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Workplace factors and the transition to major depression in a representative sample of Alberta employees

by

Carmelle Angelie Bolo

A THESIS

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Abstract

Subthreshold depression is prevalent and increases risk of Major Depressive Disorder (MDD), though psychosocial workplace factors associated with the transition have not been explored. Using data from the Population-based Longitudinal Study on Work and Health, participants with no depression (n=2840) and subthreshold depression (n=305) were followed prospectively for two years. Subthreshold depression was measured with the Patient Health Questionnaire-9, while MDD was measured with the Composite International Diagnostic Interview-Auto 2.1. Using binomial regression modelling, those with high work to family conflict had an increased risk of 2-year transition to subthreshold depression (RR_{adj} 1.47; 95% CI: 1.05-2.05; p=0.02) and 1-year transition to MDD (RR_{adj} 2.88; 95% CI: 1.08-7.62; p=0.03) compared to those with low work to family conflict. Similar risk factors appear to exist for subthreshold depression and MDD. Future studies with larger sample sizes should consider multinomial transitions including outcomes of more severe depression, less severe depression, and no change.

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Chapter One: **Introduction**

1.1 Background

Mental disorders were among the main contributors to the global Years lived with disability (YLDs) in 2010, according to the Global Burden of Disease Study (Vos et al., 2012). From 1990 to 2010 major depressive disorder increased 37% from the 15th to the 11th rank for Disability-adjusted life years (DALYs), and remained the 2nd leading cause of YLDs (Murray et al., 2012; Vos et al., 2012). In Canada major depression has a 12-month prevalence of 4.7% among the general population (Pearson, Janz, & Ali, 2013), and incurs considerable personal and economic burdens. Major depression is also highly prevalent among the workforce with a 12-month prevalence of 4.6% (Blackmore et al., 2007), and may lead to impairment in occupational functioning. Potential consequences in the workplace include absenteeism and presenteeism, both of which result in a loss of productivity (Karlsson, Bjorklund, & Jensen, 2010; Wang, Schmitz, Smailes, Sareen, & Patten, 2010).

While the exact causes of depression are unknown, it is widely accepted that the etiology is multi-factorial involving various biological, environmental, and psychosocial factors. These may include factors such as personality characteristics, family history of depression, negative life events, work stress, and various chronic illnesses (Klein, Kotov, & Bufferd, 2011; Milne et al., 2009; Netterstrom et al., 2008; Risch et al., 2009). Furthermore, there has been emerging support for a dimensional view of depression whereby depression exists as one continuous condition with various different subtypes (Ayuso-Mateos, Nuevo, Verdes, Naidoo, & Chatterji, 2010; Rodriguez, Nuevo, Chatterji, & Ayuso-Mateos, 2012). Subthreshold forms of depression are therefore stages along the

depression continuum of symptomatic severity, with major depression as the final common pathway.

Subthreshold depression (also referred to as subsyndromal symptomatic depression, subclinical depression, and minor depression) refers to the presence of clinically relevant symptoms that do not meet full diagnostic criteria for major depression (Fergusson, Horwood, Ridder, & Beautrais, 2005). Though the conceptualizations may vary, taken as a whole subthreshold depression is highly prevalent in the general population and is often accompanied by functional impairment, increased health care costs, and a decrease in overall quality of life (Judd, Schettler, & Akiskal, 2002). Additionally, subthreshold depression is associated with an increased risk of development to major depressive disorder (Cuijpers & Smit, 2004; Fogel, Eaton, & Ford, 2006).

In recent years many epidemiological studies have found that psychosocial factors in the workplace, such as psychological strain, were associated with an increased risk of major depression, while other factors such as adequate social support were associated with a decreased risk (Bonde, 2008; Netterstrom et al., 2008). There have been few population-based and clinical studies that have examined factors associated with the transition from subthreshold depression to major depression (Cuijpers, Smit, & Willemse, 2005; Pietrzak et al., 2013). However, there is a paucity of studies that have examined psychosocial workplace factors associated with the transition. The goal of this thesis research was to identify psychosocial workplace factors associated with the transition from subthreshold depression to major depression.

1.2 Rationale

1.2.1 Theory and Practice

The high prevalence, significant psychosocial impairment, and the chronic nature of subthreshold depression's course support its clinical relevance and importance for further study (Sadek & Bona, 2000). Gaining a better understanding of subthreshold depression in and of itself can help improve overall mental health. Given that subthreshold depression appears to exist along the major depression continuum, examining the longitudinal transitions from one depressive state to another can increase our understanding of the course and etiology of major depression. It may also help clarify the role of depressive symptoms in the development of major depression.

A better understanding of the transition from subthreshold depression to major depression is essential for developing effective early intervention strategies that could prevent more extensive morbidity. Studies have found that by intervening at the level of subthreshold depression the number of new cases of major depressive disorder may be reduced (Clarke et al., 1995; Cuijpers & Smit, 2004). Furthermore, treating depression at an earlier stage can improve functioning, prevent undesirable outcomes, and may even be less costly (da Silva Lima & de Almeida Fleck, 2007; Morgan, Jorm, & Mackinnon, 2012b). Since the majority of adults spend a considerable amount of time at the workplace, identifying work environment factors that affect the transition to major depression from any stage has important implications for the prevention of this disabling disease.

1.2.2 Economy

Around 30% ($15-$33 billion) of total disability claims in Canada are attributed to mental illness (Sroujian, 2003). Due to the nature of major depression, consequences such as productivity loss, sick leave, and increased health service utilization can all result in considerable financial costs. Identifying workplace factors associated with the transition to major depression will help inform prevention strategies, which can result in considerable economic savings as a result of the reduction in the number of cases.

Subthreshold depression has also been associated with an increase in economic costs when compared to healthy controls but to a lesser degree than the costs seen in major depression (Cuijpers et al., 2007). Because the prevalence of subthreshold depression may be higher than that of major depression, the impact of subthreshold depression on economic costs although lower at the individual level may be comparable to that of major depression at the population level (Cuijpers et al., 2007). This lends further support for the relevance and public health significance of subthreshold depression.

