females, patients who had experienced a myocardial infarction in the previous six months, those with self-rated poor general health, patients with self-rated physical limitations and those who underwent certain types of operations (ie. insertion of an artificial pacemaker and an atrial septal defect repair) had increased odds of experiencing clinically relevant anxiety

In Manuscript 2 we analyzed the effect of pre-operative depressive and anxious symptoms on length of hospital stay. The presence of clinically relevant depression, but not anxiety, increased length of stay b y 15.4%. Age, educational attainment, general health, and type

of surgery also predicted duration of stay. The increase in length of stay among those reporting depression may have occurred because of increased symptom reporting, a pessimistic view that reduces medical and psychiatric treatment compliance, adverse lifestyle factors that may increase risk of post-surgical complications, and an impaired immune system that hinders recovery.

6.2 Strengths and Limitations of Thesis

Few previous investigations have considered the timing of psychiatric illness in relation to surgery. Therefore, the pre-operative assessment of our sample and the prospective nature of this study are important for establishing the temporality of the relations under study. We minimized losses to follow-up because all outcome data was obtained from a comprehensive administrative database which minimizes the loss of patients to follow-up.

We also included individuals who met the criteria for mild disorders, since the addition of such cases increases the correct classification of psychiatric illness by 33%[1]. Furthermore, the effects of mild depression and anxiety are not often included such research, despite their widespread prevalence and association with adverse surgical outcomes[8,10].

Although time and space constraints prevented use of the gold standard exposure measurement (clinical diagnostic interviews), the measures employed in our study have been widely validated. Furthermore, these self-report questionnaires provided us with information pertaining to sub-threshold symptoms, which could not have been attained by clinical diagnostic interviews. The brevity of these measures also allowed us to attain a large sample size.

Finally, we have contributed to the limited Canadian research concerning the prevalence and length of stay of cardiac surgery patients with co-morbid depression and anxiety, and we

collected standardized data for a variety of important potential confounders and effect modifiers that were often overlooked in previous research.

A major limitation for this analysis was that a number of respondents did not provide complete data for our exposure measures. Mean imputation was used to assess the impact of this missing data on our results[17]. However, this assumes items were missing at random—an assumption that is difficult to test. If patients who were more depressed and anxious were more likely to miss items on the survey (perhaps owing to poor concentration or cognition), then our results would be biased toward the null. This may explain why our prevalence estimates are lower than many reported in the literature.

Volunteer bias also may have affected the data as patients who consented to our study may have been inherently different than those who refused. For instance, a previous investigation determined that volunteers tended to be more highly educated, less likely to smoke, and more interested in health issues than those who do not volunteer[18]. Since these characteristics are related to depression and/or anxiety as well as length of stay, this selection bias also has the potential to bias our results toward the null.

The inclusion of somatic symptoms on the Zung Depression and Anxiety Scales may have led to exposure misclassification. As the inclusion of somatic symptoms would have biased our findings towards the null, we can remain confident that the relationship between depression and length of stay is meaningful. Given that many cardiac-like symptoms may mimic anxiety, and so may have been more likely to be diagnosed and treated, this bias may explain our null finding with respect to the relationship between anxiety and length of stay.

While the conclusions of this study are generalizable to a wide geographical range of individuals (as this was the only cardiac surgical centre in the health region), they are not generalizable to those undergoing non-elective cardiac surgery.

Two potential confounders, co-morbid psychiatric disorders and socioeconomic status, were not addressed in this study[7]. Missing confounders could potentially distort the true effect observed between depression and/or anxiety and length of hospital stay. However, our study took a wide array of confounders into account (more than in past research). It is also possible that some of the missing confounders may be partially accounted for by other variables. For instance, education level was assessed, which minimizes any effects associated with not adjusting for socioeconomic status. Undertaking a full diagnostic work up would not have been feasible due to the time constraints of this investigation and lengthier questionnaires would likely have decreased participation rates. Despite missing these two covariates, this investigation covers a wide range of confounders that have not been previously assessed in similar investigations.

The reliability of PACS database and discharge hospital records is unclear as they may have contained coding errors, misdiagnoses, or missing information. However, these data were used to support hospital funding and monitor expenses, so extensive resources were used to ensure their ongoing accuracy.

Unfortunately we were unable to control for post-operative depression, anxiety or treatment. Occurrence of post-operative symptoms could have affected our length of stay as these, rather than the pre-operative symptoms, could have been associated with poorer post-surgical outcomes[9]. This would bias our results toward the null. However, because post-surgical psychiatric illness may be predicted from a pre-surgical psychiatric disorder, it is likely that few individuals developed such illness who were not already identified[3]. Furthermore, our inability

to account for patients who have been treated for depression and/or anxiety may also have biased our results toward the null.

Clinic staff did not track the total number of individuals attending the Foothills Pre-operative Assessment Clinic who declined to participate in this study. It is possible that selection bias may have arisen since patients with severe psychiatric disorders may have been more likely to have refused due to the stigma attached to psychiatric illnesses. If this were true, then our prevalence estimates would have been biased toward the null.

6.5 Public Health and Policy Implications

These manuscripts highlight the magnitude and impact of depression and anxiety in elective cardiac surgical patients. Although our prevalence estimates were lower than previous studies, they still exceed those of community samples and represent significant concern. Because depression predicted length of stay and because these psychiatric conditions are often under-diagnosed and under-treated, these findings should be of interest to clinicians and administrators alike. Understanding the distribution and determinants of psychiatric illness in this population could allow for targeted screening and intervention catered towards those most in need. Such screening and treatment of co-morbid depression and/or anxiety in elective cardiac patients would not only improve their quality of life, but it would substantially improve the overall treatment of cardiac illness and, in the case of depression, speed recovery.

The treatment of pre-operative depression in this population would not only reduce length of stay but would also improve overall health and would likely reduce health care utilization, since pre-operative symptoms strongly predict ongoing post-operative psychiatric illness and morbidity[19]. In fact, pre- and post-operative depression has been found to increase morbidity six

months and five years following coronary artery bypass graft surgery, while post-operative depression has been found to increase mortality one month following cardiac surgery and to hinder prevention efforts following a myocardial infarction[2,3,4,20]. As an added benefit, treatment of depression in this population could greatly enhance quality of life since this disorder may be chronic and debilitating (if not adequately treated), and negatively impact quality of life, functional abilities, and adherence to healthy lifestyles[12,19]. In fact, the Global Burden of Disease study, conducted by the World Health Organization in 2002 demonstrated that depression contributed to 4.5% of global DALYs, thereby ranking it as the fourth largest cause of lost DALYs that year. The stigma attached to psychiatric illnesses serves to exacerbate this burden. This same study projected that depression will be the most debilitating illness, worldwide, by the year 2020[11]. Furthermore, depression is a stronger indicator of quality of life, symptom severity, and physical limitation than many physical risk factors of heart disease (such as left ventricular function). Despite that, physical risk factors are routinely assessed whereas depression is not[21].

