THE RELATIONSHIP BETWEEN DEPRESSION AND PHASE II CARDIAC REHABILITATION COMPLETION: A SYSTEMATIC LITERATURE REVIEW AND META-ANALYSIS

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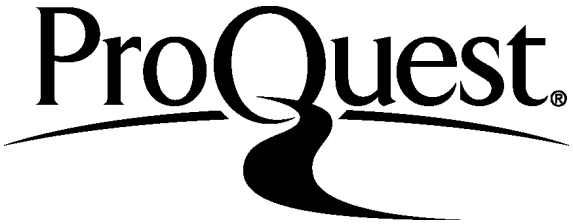

ABSTRACT

THE RELATIONSHIP BETWEEN DEPRESSION AND PHASE II CARDIAC REHABILITATION PROGRAM COMPLETION: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Depression is a serious condition experienced by many individuals diagnosed with coronary heart disease (CHD). Depression after CHD diagnosis has been associated with poor cardiac prognosis, cardiac mortality, and is postulated to influence adherence to physician recommendations, including attendance at cardiac rehabilitation programs. Cardiac rehabilitation (CR) is an empirically supported secondary intervention for cardiac patients and is recommended by the American Heart Association (AHA) and the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) to reduce disease progression, however many CR participants do not complete. A number of studies have investigated depression and phase II CR programs. The goal of the current systematic literature review and meta-analysis was to explore the association between depression and phase II CR completion. A literature search cross-referenced three electronic databases (PsycINFO, MEDLINE, *Dissertation Abstracts International*) up through December 2014. Studies quantifying an association between depression and phase II CR completion were reviewed. After duplicate studies were removed and study inclusion criteria applied, 17 observational studies with 19 independent samples consisting of 30,586 cardiac patients remained for meta-analysis. A random-effects model found a moderate inverse relationship between depression and phase II CR completion (g = -.44, 95% CI -.59 to -.29), indicating that depressed CR patients were significantly less likely to complete their program. A minor amount of publication bias was detected with a funnel plot and trim-and-fill

analysis. No significant moderator variables were detected

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CHAPTER 1: INTRODUCTION

Many people with coronary heart disease (CHD), especially those who experience a coronary event (CE), report some form of depression (American Heart Association [AHA], 2014). Research has shown that post-CE depression attenuates physician recommendations, including secondary prevention measures for disease maintenance (Zeigelstein et al., 2000). One of the most powerful secondary prevention programs for CHD patients is cardiac rehabilitation (CR)(American Association of Cardiovascular and Pulmonary Rehabilitation [AACVPR], 2014), yet dropout can be common (Grace et al., 2002). Post-CE depression may adversely influence CR participation, though research has reported varied results. This study is a systematic literature review and meta-analytic exploration of the relationship between depression and CR completion.

CVD/CHD Epidemiology

Prevalence. Cardiovascular disease (CVD) refers to diseases of the blood vessels and heart, including CHD, cerebrovascular disease (stroke), heart failure, rheumatic disease, and hypertension (AHA, 2014; Center for Disease Control [CDC], 2015). CVD is the leading cause of mortality, causing over 17 million deaths internationally each year (World Health Organization [WHO], 2015). Moreover, CVD is also the leading cause of death under the age of 70 due to noncommunicable diseases (WHO, 2015). CHD comprises 42% of all CVD cases and is the leading cause of death of both men and women in the United States (US), contributing to 600,000 deaths per year, or one in four deaths (CDC, 2015; WHO, 2015). CHD costs the US

108.9 billion dollars annually, including medical services, medication, and loss of productivity (CDC, 2015).

Acute coronary syndrome (ACS) is an umbrella term describing medical conditions that limit the blood supply to the heart, which includes myocardial infarction (MI) and unstable angina pectoris (AHA, 2014). An MI is an acute loss of blood supply to the myocardium resulting in death of heart tissue, also known as a heart attack (AHA, 2014). Notably, around 720,000 Americans experience a heart attack annually, with 72% (515,000) being their first cardiac event, and 205,000 experiencing additional heart attacks beyond their first (CDC, 2009). Rehospitalization within 1 year of diagnosis or CE occurs in 20% of ACS patients (Kolansky, 2009). Unstable angina pectoris is chest pain due to a lowered blood supply to the myocardium, usually due to atherosclerosis, or a reduced blood supply caused by a build-up of arterial plaque (AHA, 2014). Surgical interventions for ACS and other CHD conditions include Coronary Artery Bypass Graft surgery (CABG), and Percutaneous Coronary Intervention (PCI), which are some of the most common surgical procedures performed in US operating rooms annually (AHA, 2014; Weiss, Elixhauser & Andrews, 2014).

Risk factors for CHD. Non-modifiable risk factors for CHD include age, gender, and heredity (CDC, 2009). Four traditional or "modifiable" risk factors are also independent predictors of CHD: current tobacco smoking, hyperlipidemia, high blood pressure (hypertension), and diabetes (Khot et al., 2003; Yusaf et al., 2004). These four risk factors are well-established through decades of epidemiological studies and clinical interventions (Greenland et al., 2003; Khot et al., 2003; Yusaf et al., 2004). Behavioral risk factor modification of these four variables has been shown to reduce CHD mortality up to 17-50% (Jousilhanti et al., 1998: Kannel et al., 1986). Meta-analyses, review articles, and large epidemiological studies now

indicate that depression is considered another independent risk factor for the development of CHD and poor cardiovascular health, and a predictor of recurrent events in CVD populations (Barth, Schumacher, & Herrmann-Lingen, 2004; Freedland & Carney, 2013; Gan et al., 2014; Lichtman et al., 2014; Van der Kooy et al., 2007; van Melle et al., 2004).

Depression and CHD

Depression prevalence. Thirty-three percent of CHD patients report mild to severe depression post event, with one in five newly diagnosed CHD patients meeting the diagnostic criteria for major depressive disorder (MDD) (AHA, 2014; Carney, Freedland, Miller, & Jaffe, 2002; Frasure-Smith, Lesperance, & Talajic, 1993; Wilder-Schaaf et al., 2013). Depression is also highly co-morbid with other CVD illnesses, such as Congestive Heart Failure (CHF)**.** Meta-analyses and review articles report that clinically significant depression is present in over 20% of CHF patients, and is associated with longer and more frequent hospital visits (Rutledge, Reis, Linke, Greenberg, & Mills, 2006; Yohannes, Willgoss, Baldwin, & Connolly, 2010). Not only is there a significant relationship between depression and CHD/CVD diagnoses, research suggests that depression after a CE also predicts poor cardiac prognosis (Frasure-Smith, Lesperance, & Talajic, 1995; Lesperance, Frasure-Smith, Talajic, & Bourassa, 2002; Rutledge et al., 2006; Van der Kooy et al., 2007; van Melle et al., 2004).

Depression as an independent risk factor for cardiac mortality. In addition, meta-analytic studies have shown that depression after an MI increases the likelihood of poor cardiac prognosis and subsequent cardiac events 2 to 2.5 times that of non-depressed patients (Barth et al., 2004; Meijer et al., 2011; van Melle et al., 2004). For example, depression in CHD patients significantly increases risk of mortality within two years of initial CHD diagnosis or

after an MI (Barth et al., 2004; Meijer et al., 2011; van Melle et al., 2004; Zuidersma, Conradi, van Melle, & de Jonge, 2013).

Depression in the CHD population is also associated with reduced adherence to physician recommendations, medical treatments, is significantly correlated with more CHD risk factors, and is negatively associated with participation in physical exercise (Gehi, Haas, Pipkin, & Whooley, 2005; Pomp, Fleig, Schwarzer, & Lippke, 2012; Ziegelstein et al., 2000). The relationship between depression and cardiac mortality has been found to be no longer significant when lifestyle mechanisms are controlled for, such as current smoking or lack of physical activity, suggesting that the relationship between depression and cardiac mortality may be moderated by behavior (Ye et al., 2013).

Cardiac Rehabilitation

Consequently, after diagnosis of CHD most patients are given basic behavioral strategies and recommendations for secondary prevention to help reduce or stabilize their disease, and may be referred to cardiac rehabilitation for recovery. Cardiac rehabilitation is an empirically supported form of secondary intervention for cardiac patients (AHA, 2014; Thomas et al., 2007). CR is a structured treatment program, consisting of four phases, aimed at reducing CVD morbidity and mortality. CR slowly returns recovering CVD patients back to normal physical health and a healthy lifestyle, including improvement of modifiable CHD risk factors, medication management, and increased psychological function (Balady et al., 2011). The first phase (phase I) is mandatory while inpatient in the hospital setting, whereas the final three outpatient phases are optional. Cardiac rehabilitation is recommended for most CVD patients, including those with: ACS; CABG; PCI; stable angina pectoris; valvular repair; heart or lung transplant; CHF; and Peripheral Artery Disease (AAVCPR, 2014).

Outpatient phase II CR in the US is typically covered by insurance or reimbursed through Medicare, and usually consists of 36 sessions over 12 weeks (Balady et al., 2007; Suaya et al. 2007). In order to participate in phase II CR, a referral from a medical professional is required for an initial enrollment into the program. A usual enrollment intake session involves assessment in physical and psychosocial functioning, including a recording of baseline physical activity and function, and baseline psychosocial variables, such as depression and quality of life (QOL) scores (Balady et al., 2007). Phase II CR intake assesses modifiable risk factors, behavioral and psychological health, and individualizes physical exercise goals for the patient. A tailored recovery intervention is created between the CHD patient and a medical professional, usually a case manager who charts the patient along the entirety of the program. Phase II CR programs include monitored cardiovascular exercise (e.g., electrocardiogram, leads, etc.) and possible weight training under the direct supervision of medical staff, nutritional counseling, and risk factor education and management (AACVPR, 2014).

CR Outcomes and Importance

Phase II CR has been shown to have many positive outcomes, including increased quality of life, fewer recurrent hospital visits, reduced morbidity and mortality, and is now considered a class I recommendation for all CHD patients (AACVPR, 2014; AHA, 2014; Anderson et al., 2016; Anderson & Taylor; 2014; Clark, Hartling, Vandermeer, & McAlister, 2005; Silberman et al., 2010; Thomas et al., 2007). Specifically, participation in phase II CR has shown significant risk factor reduction, increased physical activity levels, improved exercise capacity and self-care, and improved psychosocial function (Chatziefstratiou, Gakoumidakis, & Brokalaki, 2013; Gellis & Kang-Yi, 2012; Kugler, Seelbach, & Kruskemper, 1994; Leon et al.,

2005; Shepherd & While, 2012; Worcester & Le Grande, 2008; van Tol, Huijsmans, Kroon, Schothorst, & Kwakkel, 2006).

Furthermore, review articles and meta-analyses have revealed that CR participation and completion is associated with significant reduction in cardiac-mortality and all-cause mortality (AAVCPR, 2014; Barth et al., 2004; Lawler, Filion, & Eisenberg, 2011; Taylor, Barber, McIntosh, & Khan, 1998; Taylor et al., 2004; Williams et al., 2002; Worcester & Le Grande, 2008). Specifically, exercised-based CR is associated with a 50% reduction in subsequent CEs, a 35% reduction in cardiac mortality, and a 25% reduction in all-cause mortality (Lawler et al., 2011). In addition, a dose-response relationship between number of CR sessions attended and all-cause mortality and subsequent MIs has been established, with a linear trend identified between number of sessions attended and subsequent mortality rates (Hammill, Curtis, Schulman, & Whellan, 2010; Suaya, Stason, Ades, Normand, & Shepard, 2009). Unfortunately, many people do not complete CR as phase II CR initiation and completion are often problematic.