Chapter Two: **Literature Review**

2.1 Literature Review Strategies

A comprehensive literature search strategy was formed with the aid of a health sciences librarian. Relevant bibliographic databases included MEDLINE, EMBASE, and PsychINFO. Each online database was searched with subject headings or keywords in the title and abstract, using common terms relating to four main themes. The first theme was related to the concept of subthreshold depression (e.g. subsyndromal depression, minor depression, depressive symptoms). The second theme was related to psychosocial factors in the workplace (e.g. job strain, effort-reward imbalance, work to family conflict, work stress). The third theme was related to a prospective study design (e.g. prospective, cohort, transition, longitudinal). The fourth theme was related to major depression (e.g. major depressive disorder, depression). The results of all four search themes were combined using the Boolean operator "AND" to find studies meeting all four criteria. Retrieved articles were first screened by title followed by the abstract. Citations and reference lists of included studies were hand checked for possible relevance and inclusion.

2.2 Subthreshold Depression

2.2.1 Concept

There has been concern that the categorical definitions of mental disorders, as they appear in the Diagnostic and Statistical Manual of Mental Disorders (DSM) (American Psychiatric Association, 2013) or the International Classification of Diseases (ICD) (World Health Organization, 2008), may fail to capture the full spectrum of psychopathology. Diagnostic thresholds resulting from a categorical approach to

classifying mental disorders may result in a high proportion of false negatives, leading some to suggest adopting dimensional models for classification of particular psychopathologies (Widiger & Samuel, 2005). Alternatively the concept of subthreshold mental conditions (i.e. those failing to meet full diagnostic criteria) was introduced, and interest in this area of study has increased over the last few years (Pincus, McQueen, & Elinson, 2003).

Among the subthreshold mental conditions, subthreshold depression has been studied most extensively and generally refers to clinically relevant depressive symptoms that do not meet full criteria for any depressive disorder. Many conceptualizations of subthreshold depression have been proposed with varying names and definitions, and have been justified on the basis of prevalence and associated impairment. Definitions vary in regards to symptom thresholds, duration, and exclusions. In some instances different names have been given the same symptom set, while in other instances the same name has been given to different symptom sets.

The most widely researched of the proposed subthreshold depressive disorders thus far is minor depression (Pincus, Davis, & McQueen, 1999), which has been included as a research diagnosis in the appendix of DSM-IV (American Psychiatric Association, 1994). In DSM-5, the minor depression classification has now been named depressive episode with insufficient symptoms under "Other Specified Depressive Disorder" though the criteria have not changed (American Psychiatric Association, 2013). Some studies include minor depression as part of the broader subthreshold depression (Angst & Merikangas, 1997; Ayuso-Mateos et al., 2010), while others (Judd, Rapaport, Paulus, & Brown, 1994) differentiate between the two. Others under the name of subthreshold

depression use the same criteria as minor depression (Morgan, Jorm, & Mackinnon, 2012a; Pietrzak et al., 2013). There exist other conceptualizations such as subsyndromal symptomatic depression (which does not meet symptom criteria) and the less common subclinical depression (which does not meet clinical significance criteria). For this study we will use the term subthreshold depression to refer to the broader concept of conditions not meeting current diagnostic criteria, which include those named minor depression, subclinical depression, and subsyndromal depression.

2.2.1.1 Definitions

Unlike minor depression which is similar to major depression in definition though requiring 2-4 symptoms with no history of major depressive episode or dysthymic disorder (American Psychiatric Association, 1994), there is no accepted definition for broader concepts of subthreshold depression in the current diagnostic systems. For the purposes of this study, only the most relevant definitions and measurement instruments will be described.

While the definitions of subthreshold depression vary across studies, there are some definitions that are more common than others. Judd et al. [1994] first introduced the term subsyndromal symptomatic depression. This was defined as having at least 2 simultaneous depressive symptoms occurring for most or all of the time, and lasting at least 2 weeks in duration. It must also be accompanied by social dysfunction and the criteria for minor depression, major depression, and dysthymia must not be met (Judd et al., 1994). Subsequent studies have adapted this definition with slight modifications. As seen in a systematic review of studies on subthreshold depression by Pincus et al., the most common definition for subthreshold depression was defined as having between 2

and 4 depressive symptoms lasting at least 2 weeks, with some form of impairment or distress (Pincus et al., 1999).

The questionnaires used to measure subthreshold depression also vary from one study to another, and the definitions employed are largely a construct of the particular measurement used. Though subthreshold may also be defined as scoring above a specified cut-point on a depression severity scale, for the purposes of this study our focus will be on studies that used symptom threshold definitions, as these most closely resemble the current criteria for a major depression diagnosis. The studies, the instrument used, the names given, and the definitions of subthreshold depression are presented in Table 1.

Cuijpers et al. used the Instel Screen with one core (i.e. depressed mood or anhedonia) and three depressive symptoms as the cut-off for subthreshold depression, followed by the Composite International Diagnostic Interview (CIDI) to rule out major depression (Cuijpers et al., 2005). Using the Patient Health Questionnaire-9 (PHQ-9), Martin et al. defined subthreshold depression as endorsing at least one core symptom with a total of 2-4 symptoms (Martin, Rief, Klaiberg, & Braehler, 2006). Morgan et al. also defined subthreshold depression with the same criteria using the PHQ-9, with the addition of a significant impairment criterion (Morgan, Jorm, & Mackinnon, 2011; Morgan et al., 2012a). In their study Using the Alcohol Use Disorder and Associated Disabilities Interview Schedule – DSM-IV version (AUDADIS-IV), Pietrzak and colleagues classified ‘subsyndromal depression: limited symptoms’ as the endorsement of at least one core symptom but less than five total symptoms (Pietrzak et al., 2013).

Table 1 Names and definitions of subthreshold depression.