Future investigations are required to assist in clarifying the prevalence of anxiety and depression among cardiac patients, and to further assess the relationship between these psychiatric disorders and cardiac illness. A greater number of large scale studies using clinical diagnostic interviews would be instrumental in narrowing the wide range of prevalence estimates of depression and anxiety seen in this population. Assessments of the effectiveness of targeted screening and treatment, in terms of cost-saving and quality of life, would also be beneficial. Further large-scale studies are also required to demonstrate consistency and confidence in our findings regarding length of stay among cardiac patients with depression. Future research should ensure the inclusion of psychiatric co-morbidities (to assess its potential confounding effects), as well as the consideration of readmissions to identify individuals who may have been discharged too early.

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Appendix A
Literature Review References

Table 1: Literature Review References - Prevalence:

Prevalence	Reference Number
Studies documenting the prevalence of depression in cardiac patients (17)	1, 4, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 23, 24, 25, 28
Studies documenting the prevalence of people with either anxiety or depression (6)	5, 16, 17, 21, 26, 31
Of those above, prevalence studies that were performed in Canada (4)	9, 10, 11, 18

Table 2: Literature Review References - Length of Stay

Length of Stay	Reference Number
Studies documenting an association between LOS and depression in cardiac patients (6)	2, 3, 6, 7, 22, 27
Studies documenting an association between LOS and anxiety in cardiac patients (2)	22, 29
Of those above, the studies conducted in Canada (0)	

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Appendix B
Additional Tables

Table 1: Descriptive Table of Types of Cardiac Surgeries

Procedure	% (n)
Coronary Artery Bypass Graft (single) (1)	18.20 (77)
Coronary Artery Bypass Graft (double) (2)	30.26 128()
Coronary Artery Bypass Graft (triple or quadruple) (3)	9.22 (39)
Aortic Valve Replacement or Repair (4)	21.99 (93)
Mitral Valve Replacement or Repair (5)	12.77 (54)
Other (6)	7.57 (32)

Table 2: Percentage of complete data obtained from Zung's Self-Rating Depression Scale

Item	Zung Self-Rating Depression Scale Responses				
	None or a little of the time *Completed % (n)*	**Some of the time** *Completed % (n)*	**Good part of the time** *Completed % (n)*	**Most or all of the time** *Completed % (n)*	**Missing** *Completed % (n)*
1. I feel downhearted, blue, and sad	53.19 (225)	39.01 (165)	4.49 (19)	1.42 (6)	1.89 (8)
2. Morning is when I feel best	13.71 (58)	18.20 (77)	22.22 (94)	42.79 (181)	3.07 (13)
3. I have crying spells or I feel like it	75.65 (320)	16.31 (69)	3.55 (15)	0.47 (2)	4.02 (17)
4. I have trouble sleeping through the night	32.86 (139)	31.21 (132)	14.42 (61)	19.15 (81)	2.36 (10)
5. I eat as much as I used to	21.51 (91)	23.40 (99)	18.20 (77)	34.99 (148)	1.89 (8)
6. I enjoy looking at, talking to, and being with attractive women/men	7.80 (33)	21.51 (91)	21.28 (90)	43.50 (184)	5.91 (25)
7. I notice that I am losing weight	72.34 (306)	15.84 (67)	4.73 (20)	3.78 (16)	3.31 (14)
8. I have trouble with constipation	71.87 (304)	16.55 (70)	4.96 (21)	4.49 (19)	2.13 (9)
9. My heart beats faster than usual	55.56 (235)	33.10 (140)	4.73 (20)	2.84 (12)	3.78 (16)
10. I get tired for no reason	20.09 (85)	38.53 (163)	19.62 (83)	18.44 (78)	3.31 (14)
11. My mind is as clear as it used to be	7.80 (33)	17.97 (76)	23.40 (99)	47.75 (202)	3.07 (13)
12. I find it easy to do the things I used to do	31.44 (133)	37.83 (160)	19.62 (83)	8.51 (36)	2.60 (11)
13. I am restless and can't keep still	41.61 (176)	40.90 (173)	9.69 (41)	5.91 (25)	1.89 (8)
14. I feel hopeful about the future	5.20 (22)	8.98 (38)	28.37 (120)	55.32 (234)	2.13 (9)
15. I am more irritable than usual	35.22 (148)	43.26 (183)	12.29 (52)	5.91 (25)	3.31 (14)
16. I find it easy to make decision	7.33 (31)	21.99 (93)	28.61 (121)	39.72 (168)	2.36 (10)
17. I feel that I am useful and needed	5.91 (25)	15.60 (66)	20.80 (88)	55.32 (234)	2.36 (10)
18. My life is pretty full	5.20 (22)	14.42 (61)	27.90 (118)	50.35 (213)	2.13 (9)
19. I feel that others would be better off if I were dead	84.40 (357)	11.35 (48)	0.95 (4)	0.71 (3)	2.60 (11)
20. I still enjoy the things I used to do	7.57 (32)	19.39 (82)	23.17 (98)	47.99 (203)	1.89 (8)
Total	82.03 (347)				

Table 3: Percentage of complete data obtained from Zung's Self-Rating Anxiety Scale