CR Participation

CR initiation. Unfortunately, initiation into phase II CR is fairly low in the cardiac population. Of those eligible, only 14 to 35% of MI survivors, and 31% of CABG patients initiate phase II CR in the US (Grace et al., 2008; Suaya et al., 2007). Factors associated with lack of enrollment include sex, increasing age, non-white, additional co-morbid illnesses and depression (Cooper, Jackson, Wienman, & Horne, 2002; Grace et al., 2002; Grace et al., 2008; Suaya et al., 2007). However, CR initiation is a separate phenomenon, and is beyond the scope of the current project.

CR completion. Amongst those who initiate phase II CR, attrition is very common. On average, 25 to 50% of individuals who are referred to phase II CR attend a first

intake session, but then drop out before completion (Cooper et al., 2002; Worcester & Le Grande, 2008; Beswick et al., 2005) To provide a background into the literature assessing depression and phase II CR participation, an initial review investigating potential moderators is provided on: sampling characteristics, medical characteristics, and measurement factors. A review of potential moderators is provided below.

Depression and CR Completion

A preliminary literature review of depression and phase II CR for the proposal of the current thesis detected 13 studies that assessed the relationship between depression and participation in phase II CR after enrollment (Blumenthal, Williams, Wallace, Williams, & Needles, 1982; Casey, Hughes, Waechter, Josephson, & Rosneck, 2008; Farley, Wade, & Birchmore, 2003; Glazer, Emery, Frid, & Banqasz, 2002; Kronish et al., 2006; Lane, Carroll, Ring, Beevers, & Lip, 2001; McGrady, McGinnis, Badenhop, Bentle, & Rajput, 2009; Murray, Murphy, Clements, Brown, & Connolly, 2013; Sanderson & Bittner, 2005; Swardfager et al., 2011; Turner, Bethell, Evans, Goddard, & Mullee, 2002; Whitmarsh, Koutanji, & Sidell, 2003; Yohannes, Yalfani, Doherty, & Bundy, 2007). Results were inconsistent between the preliminary sample studies. Upon further investigation, contrasting results may be accounted for by differences amongst the studies, which can be categorized into possible moderators: sample characteristics and measurement factors. Overall, the majority of research has identified a relationship between depression and CR participation, though it is still unclear what direction or size of effect depression actually has on completion rates. A review of potential moderators, based on the 13 studies located for the thesis proposal as well as a review of literature examining other predictors of CR completion, is provided below.

Moderator Variables

Sample characteristics. Sample (subject-level) characteristics, such as sociodemographic and medical variables were explored as additional predictors of CR attendance.

Sociodemographic characteristics. Many sociodemographic characteristics have been associated with participation and completion of phase II CR, such as ethnicity, SES, education, marital status, and distance from the CR clinic (Balady et al., 2011: Beswick et al., 2005; Clark et al., 2013; Cooper et al., 2002; Grace et al., 2002). The two most common predictors of CR attendance reported and analyzed in the literature include age and sex. Literature reviews and meta-analyses have identified age as one of the most common predictors of CR attendance, with younger CHD patients exhibiting higher attendance rates in comparison to older CHD patients (Cooper et al., 2002; Menezes et al., 2014; Williams et al., 2002). Elderly cardiac patients report poor CR participation for many reasons, though most are due to medical co-morbidities and a lack of physical mobility (Menezes et al. 2014). Women have significantly lower phase II CR completion rates compared to their male counterparts, with female participation being almost half that of male participation (Clark et al., 2013; Jackson, Leclerc, Erskine, & Linden, 2005; Suaya et al., 2007; Parkosewich, 2008). Literature reviews assessing female cardiac patients have identified a cluster of predictors specific to females that may influence CR participation rates, including an increased prevalence of depression (Benz Scott, Ben-Or, & Allen, 2002; Clark et al., 2013; Daniels, Arena, Lavie, & Forman, 2012; Grace, Yee, Reid & Stewart, 2014; Jackson et al., 2005; King & Lictman, 2009; Parkosewich, 2008; Shanmugasagaram et al., 2012). For example, women cardiac patients are almost twice as likely

to report major depression in comparison to male cardiac patients (Grace et al., 2014; Shanmugasagaram et al., 2012).

Medical characteristics. Severity of cardiac condition and coronary procedure have been found to have a variable relationship with attendance, with some studies finding increased severity and procedure associated with more attendance, whereas other studies find they are associated with lower attendance rates (Hammill et al., 2010; Lane et al., 2001; Suaya et al., 2007; Turner et al., 2002). For example, attrition rates were significantly higher for angina and PCI patients, in comparison to those who were diagnosed with an MI or CABG (Turner et al., 2002). Lane et al. (2001) found that increasing cardiac severity and procedure were associated with lower attendance rates; furthermore, they were also associated with more depression. In contrast, those that have experienced a second CE or MI complete phase II CR significantly more than other CHD patients, despite reporting higher levels of depression (Suaya et al., 2007). In addition, CHD patients who endorse a greater number of traditional risk factors and co-morbidities have also been found to complete CR significantly less (Hammill et al., 2010; Wattanakit, Folsom, Chambless, & Nieto, 2004).

Measurement factors. Measurement factors in operationalizing CR completion, and depression varied across studies, and are reviewed below.

Inconsistencies in length of CR program. The length of CR programs was a source of variation amongst the literature, ranging between 6 weeks to 1 year (Blumenthal et al., 1982; Yohannes et al., 2007). The length of CR program could impact attendance independently, and the individual contribution of depression on CR participation may be confounded by the duration of program.

Artificial dichotomization of depression and completion. Depression and completion were dichotomized and varied disparately within the sample literature. For example, depression was artificially dichotomized in a number of studies, and diagnosed in different ways (e.g., depression was diagnosed with a BDI-II score of ≥10 in one study, and ≥14 in another study)(McGrady et al., 2009; Sanderson & Bittner, 2005). Attendance was measured dichotomously as either "complete" or "not complete" in all of the 13 studies located for the thesis proposal. The operational definition of completion differed between quantitative and qualitative measures (e.g., if the attending medical professional and/or case manager deemed the patient was ready to leave due to attainment of personalized goals; completion of prescribed number of CR sessions operationally defined as 50% or 100%)(Casey et al., 2008; Lane et al., 2001; McGrady et al., 2009). Artificial dichotomization and measurement errors may result in inflated margins of error, including a reduction in variability and sensitivity, and an increase in biased results (Altman & Royston, 2006; Lipsey & Wilson, 2001; MacCallum, Zhang, Preacher, & Rucker, 2002).

Assessing different dimensions of depression. The manifestation of depressive symptoms vary within CHD populations, and have been found to determine cardiac prognosis differently (de Jonge, 2006; Martens, 2006; Tully, Winefield, Baker, Turnbull, & de Jonge, 2011). Correspondingly, depression is diagnosed differently according to the diagnostic measure administered. For example, the CES-D assesses cognitive and affective symptoms of depression, whereas the HADS assesses both anhedonic and somatic symptoms of depression, and the BDI-II assesses cognitive, affective, and somatic symptoms of depression (Mykletun, Stordal, & Dahl, 2001; Snaith, 2003; Tully et al., 2011; Zigmond & Snaith, 1983). Thus, different dimensions of depression measured in the cardiac literature varied as a function of diagnostic instrument used.

Research Synthesis

Within the field of social and behavioral sciences, it is widely accepted that multiple studies are required to garner an understanding of a research question, as sampling characteristics may influence findings in individual studies (Borenstein, Hedges, Higgins, & Rothstein, 2009; Lipsey & Wilson, 2001). Results across all of the studies within the same research domain must be taken into consideration and synthesized for a robust interpretation of the inquiry. Research synthesis is instituted in both systematic reviews and meta-analyses. A systematic literature review synthesizes research in a narrative fashion, and provides a larger perspective on research within the area of investigation (Lipsey & Wilson, 2001). When combined with a meta-analysis, it quantifies and analyzes results across studies, therefore having the additional support of statistical data to bolster conclusions.

Meta-analysis. Research synthesis in the form of literature reviews and meta-analyses are important by providing a larger perspective on clinical research, including quantitative data to support findings. A meta-analysis is a well documented, structured research technique, that is transparent and open to critique (Lipsey & Wilson, 2001). A proper meta-analysis includes: a sample of studies that meet specific criteria for the question at hand; organized, documented, and replicable search strategies to identify and obtain studies used; systematic coding for study characteristics and findings; and data analysis that supports conclusions of the review (Lipsey & Wilson, 2001). To combine results across studies, meta-analyses utilize the effect size (ES), which serves as a standard representation of the association between two variables. An aggregation of effect sizes (summary effect) may be reflected in smaller confidence intervals, larger or smaller effects sizes, and increased confirmation of accurate moderator variables, than individual studies alone (Cumming, 2012). This not only is a

more refined way to interpret results beyond statistical significance testing, it is a more accurate representation of the relationship between two variables by providing elevated statistical power and increased generalizability (Cumming, 2012). In sum, meta-analyses provide a more accurate insight into the relationship of interest, with strong statistical conclusions that provide a significant contribution to the scientific community.

Purpose of Study

Although there is a growing body of literature exploring the association between depression and phase II CR completion, there have been no systematic literature reviews or meta-analyses investigating this relationship. The first goal of this study was to: (1) conduct a systematic literature review on depression and phase II cardiac rehabilitation completion, and (2) run a meta-analysis investigating the quantitative relationship between depression and CR. As noted previously, there are numerous sociodemographic and medical variables that have been shown to influence attendance in phase II CR, as well as depression. Thus, the second goal of this study was to identify potential moderators of the depression and CR completion relationship, including methodological differences between the studies that could impact findings.

Research Questions

1. Examine the relationship of depression and phase II CR completion.
2. Determine if there are moderators of depression and CR completion.

CHAPTER 2: METHODS

This study conducted a meta-analysis examining the relationship between depression and participation in phase II cardiac rehabilitation. The research methods systematically followed the major steps associated with meta-analyses outlined by Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA)(Moher, Liberati, Tetzlaff, & Altman, 2009): (1) conducting a systematic literature search, (2) coding of studies, (3) calculating the aggregated effect size, (4) examining for publication bias, and (5) analyzing moderator variables.

Power analysis

A power analysis in a meta-analysis can either: assess if there are enough studies to detect a robust effect size or if the studies can precisely estimate an accurate effect size parameter (Borenstein et al., 2009). Most meta-analysts opt for the latter; a more precise estimation of effect size. Procedures and theory behind power analysis differs depending on the meta-analytical model chosen. All power calculations assessed the power to precisely estimate a mean summary effect, according to the procedures outlined by Borenstein et al. (2009). See Appendix B for the power equation.

A power analysis assessing the power to precisely estimate a mean summary effect was run on seven of the articles initially gathered for the thesis proposal document that met all inclusion criteria for the meta-analysis (Blumenthal et al., 1982; Casey et al., 2008; Glazer et al., 2007; McGrady et al., 2009; Sanderson & Bittner, 2005; Swardfager et al., 2011; Yohannes et al., 2007). A power analysis for a random-effects model revealed 97.6% probability to precisely estimate a small effect of .2. That is, a sample size of 1,555 from the seven studies was sufficient to detect a small mean summary effect of .2, or larger. Therefore, it was deemed that the

preceding results derived from the current meta-analysis were more than sufficient to confidently detect an estimated small effect (Borenstein et al., 2009).

Search Strategy and Data Sources

To investigate the relationship between depression and phase II cardiac rehabilitation participation, a literature search through three electronic databases was employed. Articles whose titles and abstracts pair the terms depression and phase II cardiac rehabilitation participation were searched for in the following databases: PsychINFO, MEDLINE, and *Dissertation Abstracts International*.