Study	Given name	Instrument	Definition
Cuijpers et al., 2005	Subthreshold depression	Instel Screen, CIDI	4 symptoms (1 core symptom) followed by CIDI rule out of major depression
Judd et al., 1994	Subsyndromal symptomatic depression	DIS	2-4 symptoms and impaired function
Martin et al., 2006	Subthreshold/other depressive disorder	PHQ-9	2-4 symptoms (At least 1 core symptom)
Morgan et al., 2011 & 2012	Subthreshold depression	PHQ-9	2-4 symptoms (At least 1 core symptom) and impaired function
Pietrzak et al., 2012	Subsyndromal depression: limited symptoms	AUDADIS-IV	1-4 symptoms (At least 1 core symptom)

2.2.2 Epidemiology of subthreshold depression

2.2.2.1 Prevalence in the general population

Differences in how subthreshold depression is defined across studies can result in a very broad range of prevalence estimates. In a study of a general population sample from the NIMH Epidemiological Catchment Area (ECA) Program, the 1-month prevalence of subsyndromal depressive symptoms (defined as two or more depressive symptoms beneath the diagnosis of minor depression, dysthymic disorder, and MDD) was 3.9% (Judd, Akiskal, & Paulus, 1997). In their study of randomly selected participants from the general population across 68 countries, Ayuso-Mateos and colleagues found that the standardized pooled 12-month prevalence estimate for

subsyndromal depression was 2.85% (Ayuso-Mateos et al., 2010). In a study of a nationally representative sample of US adults, a total of 11.6% met study criteria for a lifetime diagnosis of subsyndromal depression (Pietrzak et al., 2013). This estimate was split into those who did not meet the minimum symptom requirement (9.3%), and those who did not meet the significant impairment criterion (2.3%) for a diagnosis of major depression based on the DSM-IV. Finally, a systematic review found that prevalence rates of subthreshold depression ranged from 1.4% to 17.2% in community settings (Rodriguez et al., 2012).

2.2.2.2 Associated impairments

Regardless of how it is defined, subthreshold depression has been shown to be associated with significant impairments. Individuals with subthreshold depression were found to have increased disability in daily activities, which was also associated with poor health perception, and significant psychological distress (Rucci et al., 2003). Subthreshold depression has also been associated with increased health service utilization and a lower quality of life (da Silva Lima & de Almeida Fleck, 2007; Goldney, Fisher, Dal, & Taylor, 2004). A study on community-dwelling adults in Korea found that physical health, psychological health, and environmental domains demonstrated a clear deterioration across the spectrum from normal to subthreshold and finally to fully depressed subjects (Sohn, Choi, & Jun, 2013). Furthermore, the authors hypothesize that the high prevalence of individuals with depressive symptoms not meeting a diagnosis might be the missing link in explaining the high suicide rate in Korea despite the low prevalence of depressive disorders (Sohn et al., 2013).

2.2.2.3 Subthreshold depression in the workplace

Impairments in job performance have been positively associated with the severity of depression, and even "clinically improved" depressed employees performed consistently worse than controls (Adler et al., 2006). A study of community-dwelling adults found that subclinical depression was significantly related to both technical and social performance at work (Martin, Blum, Beach, & Roman, 1996). In regards to absenteeism, significant depressive symptoms not diagnosable as a depressive disorder were associated with a mean of 5.2 lost work days per month, compared to a mean of 7.4 caused by depressive disorders, and 1.4 in those without a disorder (Sohn et al., 2013). Among female employees in the Danish eldercare sector, depression symptoms on the Major Depression Inventory not meeting diagnostic criteria predicted the risk of long-term sickness absence defined as an absence of more than 2 consecutive weeks (Rugulies et al., 2013). Taken together these results suggest that impairments in job performance are not limited to formal diagnoses of major depression and that even subthreshold levels of depression are associated with significant impairments. Associations between subthreshold depression and other work aspects such as job satisfaction and intention to leave employment have been less studied. One study found that subthreshold depression was significantly associated with low job satisfaction, though it was conducted in a specific population of young adult males (Barth, Hofmann, & Schori, 2014).

2.2.3 Subthreshold depression and major depression

Characteristics of subthreshold depression more closely resemble those of major depression as opposed to those of healthy individuals. One study in particular found that in measures of quality of life and psychological wellbeing, the impairments seen in

participants with minor depression were closer to those seen in participants with major depression than to the community norms (Nierenberg et al., 2010). Specifically, mean scores for the Environmental Mastery and Self-acceptance, Purpose in Life, and Positive Relations with Others subscales were lower in subjects with minor depression than in healthy subjects. In a study on risk of mortality, the significant increase in risk of mortality in individuals with subthreshold depression resembled the rates seen in those with major depression (Cuijpers et al., 2013).

In a systematic review of prospective studies, Cuijpers and Smit found that the incidence of major depression was greater for those with subthreshold depression compared to those without subthreshold depression. Several studies have found that subthreshold depression is a risk factor for major depression despite the heterogeneity in measurement of subthreshold depression (Cuijpers & Smit, 2004; Fogel et al., 2006). Furthermore, the predictive value of depressive symptoms for developing major depression increases in a dose-response fashion with increasing symptoms (Regeer et al., 2006).

One study observed a qualitative similarity between major depressive symptoms and subthreshold depressive symptoms, which they took to suggest continuity between the two (Judd, Paulus, Wells, & Rapaport, 1996). Although several studies observed negative impacts of subthreshold depression approaching that of major depression, most studies observed a linear gradient of impairment as a person moved from no depression, to subthreshold depression, and finally to major depression. One study in particular observed a linear increase in relative risk for negative outcome that was lowest in participants with no depressive symptoms, significantly higher in subjects with

subsyndromal depressive symptoms, and highest among persons with major depressive and dysthymic symptoms (Johnson, Weissman, & Klerman, 1992). Similarly Judd and colleagues found that psychosocial disability increased linearly in a significant step-wise fashion with each increment in the level of depressive symptom severity during the longitudinal course of illness within an individual patient (Judd et al., 2000).