Item	Zung Self-Rating Anxiety Scale Responses				
	None or a little of the time *Completed % (n)*	**Some of the time** *Completed % (n)*	**Good part of the time** *Completed % (n)*	**Most or all of the time** *Completed % (n)*	**Missing** *Completed % (n)*
1. I feel more nervous and anxious than usual	29.08 (123)	48.46 (205)	13.95 (59)	7.09 (30)	1.42 (6)
2. I feel afraid for no reason at all	70.21 (297)	21.75 (92)	4.26 (18)	1.42 (6)	2.36 (10)
3. I get upset easily or feel panicky	52.25 (221)	34.52 (146)	8.75 (37)	2.60 (11)	1.89 (8)
4. I feel like I'm falling apart and going to pieces	74.94 (317)	16.78 (71)	3.07 (13)	2.60 (11)	2.60 (11)
5. I feel that everything is all right and nothing bad will happen	12.29 (52)	21.28 (90)	27.19 (115)	36.64 (115)	2.60 (11)
6. My arms and legs shake and tremble	85.34 (361)	11.35 (48)	0.71 (3)	0.47 (2)	2.13 (9)
7. I am bothered by headaches, neck and back pain	58.87 (249)	27.42 (116)	6.62 (28)	5.44 (23)	1.65 (7)
8. I feel weak and get tired easily	17.97 (76)	43.50 (184)	20.33 (86)	16.78 (71)	1.42 (6)
9. I feel calm and can sit still easily	13.24 (56)	26.71 (113)	23.40 (99)	33.57 (142)	3.07 (13)
10. I can feel my heart beating fast	53.43 (226)	34.75 (147)	7.09 (30)	2.60 (11)	2.13 (9)
11. I am bothered by dizzy spells	68.09 (288)	23.40 (99)	3.55 (15)	2.60 (11)	2.36 (10)
12. I have fainting spells or feel like it	84.40 (357)	10.40 (44)	0.95 (4)	0.95 (4)	3.31 (14)
13. I can breathe in and out easily	12.06 (51)	10.64 (45)	17.02 (72)	57.68 (244)	2.60 (11)
14. I get feelings of numbness and tingling in my fingers and toes	53.90 (228)	33.33 (141)	7.09 (30)	3.78 (16)	1.89 (8)
15. I am bothered by stomach aches or indigestion	63.36 (268)	25.06 (106)	5.91 (25)	3.55 (15)	2.13 (9)
16. I have to empty my bladder often	30.02 (127)	39.01 (165)	16.08 (68)	13.00 (55)	1.89 (8)
17. My hands are usually dry and warm	20.33 (86)	16.08 (68)	19.62 (83)	41.84 (177)	2.13 (9)
18. My face gets hot and blushes	70.21 (297)	21.28 (90)	4.49 (19)	1.89 (8)	2.13 (9)
19. I fall asleep easily and get a good night's rest	22.46 (95)	26.95 (114)	19.86 (84)	28.61 (121)	2.13 (9)
20. I have nightmares	73.76 (312)	21.04 (89)	1.65 (7)	1.42 (6)	2.13 (9)
Total	89.83 (380)				

Table 4: Full responses to CAGE Questionnaires, by sex

	Females n= 102	**Males n= 321**	**Total n= 423**
	Valid % (n)	**Valid % (n)**	**Valid % (n)**
Alcohol Consumption			
Cage Question 1: Have you ever felt you should cut down on your drinking?			
▪ *Yes*	1.09 (3)	13.86 (42)	11.25 (45)
▪ *No*	96.90 (94)	86.14 (261)	88.75 (355)
▪ *Missing (n)*	(5)	(18)	(23)
Cage Question 2: Have people annoyed you by criticising your drinking?			
▪ *Yes*	4.26 (4)	4.35 (13)	4.33 (17)
▪ *No*	95.74 (90)	95.65 (286)	95.68 (376)
▪ *Missing (n)*	(8)	(22)	(30)
Cage Question 3: Have you ever felt bad or guilty about your drinking?			
▪ *Yes*	1.06 (1)	6.33 (19)	5.08 (20)
▪ *No*	98.93 (94)	93.67 (281)	94.92 (374)
▪ *Missing (n)*	(8)	(21)	(29)
Cage Question 4: Have you ever had a drink first thing in the morning to steady your nerves or get rid of a hangover (eye-opener)?			
▪ *Yes*	1.05 (1)	1.99 (6)	1.77 (7)
▪ *No*	98.95 (94)	98.02 (295)	98.23 (389)
▪ *Missing (n)*	(7)	(20)	(27)

Table 5: Prevalence of mild depression and anxiety disorders, by CAGE questionnaire responses

Variable (n)	Mild depression[1]		Mild anxiety[1]		Co-morbid mild depression and anxiety	
	Non-imputed[2] n= 76 Valid% (95% C.I)	Mean imputed n = 94 Valid% (95% C.I)	Non-imputed[2] n=125 Valid% (95% C.I)	Mean imputed n=136 Valid% (95% C.I)	Non-imputed[2] n=42 Valid% (95% C.I)	Mean imputed n = 54 Valid% (95% C.I)
Alcohol Consumption						
Cage Question 1: Have you ever felt you should cut down on your drinking?						
▪ *Yes*	22.22 (18.30 – 26.14)	20.93 (17.09 – 24.77)	24.32 (20.27 – 28.37)	25.58 (28.20 – 37.04)	10.26 (7.40 – 13.12)	11.63 (8.61 – 14.65)
▪ *No*	20.88 (17.05 – 24.71)	22.48 (18.54 – 26.42)	32.62 (28.20 – 37.04)	33.43 (28.99 – 37.88)	10.56 (7.66 – 13.46)	13.54 (10.31 – 16.77)
	Missing (n) = 90	Missing (n) = 33	Missing (n) = 58	Missing (n) = 33	Missing (n) = 62	Missing (n) = 33
Cage Question 2: Have people annoyed you by criticising your drinking?						
▪ *Yes*	13.33 (10.13 – 16.54)	20.00 (16.23 – 23.77)	26.67 (22.50 – 30.84)	13.33 (10.13 – 16.54)	6.25 (3.97 – 8.53)	6.67 (4.32 – 9.02)
▪ *No*	21.79 (17.90 – 25.68)	22.49 (18.55 – 26.43)	32.27 (27.86 – 36.68)	33.60 (29.15 – 38.05)	10.91 (7.97 –13.85)	13.82 (10.57 – 17.07)
▪ *Missing*	Missing (n) = 96	Missing (n) = 39	Missing (n) = 64	Missing (n) = 39	Missing (n) = 68	Missing (n) = 39
Cage Question 3: Have you ever felt bad or guilty about your drinking?						
▪ *Yes*	18.75 (15.07 – 22.43)	26.32 (22.17 – 30.47)	29.41 (25.11 – 33.71)	31.58 (27.20 – 35.96)	11.76 (8.72 – 14.98)	15.79 (12.35 – 19.23)
▪ *No*	21.41 (17.54 – 25.28)	22.40 (18.47 – 26.33)	32.36 (27.95 – 36.77)	32.79 (28.36 – 37.22)	10.59 (7.69 – 13.49)	13.39 (10.18 – 16.60)
▪ *Missing*	Missing (n) = 94	Missing (n) = 38	Missing (n) = 63	Missing (n) = 38	Missing (n) = 66	Missing (n) = 38
Cage Question 4: Have you ever had a drink first thing in the morning to steady your nerves or get						