To obtain the largest number of articles pertaining to depression, the umbrella term "depress*" was used to capture all studies that had a title related to depression or depressive symptomatology. This was cross referenced with a search term explicitly related to the outcome variable: "cardiac rehabilitation." In order to increase the comprehensive nature of the literature search, additional search terms were included; "cardiovascular rehabilitation," "secondary prevention," and "adherence." Further, search terms outside of cardiac rehabilitation were added to obtain studies that did not specifically mention depression or cardiac rehabilitation within the title, as it was found that one study (Murray et al., 2013) out of the sub-sample of thirteen studies located for the thesis proposal document did not contain any words pertaining to "depress*," or "cardiac rehabilitation" in its title, but rather "cardiovascular," "adherence," and "secondary prevention."

A final search strategy included searching studies from reference sections of located articles to be reviewed for additional research that may not have been identified in the original electronic search. Lastly, authors of published studies were contacted and additional data requested if the reported data was incomplete or missing, such that located results could not be

included in the current meta-analysis. All located articles were imported, hosted, cross-referenced, and screened for duplicate articles through the Refworks database, provided by NAU's Cline Library.

Inclusion and Exclusion Criteria

Inclusion criteria. To be included in the present meta-analysis, studies had to assess the relationship between depression and CR participation. For research to be included in the current investigation, all studies were required to meet the following criteria:

1.) *be written in English*.

2.) *be identified in literature searches up to and inclusive of year 2014, using the procedures noted above.*

3.) *provide a measure of relation between depression and CR attendance using the same participants.* Studies were included if there was a measurement of depression for both CR attenders and non-attenders, or a measure of association between depression and CR attendance.

4.) *provide sufficient information to compute effect sizes.* Each study had to provide the sample size, and a statistic that enables the calculation of a standardized mean difference (Cohen's d). Such statistics included: r, t,F , χ^2, OR, p, raw frequency data, and means/standard deviations of depression scores, attendance data, or completion data.

Exclusion criteria. In order to refine homogeneity of the research sampled and increase generalizability of findings regarding depression and CR participation, this study excluded articles if:

a) *they assess phase I, III, or IV cardiac rehabilitation*. All studies were required to measure attendance in the initial phase of outpatient CR (starting 2-6 weeks after hospitalization or diagnosis; currently known as phase II CR in the US, or phase III in Europe.)

If a study assessed multiple phases of CR, and a measure for phase II CR could not be apportioned from other measures of CR phases, it was excluded.

b) *they assess CR initiation*. All included studies must have provided data on phase II CR attendance. CR initiation is not the same phenomenon as CR attendance, including different predictors, moderators, and association with depression. If a study investigated phase II CR initiation only, or if a study measured both CR initiation and attendance, and a measure of attendance could not be apportioned from the combined measure, it was excluded.

Data Coding

Study characteristics were coded with the intention to gather important descriptive information and to identify moderators of the relation between depression and CR participation, such as demographic characteristics. Studies were coded based on the two categories of potential moderators previously mentioned: sample characteristics (e.g., age, sex, SES, employment, relationship status, CHD diagnoses/procedure, type of depression measure, length of CR program) and measurement factors (e.g., operationalization of CR completion, dichotomization of depression and completion). In addition, common meta-analytic moderators were categorized into publication characteristics. See Appendix A for coding sheet.

Quality Assessment

Inter-rater agreement. Coded study characteristics were rated by two independent raters; an individual who completed the Masters of Arts in Pre-Doctoral Clinical Psychology at Northern Arizona University (A.G.), and the principal investigator (B.E.). Raters coded data required to calculate an effect size for the entire sample of 17 studies, and statistical data for two independent cohorts in two individual studies, in addition to moderator variables. Specifically, two studies (Lavie & Milani, 2006; McGrady et al., 2014), reported statistics

relating to depression and CR attendance for two independent cohorts, which were included in the meta-analysis as two independent effect sizes. Lavie and Milani (2006) provided quantitative data for phase II CR participants dichotomized into two independent groups; participants 55 years of age or below, and participants 56 years and older. McGrady et al. (2014) provided depression scores and completion rates for two independent phase II CR cohorts: a historical control group, and a recent CBT intervention group. Therefore, the two aforementioned studies included two independent effect sizes each, in addition to coding for moderator variables in each individual cohort, summing to a grand total of 19 independent effect size studies.

Due to the dichotomous nature of the inter-rater reliability, with reliability between independent coders to be either "agree" or "not agree" for each coded variable, a simple percentage of agreed upon variables was calculated to detect a basic, unadjusted reliability quotient. Percentage agreement on observational data was defined as consensus between coders for binary data, calculated by summing the number of data sets that received identical extracted data by both coders (n = 1023) divided by the total number of data sets (n = 1231) coded. Any data set that both coders obtained the exact same data was coded as "agreement", whereas any data set that contained missing data (i.e., if one coder coded for a variable, and the other coder did not code the variable), or a difference in extracted data was considered a "non-agreement". The percentage agreement between coders was 83.14%. Secondly, Cohen's kappa (k), a measure of "true agreement" between raters that takes into account the amount of actual observed agreement compared to how much agreement is expected from chance alone, was calculated (Viera & Garrett, 2005; see Appendix B for power equation). The unadjusted percentage agreement (83.14%) and Cohen's kappa (k = .83, p < .001) both met the recommended value

of .80 (Cohen, 1968). Any item that did not have a reliability quotient of 1.0 (24%) was reviewed by coders until a unanimous decision was obtained.

Lastly, data coding for the omnibus analysis was re-confirmed by the thesis Chair, Dr. Sumner Sydeman, and the principal investigator (B.E.). Specifically, Dr. Sumner Sydeman and the principal investigator reviewed all included studies on the following variables: sample size, type of depression measure, operationalization of depression, operationalization of CR attendance/completion, measurement of depression (continuous or dichotomous), measurement of attendance (continuous or dichotomous), summary effect statistic and result, type of analysis used, effect direction, and study outcome, to reach 100% agreement.

Computation of Effect Size

Of the 19 samples in the meta-analysis, eleven provided mean differences, one provided odds ratios (ORs), one provided both mean differences and ORs, while the remainder provided various other statistics used to calculate an effect size, as described below. Thus, several options were viable for calculating the omnibus statistic. Lipsey and Wilson (2001) suggest that assessing group contrasts using inherently dichotomous (OR) and continuous (Cohen's *d*) outcome measures together may be problematic, as the two ES indexes are numerically incomparable. However, Borenstein et al. (2009) advises that conversion between different ES measures to one common index is appropriate as long as the studies are theoretically relevant, based on the assumption that the ES has the same meaning in all studies, irregardless of the specific ES statistic reported.

In regard to CR attendance, the studies for the meta-analysis indicated that the use of OR and Cohen's *d* as indices of overall CR participation were solely due to differences in statistical reporting, making it appropriate to combine them into one common index rather than

estimating two different summary effects. Hence, this meta-analysis was conducted by calculating all extracted statistical data into a standardized mean difference effect size (Hedges' *g*), proposed by Borenstein et al. (2009).

Standardized Mean Difference. The standardized mean difference, or Cohen's *d*, is an index of group contrasts which explores the amount of overlap, or true differences between group distributions (Borenstein et al., 2009). The calculation divides the mean difference between groups, by a pooled standardized deviation (see Appendix B for equation to calculate effect size). The variance of Cohen's *d* reflects both uncertainty in the estimate of mean difference between groups, in addition to the pooled standard deviation (within-group variance; Borenstein et al., 2009). Cohen's *d* is not the most advantageous in small samples, as it has a tendency to overestimate the absolute value in effect size, though this can be corrected (Hedges, 1981).

Hedges' g. Hedges' *g* corrects for the small sample bias of Cohen's *d* with the use of a correction factor (*J*; see Appendix B for equation). Specifically, the degrees of freedom are utilized to estimate the within-studies variance, which provides a small, albeit unbiased difference in effect sizes (Hedges, 1981). Hedges' *g* is always smaller than Cohen's *d* due to the correction factor, though the difference is usually very small (Borenstein et al., 2009; Hedges, 1981).

Omnibus summary effect. To meta-analytically investigate the relationship between depression and CR participation, group contrasts were utilized. A Hedges' *g* was used as the effect size measure, representing the difference in CR attendance between groups of depressed and non-depressed participants. Mean depression scores and standard deviations between CR attenders and non-attenders was chosen to be the preferred method of effect size

calculation, since 11 out of the 19 independent ES calculations across the 17 studies reported group differences, with sample sizes ranging between small (n = 35) to very large (n = 26, 957). Thus, Hedges' g was chosen because it is an unbiased measure of Cohen's d for small sample sizes (Lipsey & Wilson, 2001). For the other studies that did not report depressive score means and SDs between CR attenders and non-attenders, a Hedges' g was calculated from a combination of: t, F, and p values, proportions, Pearson's r, and odds ratio.

Meta-Analytic Model

A random effects model was used to obtain an overall summary effect measure estimating the relationship between depression and phase II CR attendance. A mixed effects analysis was used to investigate moderators of the relationship between depression and CR participation. Both analytic models are described below.

Random effects. The random effects model was used to investigate the relationship between depression and CR completion because it assesses both within-study and between-study variance by creating a distribution of "true" effects and assessing what covariates moderate the distribution (Borenstein et al., 2009). Furthermore, it assumes that variations of ES are influenced not only by subject-level sampling error, but also by study-level sampling error (Lipsey & Wilson, 2001). It is considered the most conservative and generalizable meta-analytic model for heterogeneous (or dissimilar) studies, or study populations (Lipsey & Wilson, 2001). Publication bias and moderator analyses were performed after the random effects omnibus analysis.

Detecting publication bias. Publication bias was examined using a funnel plot analysis and trim-and-fill procedures (Borenstein et al., 2009; Taylor & Tweedie, 2000). A funnel plot was created by plotting the estimated summary effect against study size. Bias was

examined by looking for any asymmetry found within the funnel plot, especially toward the bottom right half, near the smaller studies (Borenstein et al., 2009). Though bias can be detected by an asymmetrical funnel plot, it can also be a representation of small-study effects (Taylor & Tweedie, 2000). To explore publication bias further, trim-and-fill analyses was conducted as a sensitivity analysis. Trim-and-fill estimates the number of unpublished studies by removing the small-sample studies from the funnel plot, adjusting the summary effect for the larger studies only, and finally replacing the smaller studies with their estimated missing counterparts around the adjusted summary effect (Taylor & Tweedie, 2000).

Moderator Analysis

Mixed effects sub-group analysis. The mixed model is an extension of the random effects model, where some heterogeneity is explained by moderators and the remainder of variance is explained by a random effect term (Borenstein et al., 2009). The mixed effects model assumes that a variation in the ES is due to both systematic and random components at the subject-level sampling, in addition to random components at the study-level (Borenstein et al., 2009; Lipsey & Wilson, 2001). Systematic differences between ES are associated with identifiable study characteristics that act as known moderators, such as gender, age, or cardiac diagnosis. After the systematic portion of ES variation is accounted for, residual variance may be present. This is considered the random component that represents sampling error at the subject level. Once subject-level errors are accounted for, the remaining variance is hypothesized to come from the study-level error (Borenstein et al., 2009). Sub-group analysis using a mixed-effects model allows a comparison of summary effect variation due to differences in study-level characteristics. For example, the summary effect variation between CR program length can be contrasted, similar to an analysis of variance (Borenstein et al., 2009).

The mixed effects model is considered the most robust approach to meta-analytically investigate a research question that has pre-established predictors or covariates (Borenstein et al., 2009; Lipsey & Wilson, 2001). Considering participation in CR has been shown to be moderated by a number of identifiable variables, the mixed-effects model is the most advantageous analytic model to use for an accurate and detailed assessment of known and unknown moderators, in addition to the summary estimate in the population (Borenstein et al., 2009; Lipsey & Wilson, 2001). In order to run a moderator analyses with minimal statistical error, *a priori* criteria was set at a minimum of 10 studies ($k \geq 10$) per moderator, with a minimum cell size of three ($k \geq 3$) for categorical comparisons specifically (Borenstein et al., 2009).