2.2.3.1 Subthreshold depression exists on the major depression continuum

Overall previous results support the view of a continuous distribution of depression symptomatology with a graded impact on well-being and functioning (Regeer et al., 2006). Instabilities in fulfilling criteria for specific depressive sub-types over time have been previously reported (Angst & Merikangas, 1997) as individuals fluctuate from one depressive category to another. Depression can be better viewed as a spectrum of disorders, which is seen by the continuous evolvement of diagnostic categories (Regeer et al., 2006). Subthreshold depression may exist as pre-morbid manifestations or partial remittances of a major depressive disorder. Subthreshold depression can be regarded as part of the prodromal phase of major depression as nearly all individuals who develop major depression have initially passed through a period, although brief, of subthreshold depression (Eaton, Badawi, & Melton, 1995). However, not all people with subthreshold depression will develop major depression. Subthreshold depressive symptoms can therefore be viewed as intermediary phenotypes on the depression continuum, that after exposure to additional risk factors may progress to a major depressive disorder (Hanssen, Bijl, Vollebergh, & van, 2003). Under this framework, the study of the course of subthreshold depression and associated factors gives us insight into the development of major depression.

2.3 Psychosocial Workplace Factors and Depression

Although a variety of factors ranging from demographic, socioeconomic, and clinical factors have been found to be associated with major depression, there has been growing focus on psychosocial factors over the last few years. In particular, psychosocial factors related to the work environment which may have major influences on mental health (Vezina, Bourbonnais, Brisson, & Trudel, 2004). Several of these factors are covered by the Demand-Control Model, the Effort-Reward Imbalance Model, and the Work-Family Conflict Model, which form the theoretical basis of the present study (Chandola et al., 2004; Frone, 2000; Karasek et al., 1998; Siegrist et al., 2004). These three job-related stress models have been widely used in workplace mental health research.

2.3.1 Demand-Control Model

This model conceptualizes work stress. The demand control model postulates that negative health outcomes result from situations where psychological demands are high but control over one's work is low (Karasek, 1979). These negative health outcomes include fatigue, depression, and physical illnesses. Job strain results when the work demands are high but the decision latitude is low. Jobs can be characterized as either low or high demand as well as low or high decision latitude. This results in four types of jobs: passive jobs (low demand, low decision latitude), low strain jobs (low demand, high decision latitude), high strain jobs (high demand, low decision latitude), and finally active jobs (high demand, high decision latitude). This model also postulates that support from supervisors and co-workers may act as buffering mechanisms between psychological

stressors at work and adverse health outcomes by affecting the physiological process important for maintenance of health (Karasek et al., 1998).

2.3.2 Effort-Reward Imbalance

Effort-reward imbalance occurs when there is a lack of reciprocity in terms of costs and gains. In this case high efforts spent and low rewards received can result in negative emotions (Siegrist et al., 2004). Inappropriate rewards can result in feelings of disappointment and unfair treatment, which are paralleled by consistent strain reactions in the autonomic nervous system resulting in negative health outcomes (Siegrist et al., 2004).

2.3.3 Work-Family and Family-Work Conflicts

Due to the increasing rate of participation by women in the labour force along with the increasing rate of participation by men in family roles, there has been considerable research interest into the role of the work-family interface on worker's health. Work to family conflicts occur when efforts to fulfill the demands of the employee interfere with the ability to fulfill the demands of a spouse, parent, or care provider (Frone, 2000). Alternatively, family to work conflict occurs when the family may be an obstacle to meeting work-related demands or responsibilities successfully. This can also undermine a person's ability to construct and maintain a positive work-related self-image (Frone, 2000).

All three models have been found to be equally important in predicting major depression and may also have interacting effects (Wang et al., 2012). However, there has been no research on whether these work stress models predict the onset of major depressive disorder specifically in individuals with subthreshold depression.

2.3.4 Other factors and depression

There are many other risk factors for depression including sex, age, low education level, and low income (Ayuso-Mateos et al., 2010; Blackmore et al., 2007). These factors may also be associated with psychosocial workplace factors, and therefore have the potential to either modify or confound the relationship between psychosocial workplace factors and depression. While these factors have been widely studied, they have not been examined in people with subthreshold depression specifically. Therefore there may be some factors that are more important than others in the transition from subthreshold to major depression. One other important psychosocial workplace factor is social support either from the co-worker or the supervisor. High social support has been shown to have positive influences on health. One study in particular found that the impact of stress on depression symptoms was modified by social support in individuals with subthreshold depression (Yang et al., 2010).

2.4 Studies focusing on risk factors in the transition to major depression

The prognosis of subthreshold depression is relatively unknown in terms of transition to the full disorder. In addition, while previous literature has shown that subthreshold depression increases the risk for major depression, the specific factors that affect this transition from subthreshold depression to major depression are unknown. There are only two studies that look at subthreshold depression and associated risk factors for major depression, however their focus was not on workplace factors.

Cuijpers, Smit, & Willemse (2005) conducted a prospective study using the control group of a randomized trial of primary care patients. They identified 109 individuals with subthreshold depression (as defined in Table 1) at baseline and 20 of

these individuals developed major depression after one year. Using the vulnerability-stress theory, they found that chronic illnesses and family history of depression were significant predictors of major depression (Cuijpers et al., 2005). Their results showed that these two factors were able to predict to a certain degree the risk of transition from subthreshold depression to major depression. However, they did not account for major depression occurring prior to the 12-month period pre-baseline. As a result, it is not possible to determine whether the cases of major depression observed one year later were new-onset or recurrent cases. Since previous major depressive episodes increase the risk for subsequent episodes this may be a potential confounder that was not accounted for in the relationship seen.