rid of a hangover (eye-opener)?						
▪ *Yes*	28.57 (24.31 – 32.83)	33.33 (28.89 – 37.78)	66.67 (62.23 – 71.12)	16.67 (13.16 – 20.19)	28.57 (24.31 – 32.83)	16.67 (13.16 – 20.19)
▪ *No*	21.12 (17.27 – 24.97)	22.31 (18.38 – 26.24)	31.64 (27.25 – 36.03)	32.81 (28.38 – 37.24)	10.29 (7.42 – 13.16)	13.39 (10.18 – 16.60)
	Missing (n) = 94	Missing (n) = 36	Missing (n) = 63	Missing (n) = 36	Missing (n) = 66	Missing (n) = 36

1. Mild depression was defined by a Zung SDS score ranging between 50 and 59.9; mild anxiety was defined by a Zung SAS score ranging between 45 and 59.9; co-morbid depression and anxiety was defined by a Zung SDS score between 50 and 59.9 and a Zung SAS score between 45 and 59.9.
2. Missing values for depression questionnaire = 76; missing values for anxiety questionnaire = 43; missing values for co-morbid illness = 47

Table 4: Prevalence of clinical depression and anxiety disorders, by CAGE questionnaire responses

Variable (n)	**Clinical depression[1] Valid % (95% CI)**		**Clinical anxiety[1] Valid % (95% CI)**		**Co-morbid clinical depression and anxiety Valid % (95% CI)**	
	Non-imputed[2] n =37 Valid% (95% C.I)	**Mean imputed n=46 Valid% (95% C.I)**	**Non-imputed[2] n = 13 Valid% (95% C.I)**	**Mean imputed n=19 Valid% (95% C.I)**	**Non-imputed[2] n = 8 Valid% (95% C.I)**	**Mean imputed n=13 Valid% (95% C.I)**
Alcohol Consumption						
Cage Question 1: Have you ever felt you should cut down on your drinking?						
▪ *Yes*	11.11 (8.15 – 14.07)	11.63 (8.61 – 14.65)	2.70 (11.72 – 4.23)	4.65 (2.66 – 6.64)	2.63 (1.12 – 4.14)	4.65 (2.66 – 6.64)
▪ *No*	10.77 (7.85 – 13.69)	10.37 (7.50 – 13.25)	3.66 (1.89 – 5.43)	4.61 (2.63 – 6.59)	2.08 (0.73 – 3.43)	3.75 (1.96 – 5.54)
▪ *Missing*	Missing (n) = 90	Missing (n) = 33	Missing (n) = 58	Missing (n) = 33	Missing (n) = 49	Missing (n) = 33
Cage Question 2: Have people annoyed you by criticising your drinking?						

▪ *Yes*	13.33 (10.13 – 16.54)	6.67 (4.32 – 9.02)	6.67 (4.32 – 9.02)	6.67 (4.32 – 9.02)	6.25 (3.97 – 8.53)	6.67 (4.32 – 9.02)
▪ *No*	10.90 (7.96 – 13.84)	10.84 (7.91 – 13.77)	3.49 (1.76 – 5.22)	4.61 (2.63 – 6.59)	1.99 (0.67 – 3.31)	3.79 (1.99 – 5.59)
▪ *Missing*	Missing (n) = 96	Missing (n) = 39	Missing (n) = 64	Missing (n) = 39	Missing (n) = 55	Missing (n) = 39
Cage Question 3: Have you ever felt bad or guilty about your drinking?						
▪ *Yes*	6.25 (3.97 – 8.53)	10.53 (7.64 – 13.42)	0.0 (0)	5.26 (3.15 – 7.37)	0.00 (0)	5.26 (3.15 – 7.37)
▪ *No*	11.18 (8.21 – 14.15)	10.66 (7.75 – 13.57)	3.79 (1.99 – 5.59)	4.64 (2.63 – 6.59)	2.27 (0.87 – 3.67)	3.83 (2.02 – 5.64)
▪ *Missing*	Missing (n) = 94	Missing (n) = 38	Missing (n) = 63	Missing (n) = 38	Missing (n) = 27	Missing (n) = 38
Cage Question 4: Have you ever had a drink first thing in the morning to steady your nerves or get rid of a hangover (eye-opener)?						
▪ *Yes*	28.57 (24.31 – 32.83)	0.00 (0)	16.67 (13.16 – 20.19)	0.00 (0)	16.67 (13.16 – 20.19)	0.00 (0)
▪ *No*	10.56 (7.66 – 13.46)	10.76 (7.84 – 13.68)	3.39 (16.83 – 50.97)	4.72 (2.72 – 6.72)	1.92 (0.63 – 3.21)	3.94 (2.11 – 5.77)
▪ *Missing*	Missing (n) = 94	Missing (n) = 36	Missing (n) = 63	Missing (n) = 36	Missing (n) = 53	Missing (n) = 36

1. Clinical depression was defined by a Zung SDS score of 50 and above; clinical anxiety was defined by a Zung SAS score of 45 and above; co-morbid depression and anxiety was defined by a Zung SDS score of at least 50 and a Zung SAS score of at least 45.
2. Missing values for depression questionnaire = 351; missing values for anxiety questionnaire = 202; missing values for co-morbid illness = 151
3. A higher SF-12 score indicates better health.