Statistical Software

Inter-rater reliability (Cohen's kappa) and descriptive data were run on SPSS v22.0 (IBM, 2013), while power analyses and inter-rater agreement were calculated by hand. All remaining analyses: meta-analysis, publication bias analyses, and sub group analyses were run by Comprehensive Meta-Analysis (CMA) software, version 3.0 (BioStat, 2010).

CHAPTER 3: RESULTS

Literature Search

The literature search resulted in a retrieval of 1446 titles, with an additional Master's thesis (Casey, 2011) obtained by hand, culminating in a total of 1447 studies. After duplicates were removed (i = 278) and records screened (k = 1169), 117 full papers containing original data were identified for possible inclusion. After review, 100 records were excluded while 17 eligible studies remained. Exclusion of 100 studies varied for a number of reasons (see Figure 1 for inclusion flow chart).

Of the 100 excluded studies noted above, 40 appeared to measure depression and CR attendance (or compliance, attrition, etc.), but did not provide quantitative data for the relationship between depression and CR attendance or the entire CR sample, did not have sufficient quantitative data to calculate an effect size, or grouped CR completion with CR enrollment/referral. Of those 40 studies, 31 individual authors were contacted based on corresponding author email information provided in the publication, while seven studies did not provide information on author correspondence, and three authors had multiple publications requiring data requests. Out of the 31 contacted authors, seven email addresses were no longer working, with emails “returned to sender.” In several instances of emails returned due to a non-working email address, the PI attempted to locate functional email addresses by searching the author's first and last name in Google. Only two correct emails were located by the Google search, and both authors were contacted. Requests for additional data was correctly sent to 26 authors total, with ten authors (38%) who responded and indicated that they did not have the necessary data as requested. Thus, no additional studies were added using author contacts.

Of the 17 studies that met inclusion criteria for the meta-analysis, 8 emails were sent to authors to confirm that the coded variables as interpreted by the current research team were correct. For example, authors were asked to confirm; the operational definition of completion, sample size between completers and non-completers, etc. Six authors (75%) responded and confirmed in each case 100% accuracy on coded variables by the current research team.

Study and Patient Characteristics

The present meta-analysis was based on a final sample of 19 independent effect sizes drawn from 17 empirical studies, incorporating more than 30,586 phase II CR participants (see Table 1 for sample characteristics). Average overall phase II CR completion rate was 67.9% (k = 19).

Patient characteristics. All studies reported sex, with a sample population consisting of 31% females (n = 9,460) and a sample population mean age of 65.5 (k = 16). Of the 12 studies that reported ethnicity (n = 29,523), cardiac rehabilitation patients were 86.5% Caucasian (n = 26,450). A serious deficit was observed in the reporting of population descriptive data for several important sociodemographic variables: only 32% of studies reported relationship status (k = 6), 15.8% reported patient education level (k = 3), 15.8% reported employment statistics (k = 3), and 10.5% reported insurance coverage (k = 2). More of the studies reported relevant medical variables: 36.8% of sampled studies reported CHD diagnosis (k = 7), and 36.8% inquired CR patients about antidepressant medication use (k = 7), both of which have been shown to be correlated with phase II CR attendance (Suaya et al., 2007). Lastly, only 36.8% of samples measured and reported the four major independent risk factors for CHD in some fashion (hyperlipidemia, k = 6; high blood pressure, k = 5; diabetes, k = 6; and current smoking, k = 7).

Study characteristics. Of the 19 studies included in the meta-analysis, 16 were published articles (between 1982-2014), two were published dissertations (2010 & 2013), and one was an unpublished Master's thesis (2011). Fifteen studies were conducted in the United States (88%), one was conducted in the United Kingdom (6%), and one in Canada (6%).

Study-level descriptive data. Depression was measured by six different assessment tools: BDI -IA ($k = 4$), BDI-II ($k = 6$), CES-D ($k = 3$), HADS ($k = 2$), KSQ ($k = 2$), MMPI-D ($k = 1$), and self-report of historic or current antidepressant use ($k = 1$). The operational definition of depression was measured continuously in 79% of the studies ($k = 15$) and measured dichotomously in 21% of the studies ($k = 4$).

Operational definitions of dichotomous completion varied amongst the literature sample populations, with: 47% defining completion as dichotomously attending 100% versus less than 100% of prescribed sessions ($k = 8$), 26.3% defining completion as discharge by medical staff ($k = 5$), while the remaining study populations ($k = 6$) each defined completion differently, including: case manager discharge or 83% attendance of prescribed sessions, attending a minimum of 2/3 (66%) prescribed sessions, attending more than seven weeks, attending at least 70% or 75% of prescribed sessions, and attending 100% prescribed sessions plus passing a physical assessment at discharge. Phase II CR completion was measured continuously in three studies, thus the operational definition of completion was total number of sessions attended rather than a dichotomous variable (Anderson & Emery, 2014; Casey, 2011; Jackson, 2008).

The length of CR programs were reported in all studies ($k = 19$), and varied between six weeks to one year, with: 6% lasting six weeks ($k = 1$), 61% lasting 12 weeks ($k =$

12), 6% lasting 24 weeks (k = 1), 6% lasting one year (k = 1), and 21% comprised of individually tailored CR durations (k = 4).

Omnibus Summary Effect

The weighted mean summary effect for a random-effects meta-analysis was greater than zero, indicating that depressed CR participants were significantly less likely to complete their prescribed program (g = - 0.44, p < .001, 95% CI -0.59 to -0.29). Given the moderate effect size and small confidence interval, it appears that depression amongst CR participants does moderately affect CR completion rates (Borenstein et al., 2009; Cohen, 1992; Lipsey & Wilson, 2000). See Figure 2 for the omnibus forest plot and Table 2 for independent summary effect sizes, including study descriptors.

Publication bias. A small amount of publication bias was detected by the funnel plot, observed by a lack of symmetry between the left and right sides of the plot, especially with an absence of studies located on the bottom-right portion of the plot. A trim-and-fill analysis indicated that a small amount of publication bias was present, with a total of five studies trimmed and imputed from the funnel plot with an adjusted decrease in summary effect, g = -0.33, 95% CI -0.46 to -0.19, Q = 116.78. See Figure 3 for funnel plot with trim-and-fill analysis.

Subgroups Analyses in a Mixed Effects Model

A significant amount of heterogeneity was found among the effect sizes, Q [18] = 95.57, p < .001, indicating that there was more variability in the effect sizes than expected by chance alone, with 81.2% consisting of true variance between studies (I^2 = 81.2). A significant amount of heterogeneity among the effect sizes suggested the need to perform moderator analyses to determine what amount of variability in the effect sizes was explained by study and subject level characteristics. Only eight categorical moderators met the *a priori* criteria of 10

studies ($k \geq 10$) per moderator, and a minimum cell size of three ($k \geq 3$) (Borenstein et al., 2009): cardiac sample, type of depression assessment, dichotomization of depression, length of program, operationalization of CR completion (100% versus <100% sessions attended; qualitative versus quantitative), dichotomization of attendance, and literature type (published versus unpublished studies). These eight variables were individually examined by testing whether between group heterogeneity (Q_B) was significantly different from zero, or rather, whether differences between studies are beyond what would be expected by chance alone. Results found no significant differences between any categorical moderator variables. See Table 3 for a summary of the categorical moderators.

Cardiac sample. Ten of the studies assessed CR participants with CHD only, whereas nine studies assessed a multitude of cardiac disorders, including CHD and CHF. Subgroup analysis detected no significant differences in effect size magnitude between cardiac populations, Q_B [1] = 0.55, p = .456, which suggests that the effect between depression and CR completion remains consistent amongst different cardiac conditions.

Type of depression assessment. Subgroups analysis was run on the six validated psychometric depression assessment tools (BDI-IA, BDI-II, CES-D, HADS, KSQ, and MMPI-D), in addition to one measure of self-reported depression (historic or current antidepressant use). Ten studies that utilized the BDI-IA or BDI-II were combined into one subgroup due to the high convergent validity between measures, while the remaining nine studies that used either CES-D (k = 3), HADS (k = 2), KSQ (k = 2), MMPI-D (k = 1), and self-report of history of antidepressant use (k = 1) were combined into a second subgroup to maintain a comparable cell size for categorical comparison. No significant differences in effect size magnitude was observed between the BDI-IA/BDI-II and the other depression assessments, Q_B [1] = 2.75, p = .097,

indicating that the type of depression assessment tool did not significantly influence the reported mean summary effect for depression and CR completion.

A second subgroups analysis was run on three depression assessment subgroups: BDI-IA/BDI-II ($k = 10$), CES-D ($k = 3$), and other (HADS, $k = 2$; KSQ, $k = 2$; MMPI-D, $k = 1$; and self-report, $k = 1$), as the BDI-II and the CES-D assess different dimensions of depression. No significant between-group differences were detected (Q_B [2] = 2.76, $p = .251$). See Table 4 for model comparison.

Dichotomization of depression. The operationalization of depression was measured either dichotomously ($k = 4$) as depressed or non-depressed patients, or as a continuous scale score ($k = 15$) as mean depression scores between completers and non-completers. The effect size magnitude did not vary significantly between studies that dichotomized depression, or measured it continuously, Q_B [1] = 0.11, $p = .739$.

Length of CR program. The durations of CR programs varied between 6 weeks to 1 year, with the modal program length of 36 sessions, or 12 weeks. The studies with 12 week programs ($k = 14$) were compared to the remaining studies ($k = 5$) that represented a large variance in program duration (6 weeks to one year). Subgroups analysis indicated that effect size magnitude did not vary significantly between the length of programs, Q_B [1] = 0.66, $p = .417$, though a significant amount of variance was detected within the 12 week programs, Q_W [13] = 78.68, $p < .001$, $I^2 = 83.48$. Specifically, the 12 week programs contained the majority of effect size variance (83.5%) within the entire model, though this may be a function of the high cell count within this subgroup.

Operationalization of CR completion. Cardiac rehabilitation program completion criteria varied amongst the CR programs, ranging between quantitative data (e.g.,

≥75% session attended; 100% sessions attended; etc.) and qualitative data (e.g., case manager discharge). Two separate subgroups analyses were run: one assessing differences in a quantitative definition of CR completion, defined as a binary moderator of 100% attendance compared to less than 100% attendance, and a second analysis assessing differences between a quantitative compared to a qualitative measure of completion.

100% versus less than 100% attendance. Nine studies defined completion as 100% attendance of required sessions (including studies that measured attendance continuously as number of sessions attended), while six studies defined completion as a percentage or ratio of attendance of required sessions. No significant differences in effect size magnitude was observed between 100% versus less than 100% attendance, Q_B [1] = 1.321, p = .25, though there was a significant amount of within-study variance in the less than 100% subgroup, Q_W [5] = 25.13, $p < .001$, $I^2 = 80.101$.

Quantitative versus qualitative definition of completion. Fifteen studies defined completion as a quantitative measure of attendance (e.g. 100% prescribed sessions, >75% prescribed sessions, number of sessions attended, etc.) while four studies defined completion quantitatively (e.g. case manager discharge). No significant differences were detected between subgroups, Q_B [1] = 0.058, p = .809.

Dichotomization of attendance. Three of the nineteen studies measured CR completion continuously, as number of sessions attended (Anderson & Emery, 2014; Casey, 2011; Jackson, 2008), rather than dichotomously as "complete/not-complete". No significant difference in effect size magnitude was observed between studies that dichotomized completion, or measured it continuously, Q_B [1] = 3.13, p = .077.