Building on these findings, the second study focused on new-onset major depression and took a much larger population-based sample of participants. Pietrzak et al. studied a large nationally representative sample of 34 653 adults in the United States. Using the AUDADIS-IV, participants were classified into subsyndromal depression based on the definition in Table 1. They found that Cluster A and B personality disorders and worse mental health status were each independently related to the development of new-onset major depression in individuals with subsyndromal depression (Pietrzak et al., 2013).

While both studies identified several important predictors, the factors they examined were mostly clinical in nature. However as we have seen, social-environmental factors are equally important in predicting the onset of major depression (Chandola et al., 2004; Frone, 2000; Karasek et al., 1998; Siegrist et al., 2004; Vezina et al., 2004). Furthermore, the two studies were conducted in the Netherlands and US, respectively.

While these were the only studies examining factors associated with the transition from subthreshold to major depression, workplace psychosocial factors have been found to be associated with the risk of major depression in general (Bonde, 2008; Netterstrom et al., 2008). Therefore it is conceivable that certain workplace psychosocial factors may contribute to the transition to major depression in subthreshold depression. However, there have been no studies specifically on this topic.

2.5 Knowledge Gaps

Based on the literature review and the previous studies, several knowledge gaps have been identified:

- The prevalence of subthreshold depression in a general Canadian working population sample is unknown.

- Very few studies have looked at the associations between subthreshold depression and each of job performance, job satisfaction, and intent to leave employment.

- The majority of studies focused on subthreshold depression as a risk factor for major depression, but only two studies looked at risk factors affecting this transition.

- Psychosocial workplace factors may play an important role in the transition. However, this has not been investigated.

Chapter Three: **Objectives**

Using a representative sample of employed Albertans between the ages of 25-65 years, the objectives of this study were to:

1) Estimate the current prevalence of subthreshold depression at baseline

2) Independently assess the associations between subthreshold depression and each of job performance, job satisfaction, and intent to leave current employment

3) Estimate the 1-year and cumulative 2-year proportions of individuals who:

    a. Reported subthreshold depression in the no depression baseline group

    b. Reported major depressive disorder in the subthreshold depression baseline group

4) Identify psychosocial workplace factors associated with the risk of transition from no depression to subthreshold depression

5) Identify psychosocial workplace factors associated with the risk of transition from subthreshold depression to major depressive disorder

Chapter Four: **Methods**

4.1 Research Design

The proposed research was a quantitative study using a longitudinal design with data over three time points: baseline, 12-month follow-up, and 24-month follow-up. Implicit in a longitudinal study design is that the action of the exposure precedes the development of the disease, occurring as a result of the exposure (Rothman, 2002). In this case exposure to psychosocial workplace factors would precede the development of depression, allowing us to identify which factors are associated with the risk of transition. Data from the Population-Based Longitudinal Study on Work and Health (PLSWH) was used, which has been approved by the Conjoint Health Research Ethics Board of the University of Calgary.

4.2 Description of the PLSWH

4.2.1 Sampling and Recruitment

In January 2008, a longitudinal cohort representative of the working population in Alberta, Canada was developed. The target population was Alberta residents between the ages of 25 to 65 years who were currently employed at the time of the baseline survey. Sampling and recruitment of study participants were conducted by experienced interviewers of the Alberta Health Services, Calgary Zone, Survey Unit. The Survey unit subscribes to a frequently updated database of listed Alberta residential telephone numbers. A simple random sample was taken from this list and the last digit of the listed telephone number was replaced with a randomly generated digit. This maximized the probability of reaching households while allowing for inclusion of unlisted numbers.

Once a household was reached the individual who was between 25-65 years of age, currently employed, and able to communicate in English, was invited to participate in the study. If there were several individuals who met the criteria, the individual who had the most recent birthday was selected. Participation in the study involved completing baseline and two follow-up interviews as well as providing detailed contact information. To be included in the study, the participant's name, primary contact number, and at least one other method of contact such as a mailing address, email, work phone number, or a secondary contact person and their number, were required. After the study objectives and procedures were thoroughly explained and participants were reminded that participation was voluntary, verbal informed consent from each participant was obtained before the start of each interview.

A total of 81,240 calls were made during baseline sampling. Of these calls, 10,455 calls were indeterminate: composed of 6039 answering machines, 4215 no answers, and 190 always busy lines. The 49,819 disqualified call dispositions were composed of the following: 17,827 numbers not in service, 16,158 no eligible participant in the household, 6,897 business numbers, 6,217 fax machines, 1,079 blocked calls, 792 language barriers, 447 self-employed, and 402 others. The calls reached 9,776 potential participants. Among those who were eligible to participate, 5,456 refused to participate and 40 partially completed the baseline interview. There were a total of 4302 individuals who completed the baseline screening interviews. The individual level response rate was 44%. Of the 4302 participants who completed the screening interviews, 3 participants had completed the interview twice leaving a total of 4299 participants in the baseline sample.

4.2.2 Data Collection

Data were collected annually through structured survey questionnaires administered by trained lay interviewers using the Computer Assisted Telephone Interview (CATI) method. Baseline and 12-month follow-up interviews each consisted of two parts. The first part of the interview was administered by interviewers of the Survey Unit. This initial screening interview consisted of demographic characteristics, work environment factors, depressive symptoms, and the mental disorder screening questions. Participants who screened positive for a possible mental disorder were contacted by a second set of interviewers for an additional in-depth mental health interview. After this second interview at baseline, 430 participants refused to continue in the study and 233 participants could not be reached by telephone, mail, or email, yielding a final baseline response rate of 85%. At the 12-month follow-up the final response rate, after both interviews, was 71% of the baseline participants. At the 24-month follow-up both the initial screening interview and the in-depth mental health interview were assessed at one time and the final response rate was 68.6% of the baseline participants.