Table 6: Average length of stay of cardiac surgical patients attending Foothills Pre-operative Assessment Clinic, by CAGE questionnaire scores

	Average Length of Days in Hospital (SD)
Alcohol Consumption	
Cage Question 1: Have you ever felt you should cut down on your drinking?	
▪ *Yes*	7.31 (2.92)
▪ *No*	8.83 (7.96)
▪ *Missing*	10.08 (11.52)
Cage Question 2: Have people annoyed you by criticising your drinking?	
▪ *Yes*	7.11 (1.62)
▪ *No*	8.77 (7.74)
▪ *Missing*	9.23 (10.24)
Cage Question 3: Have you ever felt bad or guilty about your drinking?	
▪ *Yes*	7.30 (2.11)
▪ *No*	8.91 (8.27)
▪ *Missing*	7.44 (2.40)
Cage Question 4: Have you ever had a drink first thing in the morning to steady your nerves or get rid of a hangover (eye-opener)?	
▪ *Yes*	6.14 (1.46)
▪ *No*	8.88 (8.12)
▪ *Missing*	7.33 (2.30)

Table 7: Baseline characteristics of patients with missing depression and/or anxiety data

	Total % (95 C.I.)	Missing Zung SDS data[1] % (95 C.I.) n = 351	Missing Zung SAS data[1] % (95 C.I) n = 202	Missing Zung SDS and Zung SAS data % (95 C.I) n=151
Age				
▪ 10-29	0.95 (0.035 – 1.86)	1.32 (0.24 – 2.40)	0 (0)	0.00 (0)
▪ 30-49	13.48 (10.26 – 16.70)	7.89 (5.35 – 10.43)	9.30 (6.56 – 12.04)	4.17 (2.28 – 6.06)
▪ 50-69	56.03 (51.35 – 60.71)	43.42 (38.75 – 48.09)	51.16 (46.45 – 55.87)	41.67 (37.02 – 46.32)
▪ 70-99	29.55 (25.25 – 33.85)	47.37 (42.66 – 52.08)	39.53 (34.92 – 44.14)	54.17 (49.47 – 58.87)
Sex				
▪ Male	75.89 (71.86 – 79.92)	69.74 (65.41 – 74.07)	58.14 (53.49 – 62.79)	58.14 (53.49 – 62.79)
▪ Female	24.11 (20.08 – 28.14)	30.26 (25.93 – 34.59)	41.86 (37.21 – 46.51)	41.86 (37.21 – 46.51)
Place of residence				
▪ Rural	20.33 (16.54 – 24.13)	28.95 (24.67 – 33.23)	25.58 (21.47 – 29.69)	29.17 (24.88 – 33.46)
▪ Urban	79.67 (75.88 – 83.47)	71.05 (66.77 – 75.33)	74.42 (70.31 – 78.53)	70.83 (66.54 – 75.12)
Marital status				
▪ Never Married	4.57 (2.60 – 6.54)	4.17 (2.29 – 6.06)	5.13 (3.05 – 7.21)	9.52 (6.75 – 12.29)
▪ Currently Married/Common Law	79.57 (75.77 – 83.37)	83.33 (79.82 – 86.85)	64.10 (59.58 – 68.62)	76.19 (72.17 – 80.21)
▪ Formerly Married[2]	15.87 (12.42 – 19.32)	12.50 (9.38 – 15.62)	30.77 (26.42 – 35.12)	14.29 (10.99 – 17.59)
Education level				
▪ Primary School	8.17 (5.59 – 10.75)	11.11 (8.15 – 14.07)	10.53 (7.64 – 13.42)	15.00 (11.63 – 18.37)
▪ Some or completed high school	46.39 (41.67 – 51.09)	51.39 (46.68 – 56.10)	50.00 (45.29 – 54.72)	35.00 (30.50 – 39.50)
▪ Some or completed college, trade or technical school	26.44 (22.28 – 30.60)	20.83 (17.00 – 24.66)	28.95 (45.29 – 54.72)	35.00 (30.50 – 39.50)
▪ University	18.99 (15.29 – 22.69)	16.67 (13.16 – 20.19)	10.53 (7.64 – 13.42)	15.00 (11.63 – 18.37)
Number of people in the house[3]				
▪ 1	13.35 (10.14 – 16.56)	12.33 (9.23 – 15.43)	30.77 (26.42 – 35.12)	23.81 (19.79 – 27.83)
▪ 2-3	73.54 (69.38 – 77.70)	76.71 (72.72 – 80.70)	61.54 (56.95 – 66.13)	66.67 (62.23 – 71.12)
▪ 4-5	11.65 (86.25 – 14.68)	9.59 (6.81 – 12.37)	7.69 (5.18 – 10.20)	9.52 (6.75 – 12.29)
▪ 6 or more	1.46 (0.33 – 2.59)	1.37 (0.27 – 2.47)	0.00 (0)	0.00 (0)
Prior operations				

▪ Yes	18.05 (14.42 – 21.68)	17.39 (13.82 – 20.96)	10.81 (7.88 – 13.74)	15.79 (12.35 – 19.23)
▪ No	81.95 (78.32 – 85.58)	82.61 (79.04 – 86.18)	89.19 (8.63 – 92.12)	84.21 (80.77 – 87.65)
General Health (SF-12)				
Physical Health Component				
In general, would you say your health is…				
▪ *Excellent*	5.34 (3.22 – 7.46)	5.71 (3.52 – 7.90)	7.69 (5.18 – 10.20)	10.00 (7.17 – 12.83)
▪ *Very good*	24.03 (20.00 – 28.06)	20.00 (16.23 – 2.38)	10.26 (7.40 – 13.12)	10.00 (7.17 – 12.83)
▪ *Good*	45.63 (40.93 – 50.33)	44.29 (39.61 – 48.97)	48.72 (44.01 – 53.43)	40.00 (35.38 – 44.62)
▪ *Fair*	20.15 (16.37 – 23.93)	27.14 (22.95 – 31.33)	28.21 (23.97 – 32.45)	40.00 (35.38 – 44.62)
▪ *Poor*	4.85 (2.82 – 6.88)	2.86 (1.29 – 4.43)	5.13 (3.05 – 7.21)	0.00 (0)
Does your health limit you in moderate activities, such as moving a table or pushing a vacuum cleaner				
▪ *Yes, limited a lot*	36.50 (31.96 – 41.04)	41.43 (36.79 – 46.08)	39.47 (34.86 – 44.08)	30.00 (25.68 – 34.32)
▪ *Yes, limited a little*	44.28 (39.60 – 48.96)	47.14 (42.43 – 51.85)	52.63 (47.92 – 57.34)	60.00 (55.38 – 64.62)
▪ *Not limited at all*	19.22 (15.50 – 22.94)	11.43 (8.43 – 14.43)	7.89 (5.35 – 10.43)	10.00 (7.17 – 12.83)
Does your health limit your ability to climb several flights of stairs?				
▪ *Yes, limited a lot*	50.49 (45.78 – 55.21)	55.71 (51.03 – 60.39)	58.97 (54.33 – 63.61)	65.00 (60.50 – 69.50)
▪ *Yes, limited a little*	38.05 (33.47 – 42.63)	34.29 (29.81 – 38.77)	35.90 (31.38 – 40.42)	25.00 (20.92 – 29.08)
▪ *Not limited at all*	11.46 (8.46 – 14.46)	10.00 (7.17 – 12.83)	5.13 (3.05 – 7.21)	10.00 (7.17 – 12.83)
During the past 4 weeks, with regards to work or other daily activities, have you accomplished less than you would like?				
▪ *Yes*	75.82 (71.78 – 79.86)	86.36 (83.12 – 89.60)	82.86 (79.31 – 86.41)	83.33 (79.82 – 86.85)
▪ *No*	24.18 (20.14 – 28.22)	13.64 (10.40 – 16.88)	17.14 (13.59 – 20.69)	16.67 (13.16 – 20.19)
During the past 4 weeks, were you limited in the kind of work or other activities that you were able perform?				
▪ *Yes*	77.31 (73.36 – 81.26)	89.39 (86.49 – 92.29)	75.68 (71.63 – 79.73)	84.21 (80.77 – 87.65)
▪ *No*	22.69 (18.74 – 26.64)	10.61 (7.71 – 13.51)	24.32 (20.27 -28.37)	15.79 (12.35 – 19.23)