Literature type. Sixteen studies were articles located in peer reviewed journals, two studies were dissertations located in *Dissertations and Abstracts International*, and one study was an unpublished Master's thesis. Subgroups analysis compared the 16 peer reviewed published studies to the three non-peer reviewed studies, Q_B [1] = 0.42, p = .518, indicating that there were no significant differences between the journal articles and the dissertations or the thesis.

Meta-Regression Analyses.

To examine continuous moderator variables, five separate random-effects meta-regression analyses were performed on the five variables that met the *a priori* criteria of ten studies per moderator ($k \geq 10$): mean age, percent female, percent Caucasian, percent MI, and percent CABG. To determine whether the remaining continuous variables account for significant between-studies variance, each moderator variable was correlated with the corresponding effect size. No significant between-study differences were detected amongst any of the variables. See Table 5 for a detailed report of the continuous moderators.

CHAPTER 4: DISCUSSION

Summary of Results

Cardiac rehabilitation is an efficacious secondary treatment intervention that is considered a primary recommendation for disease maintenance for cardiac patients with established CVD. However, rates of CR completion are low (AAVCPR, 2014; AHA, 2014; Cooper et al., 2002; Grace et al., 2002; Grace et al., 2008; Suaya et al., 2007). Depression has been identified as a predictor of recurrent CEs, and has been investigated as a potential barrier of CR completion (Cooper et al., 2002; Jackson et al., 2005; Lane et al., 2001). The purpose of the current study was to conduct a systematic literature review and meta-analysis to evaluate the relationship between depression and CR completion.

In the current systematic literature review, 17 studies with 19 independent samples were gathered for this meta-analysis. A random effects meta-analysis was used to test the overall summary effect between CR patient depression and completion rates, moderator analyses were conducted, and publication bias was explored.

Explanation of Findings

Omnibus analysis. The omnibus analysis included 30,586 phase II CR patients from the US, Canada, and the UK. Depression was inversely related to CR completion rates (g = -.44, 95% CI -.59 to -.29). This finding indicates that depressed CR patients were significantly less likely to complete their CR program. Results indicate the relationship between depression and phase II CR completion has a moderate effect size (Cohen, 1992).

Publication bias. Publication bias was tested using the funnel plot and trim-and-fill analysis. The funnel plot was asymmetric, with more studies found on the bottom left side of the plot, indicating possible publication bias. As a sensitivity test, Duvall and Tweedie's trim-

and-fill analysis removed and imputed five studies from the meta-analysis, with a new smaller summary effect (g = -.33) as compared to the original summary effect (g = -.44). Although the summary effect decreased in magnitude, the new readjusted summary effect still indicates a moderate effect between depression and CR completion (Cohen, 1992).

Moderator analyses. Eight discrete variables analyzed with subgroups analysis and five continuous variables assessed with meta-regression were tested. A significant amount of between-study heterogeneity was found with the Q statistic, which means the observed variance should be explained by actual differences between studies as opposed to random error (Borenstein et al., 2009). However, moderator analyses did not identify any individual moderator variable that significantly influenced effect size results. This may be a result of a few issues.

The Q statistic does not measure the true heterogeneity in meta-analyses, but rather whether study variance is statistically significant. Further, it is subject to power issues (Huedo-Medina, Sanchez-Meca, Marin-Martinez, & Botella, 2006). In addition, the I^2 statistic, representing the estimated amount of observed variance (or "true" variance) between studies also indicted a large amount of between-study variance (81.2%), yet it is also subject to power issues (Huedo-Medina et al., 2006). Hence, the inability to detect a significant moderator may have been due to a lack of power in testing moderator variables.

First, *a priori* criteria for moderator analyses specified that a minimum number of studies is required to test individual moderator variables ($k \geq 10$), in addition to a minimum cell size of three studies ($k \geq 3$) per cell needed to run analyses with minimal statistical error (Borenstein et al., 2009). The literature sampled in this meta-analysis lacked sufficient reporting to meet the *a priori* criteria for many pre-established sociodemographic and medical variables that are known to influence CR attendance, such as SES, employment, relationship status, and

number/type of CHD risk factors (smoking, diabetes, hyperlipidemia, and hypertension), which reduced the number of data points to be analyzed (Balady et al., 2011: Beswick et al., 2005; Clark et al., 2013; Cooper et al., 2002; Grace et al., 2002). Therefore, the lack of reporting reduced the ability to run potential moderator variables accurately under *a priori* conditions since most variables were reported in less than ten studies.

Second, moderator analyses may have been underpowered, therefore attenuating the ability to detect differences between studies due to subgroup membership. Many subgroup moderator variables that were tested barely met the *a priori* cell count of three ($k \geq 3$), which may have attenuated some of the analyses due to a lack of power (Borenstein et al., 2009; Huedo-Medina et al., 2006). For example, dichotomization of attendance and literature type moderator variables each tested cell counts of three ($k = 3$; continuous measure of attendance and unpublished studies) versus 16 ($k = 16$; dichotomized attendance and published studies). According to Borenstein et al. (2009), using a cell size of three may not provide sufficient variance to test moderators under the mixed effects model. To further clarify, the subgroups that contained the smallest number of studies ($k = 3$ or 4) contained the least amount of variation within subgroup membership, denoting low power. Low power may have influenced moderator analyses with small cell size. For example, comparison of the two subgroup depression assessment models shows that smaller cells provide less variation per subgroup. To demonstrate, the first depression assessment subgroup model (BDI-IA/BDI-II; $k = 10$, versus CES-D, HADS, KSQ, MMPI-D, and self report of antidepressant use; $k = 9$) had similar cell sizes and the p value approached significance ($p = .097$). On the other hand, the second depression assessment subgroup model (BDI-IA/BDI-II; $k = 10$, versus CES-D; $k = 3$, versus HADS, KSQ, MMPI-D, self report; $k = 6$) produced a smaller p value ($p = .251$), indicating that there is less between

group variance when the cell sizes are reduced. This may support the notion that many of the moderator analyses were underpowered for adequate between-study comparison.

Third, the large sample size (n = 26,957) of Gordon et al. (2013) may have dominated the moderator analyses. Gordon et al. (2013) provided data on moderator variables such as gender, ethnicity, mean age, and previous accounts of cardiac diagnoses/procedures (percentage of previous MI and CABG). Unfortunately, the lack of sufficient reporting from the other studies included in the analysis may have added to the inability to detect significant moderators. For example, 90.2% of participants in the Gordon et al. (2013) study were white (n = 24,315). This equates to 79.5% of all white CR participants in the meta-analysis from this study alone, in addition to the remaining 2,135 white participants from the remaining 11 studies that reported ethnicity. Outside of insufficient reporting from other studies, the large sample size of Gordon et al. (2013) may have confounded moderator results as well. For example, the CHD (k = 10, n = 28,329) versus all cardiac (k = 9, n = 2,257) conditions moderator is another example how the sample size of Gordon et al. (2013) may have dominated the between-study variation. Even though the cell sizes are almost evenly matched, the sample sizes are largely disproportionate, making detection of variation difficult. In conclusion, the moderator analysis may have been underpowered in general, in addition to the extremely large contribution Gordon et al. (2013) which may have independently over-contributed to the analyses itself.

Strengths of Current Study

The current study appears to be the first systematic literature review and meta-analysis conducted assessing the relationship between depression and CR completion. Also, the systematic literature review and meta-analysis was consistent with the PRISMA guidelines, with a documented protocol to ensure quality standards were met (Moher et al., 2009). Third, the

current meta-analysis included studies with an international sample of cardiac patients in English-speaking countries. Thus, the findings are expected to generalize to phase II cardiac CR patients in the US, Canada, and the UK.

Data accuracy checks were implemented throughout the data extraction and coding procedures. First, there were two coders that extracted data from all 17 studies (B.E. & A.G.), including a confirmation check on the most pertinent data by a third party (S.S.). In order to ensure data was as accurate as possible, authors of 10 studies included in meta-analysis were contacted by email for data confirmation. Of the authors who responded back with the confirmation that agreed with 100% accuracy to the data obtained by coders.

Best practices were used throughout the meta-analysis. The best practices for systematic literature reviews and meta-analyses are parallel with PRISMA guidelines, including (1) a clear introduction outlining rationale, (2) methods describing literature search, selection criteria, data extraction, and analytical choices, (3) results including a flow diagram, individual study characteristics/results, quantitative summary for each outcome variable, including subgroup and/or sensitivity analyses, (4) a discussion of main findings and limitations, (Mandrekar & Mandrekar, 2011; Moher et al., 2009). Lastly, *a priori* decisions were made for moderator analyses, with a minimum of ten studies ($k \geq 10$) and three studies per cell ($k \geq 3$) required to test each individual moderator in an effort to avoid statistical error or alpha slippage (Borenstein et al., 2009).

Limitations of Current Study

The current systematic literature review and meta-analysis included only studies that were written in English, from CR programs located in the US, Canada, and the UK. Including only publications written in English may have reduced the number of studies included

in the meta-analysis, in addition to eliminating any contributing results to the main and moderator analyses that may be present within non-English speaking populations. Also, all studies included were clinic-based CR. Home-based CR has been shown to be equally as efficacious as traditional clinic-based CR, which include cardiac patients that participate in a CR program provided at home rather than CR clinics (Dalal, Zawada, Jolly, Moxham, & Taylor, 2010). Home-based CR was not included in this study because there are no published studies assessing depression and completion of home-based CR programs. Overall, the results of this study are only generalizable for English-speaking, clinic-based CR patients.

Another limitation of the current systematic literature review and meta-analysis is that a quality analysis of studies, which rates the quality of individual observational studies on a quantitative rating scale, was not conducted (Dreyer, Velentgas, Westrich, & Dubois, 2014). This could provide insight into how rigorous the studies are, and could be analyzed to examine study quality as a moderator variable.

Lastly, the current meta-analysis made the *a priori* choice to include studies as long as they provided a quantitative measure of relation between depression and CR completion. This resulted in the inclusion of the Gordon et al. (2013) study, in which depression was defined as a history of antidepressant use as a positive identifier for depression, rather than a psychometric measure of depression administered at CR intake. Though self-reported use of antidepressants may accurately identify a history of depression, it is not seem to be conceptually comparable to total scores from validated depression measures, such as the BDI, HADS, or CES-D, that were utilized in other CR studies.

Limitations in the literature. Inconsistencies amongst the literature and clinical methodologies were observed throughout the literature. To begin, this study explored the

relationship between depression and CR attendance that included statistical artifacts. Artificial dichotomization of depression ($k = 4$) and CR completion ($k = 16$) was found in the majority studies. Regarding the measures of depression, depression was measured with continuous measures in 18 samples included in the meta-analysis, but the studies only reported on depression as a dichotomized variable (depressed/not depressed) in four studies. Moreover, the diagnostic accuracy of depression was limited due to dichotomization since studies used different operational definitions of depression, so one study would define depression with a BDI-II cutpoint score ≥ 10, and another study would define depression with a BDI-II cutpoint score ≥ 14. In like manner, CR completion was artificially dichotomized in the majority of included studies. Clinic-based CR programs record medical variables (e.g., blood pressure, heart rate, peak Vo2) at each attended CR session, hence attendance is recorded as a continuous variable in patient charts for medical purposes. Although CR completion is recorded as a continuous variable, it was reported and analyzed dichotomously in 16 of the samples included in this study. Dichotomization of the IV and/or DV reduced the ability to accurately identify the true effect of depression on CR completion, as statistical artifacts reduce sensitivity and may contribute to biased results (Altman & Royston, 2006**;** Lipsey & Wilson, 2001). Moreover, testing depression and CR completion as dichotomous variables does not allow for analysis to determine if there is a dose-response relationship between depression and number of CR sessions attended that has been identified in previous research (Hammill et al., 2010; Suaya et al., 2007). Artifact correction, which would have been the most conservative analytical choice, was not employed since all of the included studies had artifacts in some fashion. Instead, dichotomization of the IV (depression) and the DV (CR completion) were both tested in individual subgroups analyses as moderator variables.