4.2.3 Follow-Up and Attrition

Common to cohort studies is the issue of participant attrition. When losses to follow-up occur differentially by exposure and outcome, a selection bias in the estimate of the association between the exposure and outcome may result (Porta, 2014). Active strategies to prevent loss to follow-up were applied including maintaining an accurate database of contact information, sending reminder letters before each interview, and maintaining communication by providing updates of summary findings through mail, email, and the study website. The day and timing of the interview calls were varied to

ensure maximum likelihood of reaching a participant and completing the interview. If this was not successful letters were sent through mail and email in order to encourage participation.

If a participant's number was changed, reasonable measures were taken to obtain their new number through email, mail, and searching through public telephone directories. At every follow-up stage, all previous participants were invited to participate unless they withdrew from the study or were deceased. Participants could return to the study even if a previous assessment was missing or incomplete. Participants who moved out of Alberta or even Canada remained in the study provided they were willing to continue. Those who retired after the start of the study were still followed longitudinally, though they were not asked the work environment questions.

4.2.4 Longitudinal Weights

Based on 2006 census data collected by Statistics Canada, sampling weights were developed to account for the number of household telephone lines and gender-age distributions in employed Albertans between the ages of 25-65 years. As mentioned previously, there was attrition after each follow-up stage and the differences between responders and non-responders were observed. Non-responders differed by age, marital status, income, and the presence of mental disorders compared to responders. New 12-month and 24-month longitudinal weights were developed to account for the differences.

4.2.5 Measurement of psychosocial workplace factors

All three workplace questionnaires were administered in all participants at each yearly assessment, given that they were current employed.

4.2.5.1 Job Content Questionnaire

The full version of the Job Content Questionnaire (JCQ) is a validated instrument for measuring work stress that has been widely used in occupational research. The JCQ includes the following 5 dimensions: skill discretion (6 items), decision authority (3 items), psychological demands (5 items), job insecurity (3 items), and supervisor/co-worker social support (8 items). All questions were rated on a 4-point Likert scale: Strongly Disagree (1), Disagree (2), Agree (3), and Strongly Agree (4). Reverse scoring was applied to some of the items where appropriate. In a validity and reliability study that examined broadly representative populations from four advanced industrialized countries including Canada, Cronbach's alpha for the skill discretion, decision authority, and psychological demands scales respectively, was 0.73, 0.68, and 0.63 in men (Karasek et al., 1998). In women, Cronbach's alpha was 0.75 for the skill discretion scale and equivalent to the men's for the decision authority and psychological demands scales (Karasek et al., 1998).

4.2.5.2 Effort-Reward Imbalance Questionnaire

The Effort-Reward Imbalance questionnaire (ERI) was used to assess work stress due to imbalances between perceived effort (5 items) and perceived reward (11 items). Each question was rated on a 5-point Likert scale. The respondent was first asked if they "Agree" or "Disagree" with a particular statement, and depending on their answer and the particular question they were asked their associated level of distress. The distress level options ranged from "Not at all distressed", "Somewhat distressed", "Distressed", to "Very distressed". In a study based on data from five different countries, the Cronbach's alpha values for the effort scale ranged from 0.64-0.75 for men and 0.61-0.78 for women

(Siegrist et al., 2004). For the reward scale, the alpha values ranged from 0.78-0.86 for men and 0.70-0.88 for women (Siegrist et al., 2004).

4.2.5.3 Work-Family Conflict Scale

The 8-item Work-Family Conflict (WFC) scale was used to assess work-to-family (4 items) and family-to-work (4 items) conflict. Each question was rated on a 3-point Likert scale with 1 (not at all), 2 (to some extent), and 3 (a great deal). Each subscale could have a possible summary score ranging from 4 to 12. Based on data from two different studies of representative samples from four different countries, the internal consistency of the questionnaire ranged from 0.64 to 0.74 (Chandola et al., 2004; Frone, 2000).

4.2.6 Measurement of Major Depression

4.2.6.1 Patient Heath Questionnaire-9

The Patient Health Questionnaire-9 (PHQ-9) measures major depression and depression severity and was administered in all participants at each yearly assessment. The PHQ-9 is the depression module derived from the Primary Care Evaluation of Mental Disorders (PRIME-MD), which is used to diagnose common mental disorders. It consists of the 9 symptom criteria for a major depression diagnosis on the DSM-V. In terms of reliability, Cronbach's alpha was found to be 0.89 in validation studies conducted by the developers (Kroenke, Spitzer, & Williams, 2001). The response to each of the 9 symptom questions consists of a 4-point Likert scale ranging from "Not at all" (0), "Several days" (1), "More than half the days" (2), to "Nearly every day" (3) over a period of two weeks, for a total possible score of 27. Using the PHQ-9 scoring algorithm, a symptom is endorsed if the respondent responds with at least "more than half the days"

to the particular symptom question. The only exception is for suicidal ideation, which is endorsed with a response of at least "several days".

As a severity measure based on total score, the recommended guidelines are 1-4=no depression, 5-9=mild depression, 10-14= moderate depression, 15-19=moderately severe depression, and 20-27=severe depression. As a diagnostic measure, a diagnosis of current major depression is considered if at least 5 symptoms, one being depressed mood or anhedonia, are present for a period of two weeks. The diagnostic algorithm has been previously shown to have very low sensitivity in detecting cases of major depressive disorder (Zuithoff et al., 2010). As an alternative to the diagnostic algorithm, a continuous total score cut-point may be used to determine probable major depression. The optimal cut-point for major depression has been found to be $\geq$10 with a sensitivity and specificity of 88%, and is the cut-point most commonly used (Kroenke et al., 2001; Kroenke, Spitzer, Williams, & Lowe, 2010).

4.2.6.2 Composite International Diagnostic Interview Version 2.1

Major depression was measured using the full version of the World Health Organization's (WHO) Composite International Diagnostic Interview – Auto 2.1 (CIDI-Auto 2.1) (World Health Organization, 1997). The CIDI-Auto 2.1 is a fully standardized diagnostic instrument designed to assess common mental disorders and has been widely used in epidemiological research. In community settings, the CIDI has been found to have high inter-rater reliability and high test-retest reliability (Kurdyak & Gnam, 2005; Wittchen, 1994). The CIDI has separate modules for specific mood and anxiety disorders, and was designed for administration by trained lay interviewers. The modules administered depend on the participant's answers to the screening questions.