During the past 4 weeks, how much did pain interfere with your normal work?				
▪ *Not at all*	34.22 (29.75 – 38.69)	34.29 (29.81 – 38.77)	35.90 (31.38 – 40.42)	40.00 (35.38 – 44.62)
▪ *A little bit*	30.34 (26.01 – 34.68)	25.71 (21.59 – 29.83)	25.64 (21.52 – 29.76)	20.00 (16.23 – 23.77)
▪ *Moderately*	17.48 (13.90 – 21.06)	24.29 (20.25 – 28.33)	25.64 (21.52 – 29.76)	30.00 (25.68 – 34.32)
▪ *Quite a bit*	15.05 (11.68 – 18.42)	14.29 (10.99 – 17.59)	10.26 (7.40 – 13.12)	10.00 (7.17 – 12.83)
▪ *Extremely*	2.91 (1.32 – 4.50)	1.43 (0.31 – 2.55)	2.56 (1.07 – 4.05)	
Smoking Status				
▪ Daily	9.98 (7.15 – 12.81)	11.43 (8.43 – 14.43)	15.79 (12.35 – 19.23)	15.00 (11.63 – 18.37)
▪ Occasionally	2.68 (1.16 – 4.20)	1.43 (0.31 – 2.55)	0.00 (0)	0.00 (0)
▪ Never smoked	27.49 (23.28 – 3.17)	34.29 (29.81 – 38.77)	15.79 (12.35 – 19.23)	15.00 (11.63 – 18.37)
▪ Have quit smoking	59.85 (55.23 – 64.47)	52.86 (48.15 – 57.57)	68.42 (64.04 – 72.80)	70.00 (65.68 – 74.32)
Exit code				
▪ Alive	97.64 (96.21 – 99.07)	97.37 (95.86 – 98.88)	97.67 (96.25 – 99.09)	100.00 (-)
▪ Dead	2.36 (0.93 – 3.79)	2.63 (1.12 – 4.14)	2.33 (0.91 – 3.75)	0.00 (0)
▪ Not sure	(0)	0 (0)	0.00 (0)	0.00 (0)
Wait time until surgery				
▪ 0-35 days (1 to 5 weeks)	63.27 (58.72 – 67.82)	64.47 (59.96 – 68.98)	54.76 (50.07 – 59.45)	50.00 (45.29 – 54.72)
▪ 36-1106 days (more than 5 weeks)	36.73 (32.18 – 41.28)	35.53 (31.02 – 40.04)	45.24 (40.55 – 49.93)	50.00 (45.29 – 54.72)
Cardiac Risk Factors				
Age>70				
▪ Yes	29.55 (25.25 – 33.85)	47.37 (42.66 – 52.08)	39.53 (34.92 – 44.14)	54.17 (49.47 – 58.87)
▪ No	70.45 (66.15 – 74.75)	52.63 (47.92 – 57.34)	60.47 (55.86 – 65.08)	45.83 (41.13 – 50.53)
Prior heart attack				
▪ Yes	30.86 (26.50 – 35.22)	30.14 (25.81 – 34.47)	15.00 (11.63 – 18.37)	19.05 (15.35 – 22.75)
▪ No	57.66 (53.00 – 62.32)	52.05 (47.34 – 56.76)	62.50 (57.94 – 67.07)	52.38 (47.67 – 57.09)
▪ Not sure	11.48 (8.47 – 14.49)	17.81 (14.20 – 21.42)	22.50 (18.56 – 26.44)	28.57 (24.31 – 32.83)
▪ Heart attack in the last 6 months (Missing = 23)				
▪ Yes	9.55 (6.78 – 12.32)	6.85 (4.47 – 9.23)	0 (0)	0 (0)
▪ No	82.10 (78.49 – 85.72)	82.19 (78.58 – 85.80)	92.50 (90.02 – 94.98)	85.71 (82.41 – 89.01)
▪ Not sure	8.35 (5.74 – 10.96)	10.96 (8.01 – 13.91)	7.50 (5.02 – 9.98)	14.29 (10.99 – 17.59)