Recommendations for Future Research

General methodological recommendations. Many of the studies included in the meta-analysis lacked sufficient reporting of basic and theoretically important demographic information and analytical choices. For instance, ethnicity was only reported in 11 studies, employment reported in three studies, and number/type of CHD risk factors reported in four studies. In addition, covariates were not controlled for in many studies that ran regression analyses. Lastly, 19 studies were not included in the systematic review or meta-analysis due to missing, insufficient, or confusing analytical methodology and/or quantitative data. For example, five studies reported testing the relationship between depression and CR attendance, though did not provide an inferential statistic to quantify the relationship because the results were not significant. The authors were contacted as part of the systematic literature review, but did not respond or were unable to provide requested data. This raises the possibility that the true effect for depression and CR completion may be smaller than the medium effect size found. In sum, insufficient reporting within the literature contributed to an inability to test important potential moderator variables, in addition to limiting the number of studies included in the meta-analysis.

CR Reporting Standardization. Standardization of attendance measures in CR programs may be difficult due to the large variation in individual program lengths and definitions of completion. In the literature, CR attendance and completion variables have vastly different and incomparable operational definitions (e.g., attend >70% sessions; attend 100% sessions plus pass of physical assessment; case manager discharge). For that reason, it is recommended that regardless of the clinical definition of completion, for research purposes CR attendance should be analyzed and reported as a continuous variable in future literature. The dose-response relationship between CR attendance and subsequent events has been previously established yet

the majority of literature report attendance in a dichotomous fashion (Hammill et al., 2010; Suaya et al., 2009). Analyzing and reporting CR attendance by number of sessions attended would keep participation metrics standardized as a continuous variable, in addition to maintaining the statistical integrity and sensitivity that continuous metrics provide (Altman & Royston, 2006; Hunter & Schmidt, 1990).

STROBE Reporting Standards. Transparency is lacking in the majority of epidemiological research (von Elm et al., 2007). Observational studies are real-world examples of what is commonly found in daily medical and mental health practices/clinics, though reporting of observational data has it's own unique set of criteria required for transparency and quality reporting (von Elm et al., 2007). The scientific community has established that guidance and standardization are needed for quality reporting in observational research. The committee for Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) consists of researchers, methodologists, and journal editors that have created a checklist and recommendations for observational studies, called the STROBE Statement (von Elm et al., 2007). The STROBE Statement is a checklist of 22 essential items of quality reporting created for three types of observational designs: cohort, case control, and longitudinal studies (von Elm et al., 2007). Specifically, the checklist is focused on clear explanations on participant eligibility criteria, variables explored, analytical/methodological choices, and thorough reporting of participant descriptive data, all analyses and tested statistical results, and any confounding variables that may have affected findings (von Elm et al., 2007). To increase research transparency, standardization has been extended by PLOS Medicine editors (2014) that includes a requirement of adherence to the STROBE protocol and completed checklist upon manuscript submission (PLOS Medicine Editors, 2014). Thus, it is recommended that future studies

examining the relationship between depression and phase II CR attendance report according to STROBE standards.

Future research for depression and CR. Future clinical research should focus on depression interventions for depressed CR patients to determine if providing appropriate depression interventions for depressed phase II CR patients may simultaneously decrease depression and increase completion rates, both of which are predictors of reduced CEs, cardiac mortality, and all-cause mortality (Anderson et al., 2016; Gan et al., 2014; Lawler et al., 2011; Lichtman et al., 2014; Taylor et al., 2004). Lastly, if depression interventions increase attendance rates in phase II CR, subsequent research should focus on whether such depression interventions in CR reduce additional CEs, and cardiac or all-cause mortality in secondary clinical populations.

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Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica, 67,* 361-370.

Zuisderma, M., Conradi, H. J., van Melle, J. P., Ormel, J., & de Jonge, P. (2013). Self-reported depressive symptoms, diagnosed clinical depression and cardiac morbidity and mortality after myocardial infarction. *International Journal of Cardiology, 167,* 2775-2780.

Table 1
Sociodemographic and Medical Characteristics of Study Participants

Variable	% *M* (*SD*)	*N*	*k*
Study Location			
US	98.7	30202	17
UK	0.62	189	1
Canada	0.64	195	1
Age			
Mean Age	65.5 (11.7)	30003	16
CR completers	62.3 (8.9)	2516	9
CR non-completers	57.9 (9.3)	2562	10
Sex			
Female	30.9	9460	19
CR completers	75.4	722	9
CR non-completers	24.6	235	
Male	69.1	21126	19
CR completers	80.9	1196	7
CR non-completers	19.1	283	
Ethnicity			
White	86.5	26450	12
Black	6	1596	5
Married	66.2	1121	6
Employed	44.8	968	3
Education (Mean years)	13.7 (3.1)	691	3
Cardiac Diagnoses/Procedures			
MI	38.9	11128	12
CABG	31.6	9328	13
PCI/PTCA	30.1	1472	5
Angina	13.5	1414	5
CHF	7.6	61	4
CHD Risk Factors			
current smoking	7.3	28141	8
hyperlipidemia	59.7	1131	6
diabetes	24.3	27952	6
hypertension	73.1	995	5
Current Antidepressant Use	8.4	2424	6

Note. *k* = number of samples, US = United States, UK = United Kingdom, CR = phase II cardiac rehabilitation, MI = myocardial infarction, CABG = coronary artery bypass graft, PCI = percutaneous coronary intervention, PTCA = percutaneous transluminal coronary angioplasty, CHF = congestive heart failure.

Table 2

Descriptives of the 19 Individual Studies Included in the Meta-Analysis

Study	year of publication	*N*	Mean Age	Women (%)	CR completion rate (%)	Depression measure	CR length / operational definition of CR completion	Effect size (*g*)	95% CI	
									LL	*UL*
Anderson & Emery	2014	61	59.9	29.5	74.4	CES-D	ITD (20-36 sessions) / AIRS	0.08	-0.43	0.58
Beckie et al.	2014	252	62.63	100	89.3	CES-D	12 weeks (36 sessions) / attend 100% sessions	-0.74	-1.14	-0.33
Blumenthal et al.*	1982	35	53.7	8.6	60	MMPI	1 year / attend > 75% sessions	-0.76	-1.44	-0.07
Casey[a]	2011	116	63.8	27	35	BDI-II	12 weeks (36 sessions) / number of sessions attended	-0.37	-0.57	-0.17
Casey et al.*	2008	600	66	30	78.8	BDI-IA	ITD (12-36 sessions) / CMD	0.02	-0.35	0.39
Clausin-Glaser et al.	2007	348	62.62	28.7	84.7	BDI-II	12 weeks (36 sessions) / attend > 7 weeks	-1.16	-1.51	-0.80
DeYoung[b]	2013	51	61.3	31.4	62.7	HADS	ITD (20-36 sessions) / CMD	-0.81	-1.64	0.20
Glazer et al.*	2002	46	58	26	78.3	BDI-IA	12 weeks / attend > 2/3 sessions	-1.10	-0.18	-0.38
Gordon	2013	26957	68.3	30.2	45.8	Self report	12 weeks (36 sessions) / CMD	-0.12	-0.15	-0.09
Jackson[b]	2013	56	59.5	35	82.1	BDI-IA	12 weeks (36 sessions) / number of sessions attended	-0.47	-1.01	0.08
Josephson et al.	2006	402	66.2	28	79.6	BDI-IA	12 weeks (36 sessions) / attend 83% sessions	-0.48	-0.73	-0.24
Lavie & Milan cohort 1	2006	156	48	26	66.7	KSQ	12 weeks (36 sessions) / attend 100% sessions	-0.29	-0.62	0.05
Lavie & Milani cohort 2	2006	328	75	26	79.3	KSQ	12 weeks (36 sessions) / attend 100% sessions	-0.18	-0.45	0.08
McGrady et al.*	2009	380	61.2	37	50	BDI-II	12 weeks (36 sessions) / attend 100% sessions	-0.38	-0.58	-0.17
McGrady et al. cohort 1	2014	168	62.8	32	67.8	BDI-II	12 weeks (36 sessions) / attend 100% sessions	-0.40	-0.72	-0.07
McGrady et al. cohort 2	2014	136	60.3	34	64.7	BDI-II	12 weeks (36 sessions) / attend 100% sessions	-0.63	-0.99	-0.27
Sanderson & Bittner*	2005	110	62	100	53.1	BDI-II	ITD (24 – 36) / CMD	-0.78	-1.16	-0.39
Swardfager et al.*	2011	195	64.3	21	67.7	CES-D	6 months / attend >70% sessions	-0.30	-0.69	0.09
Yohannes et al.*	2007	189	60.8	31.7	71.4	HADS	6 weeks / attend 100% sessions + PPA	-0.39	-0.73	-0.04

Note. BDI = Beck Depression Inventory, BDI-II = Beck Depression Inventory II, CES-D = Center for Epidemiological Studies Depression Scale, HADS = Hamilton Anxiety and Depression Scale, KSQ = Kellner Symptom Questionnaire, MMPI = Minnesota Multiphasic Personality Inventory, AIRS = attend insurance-required sessions, CMD = case manager discharge, ITD = individually tailored durations, PPA = pass physical assessment.

* studies that were collected for thesis proposal.

[a] = Master's thesis, [b] = Doctoral dissertation

Table 3

Subgroup Comparison of Categorical Moderators, Including 95% Confidence Intervals and Amount of Both Within and Between-Study Variance Accounted For

Variable	Q_B	*p*	*N*	*k*	*g*	95% CI	Q_W	*p*
CR population	0.555	.456						
CHD only			28,329	10	-0.386	-0.58, -0.19	34.3	.000
all cardiac			2,257	9	-0.489	-0.68, -0.29	24.8	.002
Length of CR program	0.659	.417						
12 weeks			30,006	14	-0.410	-0.57, -0.25	76.7	.000
other			580	5	-0.555	-0.86, -0.24	4.4	.349
Definition of completion	0.058	.809						
Quantitative			2466	15	-0.448	-0.61, -0.29	38.6	.000
Qualitative			28210	4	-0.407	-0.69, -0.12	19.4	.000
Definition of completion	1.321	.250						
100% attendance			1726	9	-0.378	-0.57, -0.19	10.4	.235
< 100% attendance			1142	6	-0.568	-0.70, -0.12	25.1	.000
Depression instrument	2.762	.251						
BDI-IA/BDI-II			2,362	10	-0.528	-0.70, -0.36	29.5	.001
CES-D			508	3	-0.350	-0.70, -0.01	6.3	.043
other			27,716	6	-0.300	-0.52, -0.08	9.4	.096
Dichotomization of depression	0.111	.739						
Yes			27,313	4	-0.393	-0.69, -0.09	14.4	.002
No			3,273	15	-0.450	-0.61, -0.30	38.4	.000
Dichotomization of completion	3.128	.077						
Yes			30,353	16	-0.496	-0.66, -0.34	92.5	.000
No			233	3	-0.102	-0.51, 0.31	2.6	.275
Data source	0.418	.518						
Published			30,363	16	-0.461	-0.62, -0.30	91.1	.000
Unpublished			223	3	-0.307	-0.75, -0.13	4.4	.113

Note. Q_B = variance between groups; *k* = number of studies; *g* = Hedge's *g*; Q_W = variance within groups; BDI-IA = Beck Depression Inventory IA; BDI-II = Beck depression Inventory II; CES-D = Center for Epidemiologic Studies Depression Scale.