The depression module of the CIDI measures lifetime or 12-month major depression. Once the entire module is completed, the scoring algorithm automatically generates a diagnosis based on either DSM-IV or ICD-10 criteria (American Psychiatric Association, 1994; World Health Organization, 2008). For the baseline interview, the lifetime version of the CIDI-Auto 2.1 was used while the 12-month version was used for the follow-up interviews. Since the CIDI is a highly branched system, those who answer "No" to a particular screening stem question of a disorder would automatically skip the entire module and would not meet the diagnostic criteria for that specific disorder. Therefore, only participants who answered "Yes" to any of the stem questions in the screening section of the interview were administered the CIDI-Auto 2.1.

4.2.7 Measurement of Secondary Outcomes

4.2.7.1 Stanford Presenteeism Scale-6

Job performance, in terms of presenteeism, was measured using the Stanford Presenteeism Scale-6 (SPS-6). Presenteeism refers to decreased productivity and sub-optimal work performance that occurs when employees are physically present at the job as a result of health problems. The SPS-6 is a brief 6-item scale that measures a worker's ability to concentrate and complete work within the past month, despite the presence of health problems (Koopman et al., 2002). It has demonstrated construct, criterion, concurrent, and discriminant validity, and a Cronbach's alpha of 0.80 (Koopman et al., 2002). The scale is divided into two components, completing work and avoiding distraction, each assessed by 3 questions. The responses ranged from strongly disagree, disagree, uncertain, agree, and strongly agree which was coded 1-5 respectively for avoiding distraction, and reverse coded 5-1 for completing work. Higher scores indicated

a greater likelihood of presenteeism. Although the questionnaire was administered in all currently employed participants at both the baseline and 12-month follow-up interviews, those who indicated that they did not have a health problem did not complete the questionnaire.

4.2.7.2 Questions for job satisfaction and intent to leave employment

Both job satisfaction and intent to leave current employment were assessed with one question each. For job satisfaction, respondents were asked to rate how satisfied they were with their present job (not at all, not too much, somewhat, or very). For intention to leave current employment they were asked how likely they were to look for a new job in the next year because they wanted to quit their current job (not at all, somewhat likely, or very likely). All currently employed participants were asked both questions at each of the yearly assessments.

4.3 Methods of the proposed study

4.3.1 Definition of Major Depressive Disorder

Major depressive disorder (MDD) was defined by DSM-IV criteria based on data from the CIDI diagnostic interview. Diagnoses of Major depressive episodes (MDE) on the CIDI were considered MDD if there were no simultaneous diagnoses of manic episodes. This definition was used to form the MDD baseline group and for the longitudinal MDD outcome.

4.3.2 Definition of Subthreshold Depression

Subthreshold depression was defined as endorsing at least two depressive symptoms but less than five symptoms, for a period of two weeks based on the PHQ-9. Participants with any two to four symptoms and who did not meet criteria for major

depression on the PHQ-9 or major depressive disorder on the CIDI were classified as having subthreshold depression. This definition was used both to form the subthreshold depression baseline group and for the longitudinal subthreshold depression outcome. The definition is similar to that of several other studies that defined subthreshold depression by symptom count (Ayuso-Mateos et al., 2010; Judd et al., 1997; Pietrzak et al., 2013; Yang et al., 2010). One study in particular also used the PHQ-9 and defined subthreshold/other depressive disorders using similar criteria (Martin et al., 2006).

4.3.3 Definition of No Depression

Those with no depression were defined as endorsing one depressive symptom or less for a period of two weeks on the PHQ-9. MDD based on the CIDI must not be met. This definition was used to form the no depression baseline group.

4.3.4 Coding of exposure variables

4.3.4.1 Job strain ratio

Scores for each dimension of the JCQ were calculated using the formulas outlined in the JCQ user manual. Using the scores of the psychological demands, skill discretion, and decision authority dimensions, a job strain ratio variable was created. The formula was: Job strain ratio = [psychological demand*2]/ [skill discretion + decision authority] (JCQ User's Manual) (Karasek et al., 1998). This method of calculation was consistent with criteria previously used by Statistics Canada (Statistics Canada, 2010). A job strain ratio greater than 1 indicated psychological demands exceeding decision latitude, and hence greater job strain while a ratio of one indicated a balance. For ease of comparisons, job strain ratio was analyzed as a binary variable with a ratio ≤ 1 indicating low job strain (coded as 0) and a ratio >1 indicating high job strain (coded as 1).

4.3.4.2 Effort-reward imbalance ratio

An effort-reward imbalance ratio was determined from the scores on the effort and reward scales. We used the formula ERI ratio = e/(r*c), where e was the total score on the effort scale, r was the total score on the reward scale, and c was a correction factor (Peter et al., 1998; Siegrist, 2002). The correction factor took into account the different number of items in the denominator and numerator. In this case, since there were 5 items in the numerator and 11 items in the denominator the correction factor was 5/11. A higher ratio score indicated higher effort-reward imbalance. For analyses, a cut-point of 1 was used to dichotomize the variable with ratio scores ≤ 1 indicating low effort reward imbalance (coded as 0) and scores > 1 indicating high effort reward imbalance (coded as 1).

4.3.4.3 Work to family and Family to work conflicts

Total scores of items on each work-family conflict sub-scale were added separately, yielding a separate score for each type of conflict. Higher scores indicated greater conflict. Both the distributions of work to family and family to work conflict total scores were highly skewed. For the purposes of the analyses, each variable was dichotomized at the 75^{th} percentile in order to make meaningful comparisons between high and low work-family conflicts (Chandola et al., 2004). Those with low conflict were coded as 0 while those with high conflict were coded as 1.