▪ Angina (Missing = 45)				
▪ Yes	52.57 (47.86 – 57.28)	48.48 (43.77 – 53.19)	52.78 (48.07 – 57.49)	58.82 (54.18 – 63.46)
▪ No	33.74 (29.28 – 38.20)	27.27 (23.07 – 31.47)	30.56 (26.22 – 34.90)	17.65 (14.06 – 21.25)
▪ Not sure	13.69 (10.45 – 16.93)	24.24 (20.20 – 28.28)	16.67 (13.16 – 20.19)	23.53 (19.53 – 27.53)
▪ Suspected critical Aortic Stenosis (Missing = 32)				
▪ Yes	45.91 (41.21 – 50.61)	54.79 (50.10 – 59.48)	52.50 (47.79 – 57.21)	47.62 (42.91 – 52.33)
▪ No	50.00 (45.29 – 54.72)	42.47 (37.81 – 47.13)	45.00 (40.31 – 49.69)	52.38 (47.67 – 57.09)
▪ Not sure	4.09 (2.22 – 5.96)	2.74 (1.20 – 4.28)	2.50 (1.03 – 3.97)	0.00 (0)
▪ Arrhythmia (Missing = 57)				
▪ Yes	26.34 (22.19 – 30.49)	25.35 (21.25 – 29.45)	34.21 (29.74 – 38.68)	30.00 (25.68 – 34.32)
▪ No	56.59 (51.92 – 61.26)	49.30 (44.59 – 54.02)	36.84 (32.29 – 41.39)	35.00 (30.50 – 39.50)
▪ Not sure	17.07 (13.52 – 20.62)	25.35 (21.25 – 29.45)	28.95 (24.67 – 33.23)	35.00 (30.50 – 39.50)
Alcohol Consumption				
Cage>2				
▪ *Yes*	5.85 (3.64 – 8.06)	7.58 (5.08 – 10.08)	11.76 (8.72 – 14.80)	11.76 (8.72 – 14.80)
▪ *No*	94.15 (91.94 – 96.36)	92.42 (89.92 – 94.92)	88.24 (85.20 – 91.28)	88.24 (85.20 – 91.28)
Number of Procedures				
▪ 1-2	1.18 (0.16 – 2.20)	1.32 (0.24 – 2.40)	2.33 (0.91 - 3.75)	4.17 (2.28 – 6.06)
▪ 3	13.71 (10.47 – 16.95)	13.16 (9.97 – 16.35)	20.93 (17.09 – 24.77)	25.00 (20.92 – 29.08)
▪ 4	38.30 (33.72 – 42.88)	25.00 (20.92 – 29.08)	27.91 (23.68 – 32.14)	16.67 (13.16 – 20.19)
▪ 5	46.81 (42.11 – 51.52)	60.53 (55.92 – 65.14)	48.84 (44.13 – 53.55)	54.17 (49.47 – 58.87)
Number of Co-morbidities				
▪ 1	2.36 (0.93 – 3.79)	1.32 (0.24 – 2.40)	0.00 (0)	0.00 (0)
▪ 2	3.31 (1.62 – 5.00)	2.63 (1.12 – 4.14)	0.00 (0)	0.00 (0)
▪ 3-4	18.20 (14.56 – 21.84)	13.16 (9.97 – 16.35)	20.93 (17.09 – 24.77)	20.83 (17.00 – 24.66)
▪ 5-6	30.97 (26.61 – 35.33)	35.53 (31.02 – 40.04)	37.21 (32.65 – 41.77)	41.67 (37.02 – 46.32)
▪ 7+	45.15 (40.46 – 49.84)	47.37 (42.66 – 52.08)	41.86 (37.21 – 46.51)	37.50 (32.94 – 42.07)
Type of Procedure				
▪ Coronary Artery Bypass Graft (single)	18.20 (14.56 – 21.84)	17.11 (13.56 – 20.66)	16.28 (12.80 – 19.76)	20.83 (17.00 – 24.66)
▪ Coronary Artery Bypass Graft (double)	30.26 (25.93 – 34.59)	25.00 (20.92 – 29.08)	27.91 (23.68 – 32.14)	37.50 (32.94 – 42.07)

▪ Coronary Artery Bypass Graft (triple or quadruple)	9.22 (6.49 – 11.95)	6.58 (4.24 – 8.92)	6.98 (4.58 – 9.38)	4.17 (2.28 – 6.06)
▪ Aortic Valve Replacement or Repair	21.99 (18.08 – 25.90)	26.32 (22.17 – 30.47)	16.28 (12.80 – 19.76)	16.67 (13.16 – 20.19)
▪ Mitral Valve Replacement or Repair	12.77 (9.62 - 15.92)	18.42 (14.76 – 22.08)	25.58 (21.47 – 29.69)	16.67 (13.16 – 20.19)
▪ Other	7.57 (5.08 – 10.06)	6.58 (4.24 – 8.92)	6.98 (45.77 – 9.38)	4.17 (2.28 – 6.06)

1. Zung SDS = Zung's Self-Rating Depression Scale; Zung SAS = Zung's Self-Rating Anxiety Scale
2. The 'formerly married' category includes: widowed, separated and divorced
3. Household size acts as a proxy for social support in this study.

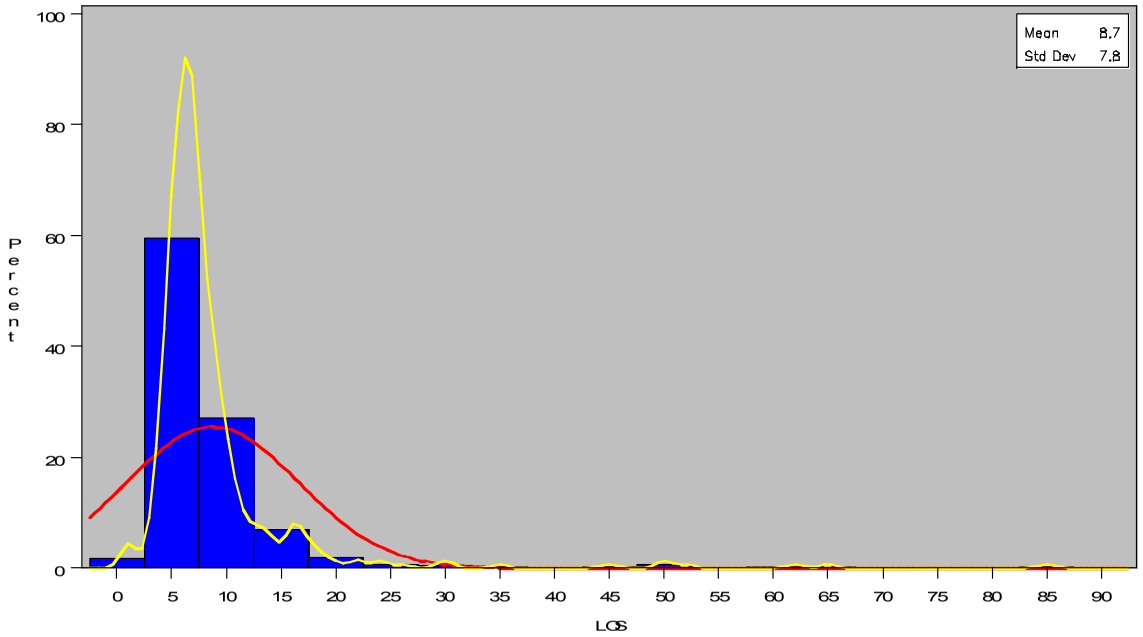

Figure 1. Distribution of the untransformed length of stay variable.