Table 4

Comparisons of Different Subgroup Models Assessing Two Definitions of CR Completion and Depression instrument

Variable	Q_B	*p*	*N*	*k*	*g*	95% CI	Q_W	*p*
Definition of completion	0.058	.809						
Quantitative			2466	15	-0.447	-0.60, -0.29	38.6	.000
Qualitative			28120	4	-0.547	-0.93, -0.22	4.0	.000
Definition of completion								
100% attendance	1.321	.250	1726	9	-0.378	-0.57, -0.19	10.4	.235
< 100% attendance			1142	6	-0.568	-0.70, -0.12	25.1	.000
Depression instrument	2.762	.251						
BDI-IA/BDI-II			2362	10	-0.528	-0.70, -0.36	29.5	.001
CES-D			508	3	-0.350	-0.70, -0.01	6.3	.043
other			27716	6	-0.300	-0.52, -0.08	9.4	.096
Depression instrument	2.747	.097						
BDI-IA/BDI-II			2362	10	-0.528	-0.70, -0.36	29.5	.001
other			28224	9	-0.315	-0.50, -0.13	19.5	.012

Note. Q_B = variance between groups; *k* = number of studies; *g* = Hedge's *g*; CI = confidence interval; Q_W = variance within groups; BDI-IA = Beck Depression Inventory IA; BDI-II = Beck Depression Inventory II; CES-D = Center for Epidemiologic Studies Depression Scale.

Table 5

Method of Moments Meta-Regression of Continuous Moderators Based on the Z-Distribution

Variable	*Coefficient*	Q_{Model}	*p*	*k*	95% CI	I^2	Q_{Resid}	*p*	R^2	*r*
Percent Female	- 0.461	0.86	.352	19	-1.025, 0.192	80.93	89.2	.000	.03	.17
Mean Age	0.014	1.21	.271	19	-0.011, 0.038	73.46	64.1	.000	.21	.46
Percent White	- 0.001	0.04	.842	12	-0.008, 0.007	85.64	62.7	.000	.00	.24
Percent MI	0.02	0.00	.953	12	-0.619, 0.658	77.78	45.0	.000	.00	.24
Percent CABG	- 0.01	0.00	.991	13	-1.756, 1.737	82.17	61.7	.000	.01	.10

Note. Q_{Model} = model fit; *k* = number of studies; *g* = Hedge's *g*; I^2 = sample variance; Q_{Resid} = residual variance.

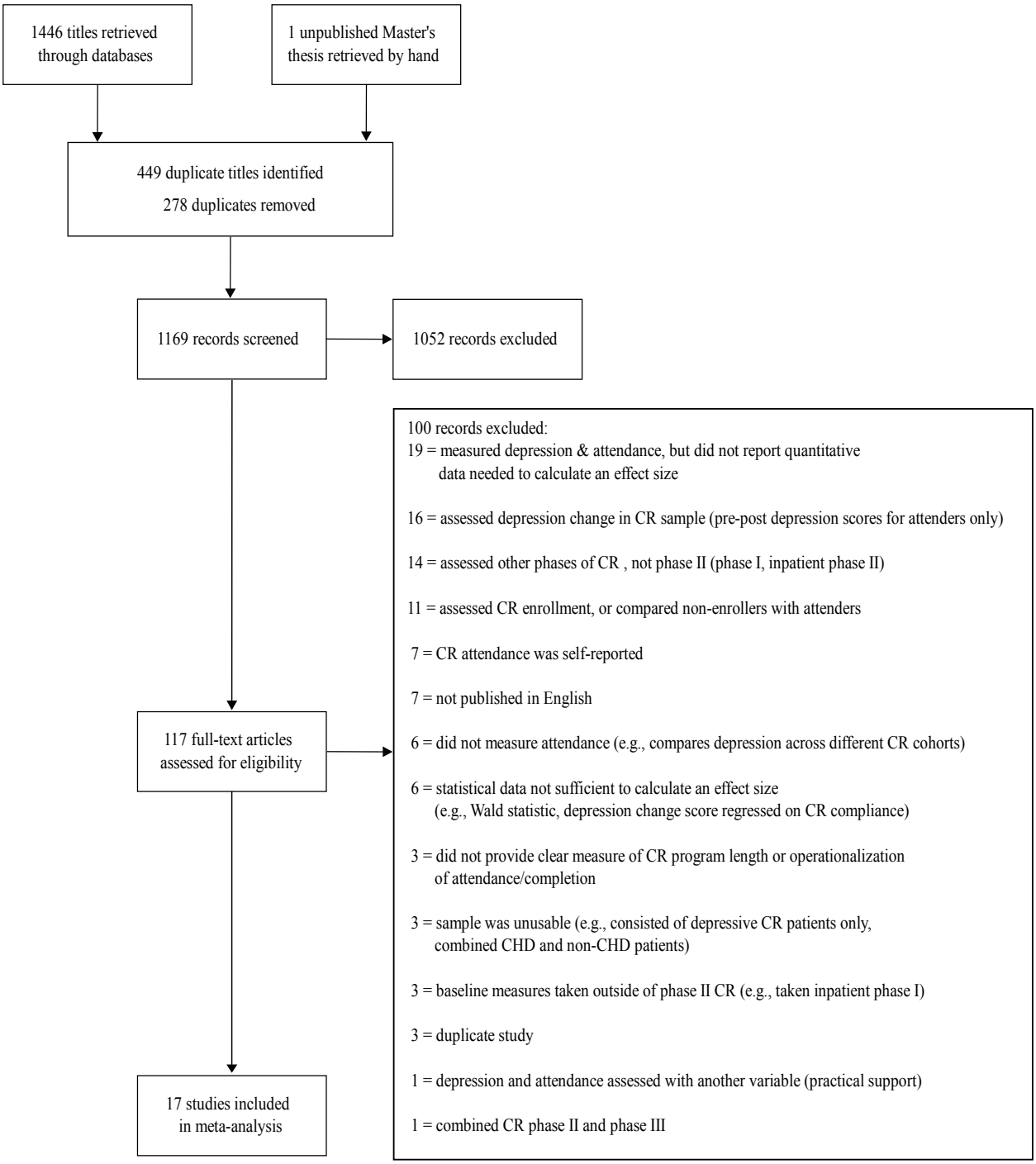

Figure 1. Study inclusion flow chart.

	Hedges' g	Lower Limit	Upper Limit	p-value
Anderson & Emery (2014)	0.079	-0.430	0.588	0.761
Beckie et al. (2014)	-0.736	-1.139	-0.333	0.000
Blumenthal et al. (1982)	-0.757	-1.441	-0.073	0.030
Casey et al. (2008)	-0.370	-0.567	-0.174	0.000
Casey (2011)	0.020	-0.346	0.386	0.915
Caulin-Glaser et al. (2007)	-1.156	-1.507	-0.804	0.000
DeYoung (2013)	-0.812	-1.644	0.020	0.056
Glazer et al. (2002)	-1.100	-1.824	-0.376	0.003
Gordon et al. (2013)	-0.118	-0.152	-0.085	0.000
Jackson (2010)[a]	-0.466	-1.012	0.079	0.094
Josephson et al. (2006)	-0.483	-0.727	-0.238	0.000
Lavie & Milani- c1 (2006)	-0.288	-0.620	0.045	0.090
Lavie & Milani- c2 (2006)	-0.184	-0.451	0.082	0.175
McGrady et al. (2009)	-0.376	-0.578	-0.173	0.000
McGrady et al.- c1 (2014)	-0.396	-0.723	-0.070	0.017
McGrady et al.- c2 (2014)	-0.633	-0.995	-0.271	0.001
Sanderson et al. (2005)	-0.776	-1.164	-0.388	0.000
Swardfager et al. (2011)	-0.299	-0.686	0.087	0.129
Yohannes et al. (2007)	-0.385	-0.729	0.042	0.028
Mean Summary Effect	**-0.442**	**-0.587**	**-0.296**	**0.000**

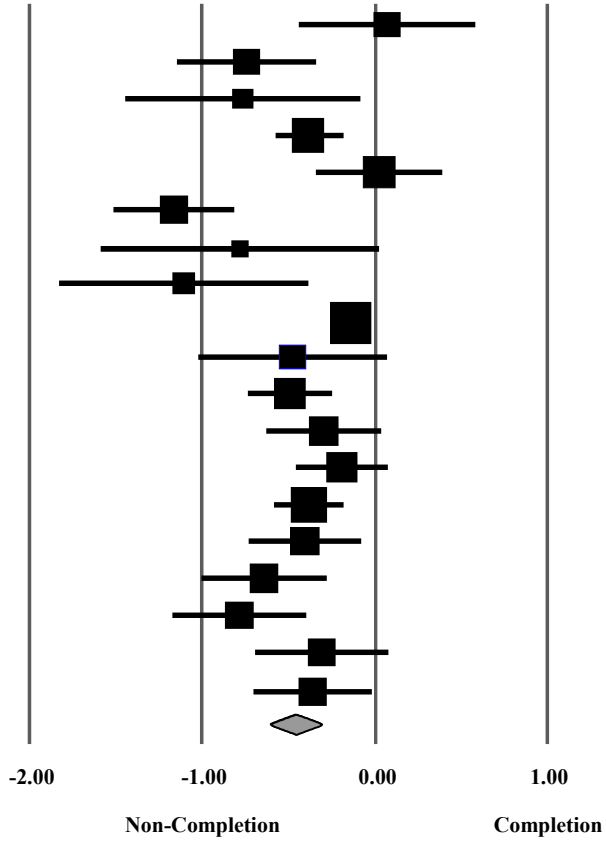

Figure 2. Omnibus forest plot.

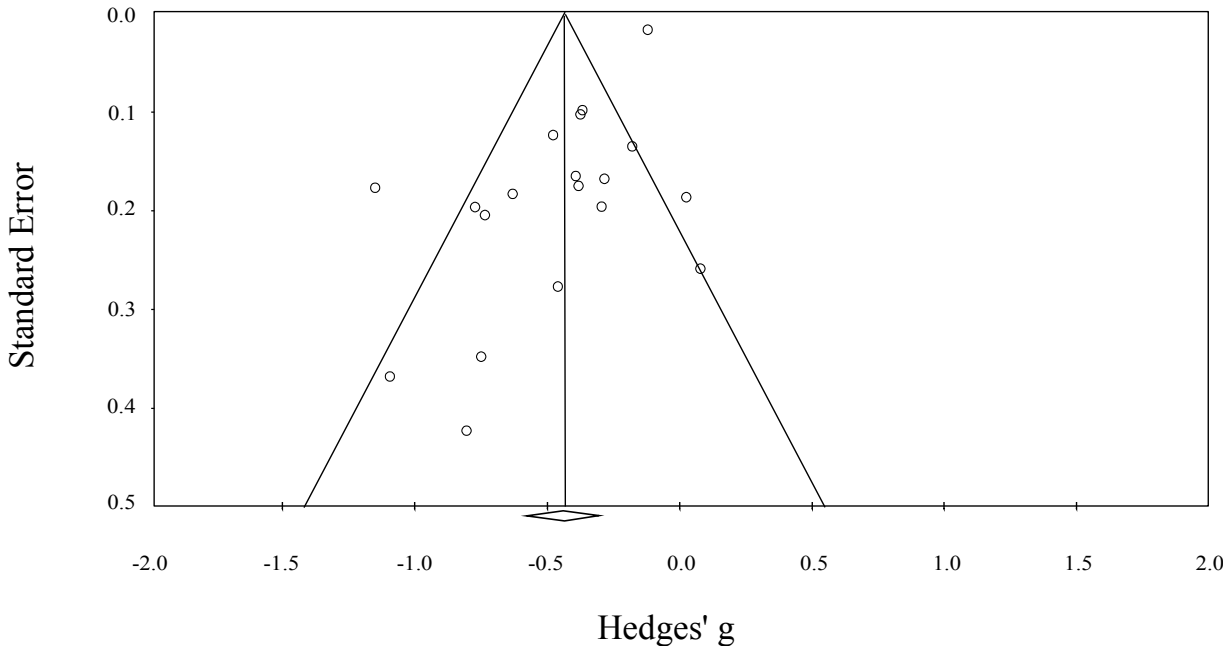

Figure 3. Funnel plot of Hedges' *g* against standard error.