Appendix C
Residual Analysis

Table 1. Variance Inflation Factor Estimates for Multiple Linear Regression Model Assessing the Effect of Depression and/or Anxiety on Length of Stay

Variable	Variance Inflation
▪ **Clinically relevant depression**	1.20111
▪ **Age**	1.30985
Sex	
▪ Female	1.34911
Education	
▪ Primary School	
▪ High School	5.04954
▪ College	4.26666
▪ Univeristy	3.68765
General Health	
Does your health limit your ability to climb several flights of stairs?	
▪ *Limited a lot*	
▪ *Limited a little*	3.59285
▪ *Not limited at all*	3.20817
During the past 4 weeks, with regards to work or other daily activities, have you accomplished less than you would like?	
▪ *Yes*	
▪ *No*	1.25687
Smoking Status	
▪ Daily/Occasionally	1.58943
▪ Quit	1.52832
▪ Never Smoked	
Cardiac Risk Factors	
▪ Previous heart attack	1.30293
Alcohol use	
▪ Cage over 2	1.04211
Type of Surgery	
▪ Coronary Artery Bypass Graft (single)	
▪ Coronary Artery Bypass Graft (double)	1.96941
▪ Coronary Artery Bypass Graft (triple or quadruple)	1.52657
▪ Aortic Valve Replacement or Repair	1.93263
▪ Mitral Valve Replacement or Repair	1.74031
▪ Other	1.46299

1. As measured by the presence of mild, moderate or severe depression

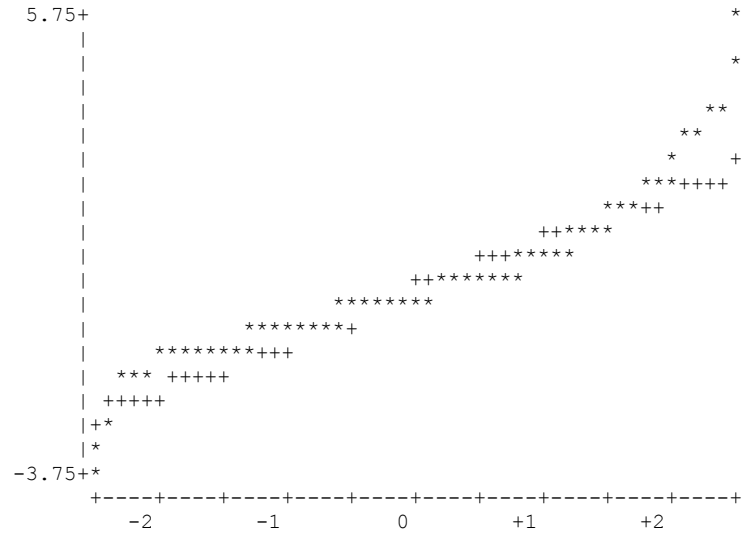

Figure 2. Normal probability plot of Jacknife Residuals

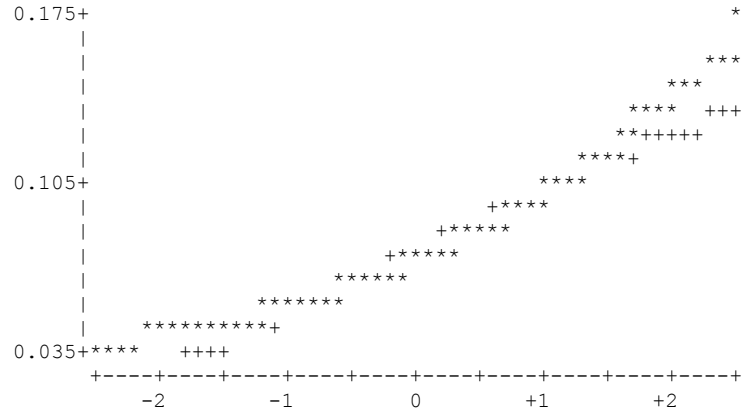

Figure 2. Normal probability plot of Leverage Values

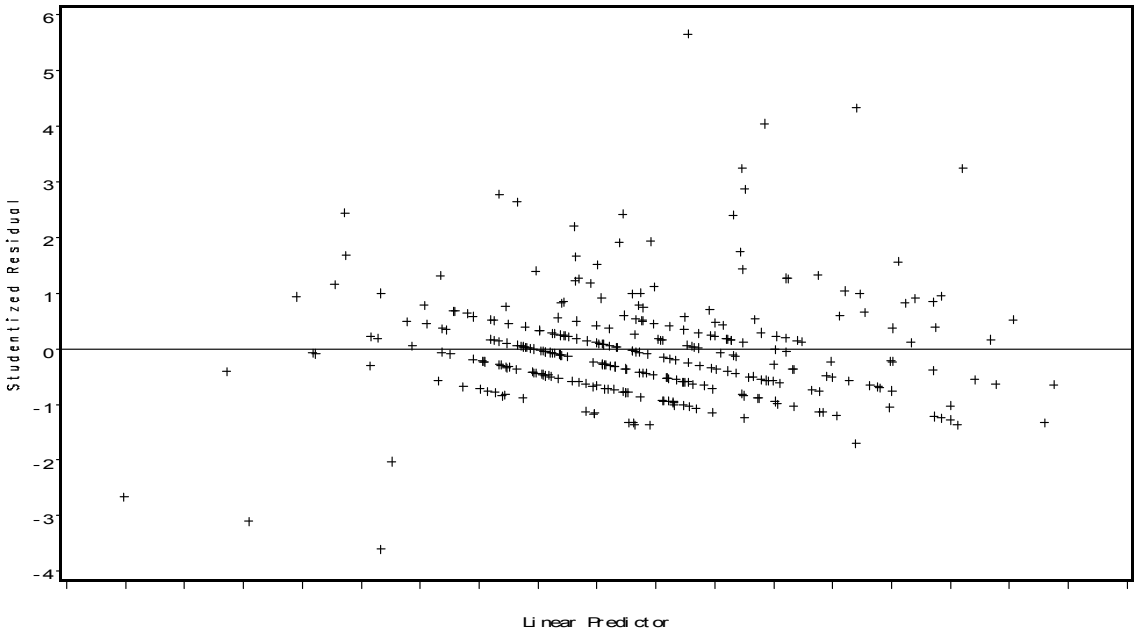

Figure 3. Studentized Residuals vs. Linear Predictor