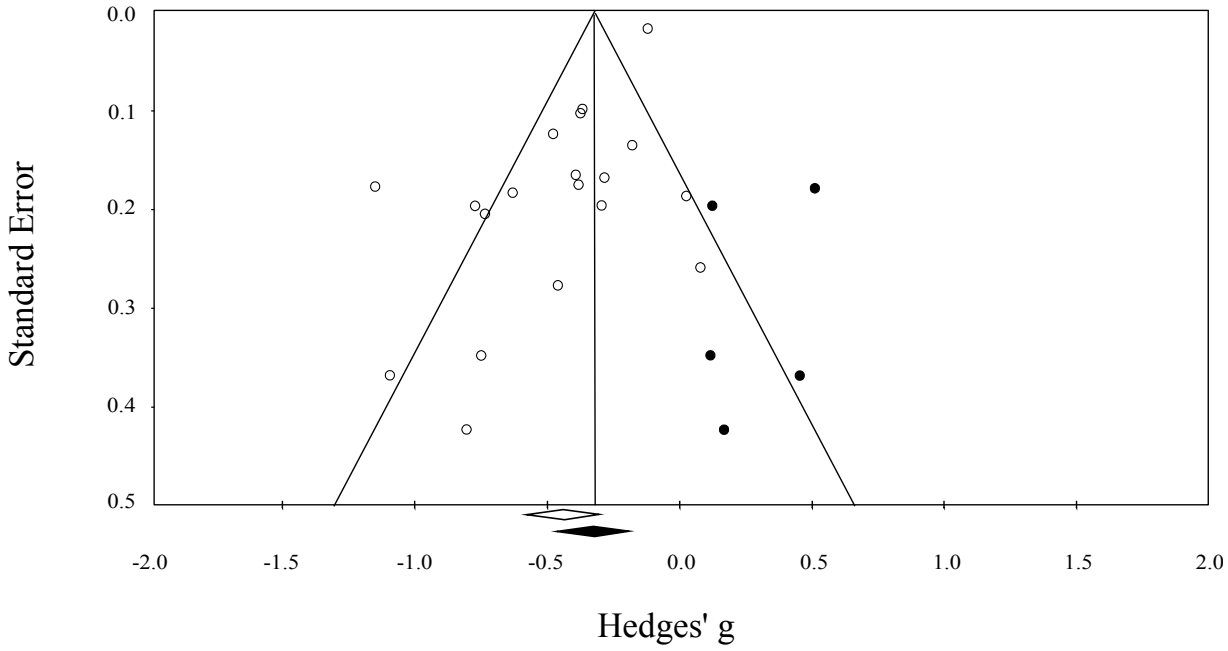

Figure 4. Imputed funnel plot with trim-and-fill analysis.

APPENDIX A
CODING FORM

Article (author, year, title): _____

Name of coder: _____

I. SAMPLE CHARACTERISTICS:

(a)	**study location (country)**	1	United States	
		2	United Kingdom (UK)	
		3	Canada	
		4	Germany	
		5	Israel	
		6	Denmark	
		7	China	
		8	other _____	
		-888	needs further review	
		-999	missing / not provided / unspecified	
(b)	**sample size** (for analysis of depression and CR attendance)	1	(N)	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	

SOCIODEMOGRAPHICS

(c)	**sex (male)**	1	raw n size	_____
		2	(% male)	_____
		-888	needs further review	_____
		-999	missing / not provided / unspecified	_____
(d)	**Mean participant age**	1	reported age (M)	_____
		2	reported age (SD)	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	
(e)	**race/ethnicity**	1	% NonHispanic White/Caucasian	_____
		2	% Non Hispanic Black	_____
		3	% Hispanic	_____
		4	% Asian/Pacific Islander	_____
		5	% Native American/American Eskimo	_____
		6	% Middle Eastern/Arab	_____
		7	% South Asian	_____
		8	other _____	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	

(f)	**SES (%)**	1	< $35,000	_____
		2	$35,000 – $60,000	_____
		3	> $60,000	_____
		4	< national average	_____
		5	at national average	_____
		6	> national average	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	
(g)	**Mean participant educational level**	1	mean educational level reported (M)	_____
		2	mean educational level reported (SD)	_____
		3	below high school (%)	_____
		4	high school (%)	_____
		5	above high school (%)	_____
		6	some college (%)	_____
		7	post college (%)	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	
(h)	**employment**	1	retired (%)	_____
		2	full time employment (%)	_____
		3	part time employment (%)	_____
		4	unemployed (%)	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	
(i)	**married**	1	married (%)	_____
		2	single/widowed (%)	_____
		3	living with someone (%)	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	
(j)	**insurance**	1	Medicare (%)	_____
		2	yes (%)	_____
		3	no (%)	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	

MEDICAL VARIABLES

(k)	**CHD diagnosis (%)**	1	CHD	_____
		2	MI	_____
		3	ACS	_____
		4	AMI	_____
		5	angina	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	

(l)	**surgical procedure (%)**	1	CABG (most recent hospitalization)	_____
		2	PCI (most recent hospitalization)	_____
		3	Any CABG (not including most recent hospitalization)	_____
		4	Any PCI (not including most recent hospitalization)	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	
(m)	**number of non-modifiable CHD risk factors** (current smoker, diabetes, hyperlipedmia, hypertension)	0	% reporting zero	_____
		1	% reporting 1	_____
		2	% reporting 2	_____
		3	% reporting 3	_____
		4	% reporting 4	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	
(n)	**other medical comorbidities** (write medical condition in spaces provided)		_____	
			_____	
			_____	
			_____	
			_____	
			_____	
		-888	needs further review	
		-999	missing / not provided / unspecified	

CR VARIABLES

(o)	**antidepressant use**	0	No, not reported	
		1	Yes, reported	
		-888	needs further review	
		-999	missing / not provided / unspecified	
(p)	**Operationalization: Length of CR program**	1	4 weeks	
		2	8 weeks	
		3	12 weeks	
		4	24 weeks (6 months)	
		5	52 weeks (1 year)	
		6	individually tailored durations	
		7	a combination of multiple programs w/ differing durations (% of each, if provided; e.g. combo of 8 & 12 week programs)	_____
		8	other _____	
		-888	needs further review	
		-999	missing / not provided / unspecified	

(q)	**Type of CR program**	1	hospital clinic based CR	_____
		2	home based CR	_____
		3	private clinic based CR	_____
		4	combination (% of each)	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	
(r)	**CR Phase**	1	Phase II	
		2	Phase III	
		3	Phase IV	
		4	other _____	
		-888	needs further review	
		-999	missing / not provided / unspecified	
(s)	**Distance from clinic (e.g. miles)**	1	miles from clinic (M)	_____
		2	miles from clinic (SD)	
		3	< XX miles from clinic (used as inclusion criteria; dichotomized; e.g. ≤ 5 miles from clinic)	_____
		-888	needs further review	
		-999	missing / not provided / unspecified	

II. MEASUREMENT FACTORS

(a)	**Operational Definition of Attendance/completion** (based on study definition of the raw number of participants that completed)	1	100% sessions attended
		2	100% sessions + final assessment
		3	> ¾ sessions attended (> 75%)
		4	> 2/3 sessions attended
		5	> ½ sessions attended (> 50%)
		6	exact # of sessions _____
		7	Medical staff/Case Manager recorded complete/did not complete
		8	qualitative self report (did you attend? Y/N)
		9	other _____
		-888	needs further review
		-999	missing / not provided / unspecified
(b)	**Operational definition of depression**	0	dichotomous
		1	continuous
		-888	needs further review
		-999	missing / not provided / unspecified

(c)	**Depression Assessment used**	1	HADS
		2	CES-D
		3	BDI-II
		4	BDI-IA
		5	PHQ-9
		6	PHQ-2
		7	MMPI
		8	SCID
		9	Professional Diagnosis
		10	Qualitative self report
		11	other _____
		-888	needs further review
		-999	missing / not provided / unspecified
(d)	**Type of research design**	1	observational
		-888	needs further review, or observational, yet nested in a larger study (e.g. RCT)

III. ANALYTICAL INCONSISTENCIES **reported result**

(a)	**Final type of analysis used to analyze relationship between depression and CR attendance**	1	Logistic Multiple Regression	_____
		2	Hierarchical Multiple regression	_____
		3	Forward Selection Multiple Regression	_____
		4	Forward Stepwise Multiple Regression	_____
		5	MANOVA	_____
		6	ANOVA	_____
		7	t-test	_____
		8	χ^2	_____
		-888	needs further review	
		-999	missing/not provided/ unspecified	
(b)	**Primary purpose of study was to investigate relationship between depression and CR attendance**	0	no (e.g. "Mandel et al: Effects of music therapy on health-related outcomes in CR: An RCT")	
		1	yes (e.g. "Yohannes: Predictors of dropout in Outpatient CR")	
		-888	needs further review	
		-999	missing/not provided/ unspecified	
(c)	**Study included a regression analysis with the following controlled for:**	0	no regression equation	
		1	sociodemographics (at least one)	
		2	medical variables (at least one)	
		3	sociodemographics and medical variables	
		-888	needs further review	
		-999	missing/not provided/ unspecified	

(b)	**Type of publication outlet**	1	published article	
		2	dissertation	
		3	thesis	
		4	unpublished data	
		5	book chapter	
		6	published report	
		-888	needs further review	
		-999	missing/not provided/ unspecified	
(c)	**effect size reported**	0	no	
		1	yes	
		-888	needs further review	
		-999	missing/not provided/ unspecified	
				reported effect size
(d)	**Effect size statistic used**	0	not reported	
		1	Cohen's d	_____
		2	OR	_____
		3	r	_____
		4	RR	_____
		5	other _____	_____
		-888	needs further review	
		-999	missing/not provided/ unspecified	
(e)	**Calculation Method of Effect Size**	1	directly reported	
		2	obtained from regression equation	
		3	*M/SD*	
		4	*t*	
		5	*F*	
		6	*r*	
		7	χ^2 value	
		8	*p* value	
		9	frequency (%)	
		-888	needs further review	
		-999	missing/not provided/ unspecified	
(f)	**direction of effect**	0	negative	
		1	positive	
		2	no direction (no effect/relationship)	
		-888	needs further review	
		-999	missing/not provided/ unspecified	
(g)	**CI reported**	0	no	
		1	yes	_____
		-888	needs further review	
		-999	missing/not provided/ unspecified	
(h)	**p value provided**	0	no	
		1	yes	_____
		-888	needs further review	
		-999	missing/not provided/ unspecified	

APPENDIX B
EQUATIONS FOR POWER ANALYSIS AND HEDGES' G

1) Power analysis $1 - \Phi(C_\alpha - \lambda) + \Phi(-C_\alpha - \lambda)$

a) $C_\alpha = \Phi(1 - 0.05/2) = 1.96$

b) $$\lambda = \frac{\delta}{V_\delta}$$

where, δ = estimated effect size

c) $$V_\delta = \frac{V_Y + \tau^2}{k}$$

where, τ^2 = estimated between study variance
& V_Y= within study variance

$$V_Y = \frac{n_1 + n_2}{n_1 \times n_2} + \frac{d^2}{2(n_1 + n_2)}$$

2) Hedges' g $g = J \times d$

a) $$J = 1 - \frac{3}{4df - 1}$$

b) $$d = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}}$$