4.3.5 Coding of secondary outcomes

4.3.5.1 Presenteeism

Avoiding distraction and completing work were separate binary variables. Participants were defined as having presenteeism or difficulties in avoiding distraction if

they had a score of at least 4 on any of the 3 questions. The variable was therefore coded as 1 for presenteeism in avoiding distraction, while 0 meant no presenteeism in avoiding distraction. The same definition and coding were applied to completing work.

4.3.5.2 Job satisfaction

The response for job satisfaction had four levels, which was dichotomized in order to make meaningful comparisons. Responses of "not at all" and "not too much" were combined to represent an "unsatisfied" response, which was coded as 1. Responses of "somewhat" and "very" were combined to represent a "satisfied" response, which was coded as 0.

4.3.5.3 Intent to leave employment

Since the responses for the intent to leave employment question had three levels, we combined two of the levels to form a binary variable for analyses. The responses of "not at all" and "somewhat likely" were combined to form the "Not very likely" group, which was coded as 0. Participants who responded "Very likely" were coded as 1.

4.3.6 Covariates

Although there were many potential covariates to consider, for the purposes of this study we focused on the possible confounding and modifying roles of a few select factors as they were found to show the strongest associations in studies looking at subthreshold and major depression (Ayuso-Mateos et al., 2010; Pietrzak et al., 2013; Yang et al., 2010). These included gender (female, male), marital status (single, widowed/divorced/separated, married), annual personal income (<$30,000, $30,000-59,999, $60,000-79,999, >$80,000), education (less than high school, high school graduate +, university graduate +), co-worker and supervisor social support (low, high),

and any other measured 12-month mood or anxiety disorder. Age and weekly work hours were included as quantitative variables. The other measured 12-month mood and anxiety disorders included generalized anxiety disorder (GAD), panic disorder, social phobia, dysthymia, and mania, and were all based on diagnoses from their respective modules of the CIDI-Auto 2.1. Furthermore lifetime depression based on the CIDI was also considered as it is a significant risk factor for future depression (Cuijpers, van, & Smit, 2005).

Confounding is a bias that results in data when the effects of an extraneous variable are mixed in with the effects of the exposure of interest (Kleinbaum D.G., Kupper, & Morgenstern, 1982). This can occur when the third variable is an independent risk factor for the outcome, associated with the exposure of interest, and not found on the causal pathway between the exposure and the outcome. Effect modification occurs when the effect of the exposure depends on a third variable, resulting in heterogeneity of effects based on levels of that third variable (Oleckno, 2008). In this study, we assessed for effect modification and controlled for confounding at the analysis stage.

4.4 Statistical Analyses

All analyses were conducted using STATA 13 (StataCorp., 2013).

4.4.1 Descriptive Analyses

The demographic and socioeconomic characteristics of all eligible participants were described based on their depression status at baseline. First, all participants with complete baseline depression data were classified into three main baseline depression groups (i.e. no depression, subthreshold depression, and major depressive disorder), A diagnosis of *major depressive disorder* was based on the results of the CIDI and formed

the MDD group. Furthermore, those who did not meet the CIDI criteria but met the PHQ-9 cut-point criteria of ≥ 10 formed a major depression group separate from the three main depression status groups. The remaining participants were classified with *subthreshold depression* if their endorsed depressive symptom count was between 2 and 4, and with *no depression* if their depressive symptom count was 1 or less. These classifications accounted for all participants and there were no participants who endorsed 5 or more symptoms that were not diagnosed with major depression on either the CIDI or the PHQ-9.

Each of the three baseline depression groups was described by baseline measurements of the covariates. The weighted proportion, along with 95% confidence intervals, of participants by levels of each demographic characteristic was estimated. Since age and weekly work hours were measured quantitatively, means were presented for each baseline depression status group.

4.4.2 Objective 1 - Estimate the point prevalence of subthreshold depression

The proportion of subthreshold depression along with 95% confidence intervals was estimated overall and by baseline psychosocial workplace factors in all participants who had complete data regarding depression at baseline.

4.4.3 Objective 2 - Assess the association between subthreshold depression and each of job performance, job satisfaction, and intent to leave employment.

This was a cross-sectional analysis using baseline data. All individuals were included given they had complete information regarding the exposure and outcome. In this case their depression status classification (i.e. no depression vs. subthreshold depression) was treated as the exposure variable. Those with a major depression

classification at baseline were excluded from these analyses. Job performance, job satisfaction, and intent to leave employment were three separate outcomes. Job performance was split into two dimensions for the analyses, presenteeism in avoiding distraction and presenteeism in completing work. The proportions of presenteeism, job dissatisfaction, and a very likely intent to leave employment were estimated for each of the two groups.

The cross-sectional associations between subthreshold depression and job satisfaction, job performance, and intent to leave employment were assessed in the form of an odds ratio (OR) through stratified analyses and logistic regression modeling. The covariates mentioned previously were evaluated for possible modification by forming interaction terms with the exposures. The Wald test was used to determine if the interaction term was significant and therefore should be included in the model. The process proceeded through backward elimination beginning with the most complex model. First, effect modification was assessed. If there was evidence of effect modification, stratum specific estimates were presented. Confounding by each covariate was assessed by comparing the crude OR estimate to the adjusted estimate and looking at changes in the magnitude of the point estimate. This was based on a judgment call as to whether the two estimates varied substantially and if the interpretation was changed. If it was found that the estimates were quite different, the variable was included in the model and adjusted estimates for the final model were presented. The identification of significant risk factors was based upon the p-value, using a standard alpha of 0.05, as well as the position of the 95% confidence intervals in relation to the null value.

4.4.4 Objective 3 – Estimate the 1-year and 2-year cumulative proportions of individuals who met criteria for subthreshold or MDD according to their baseline status

In the no depression baseline group, the 1-year and 2-year cumulative proportions of subthreshold depression were estimated overall and by baseline characteristics. Similarly in the subthreshold depression baseline group, the 1-year and 2-year cumulative proportions of MDD were estimated overall and by baseline characteristics. 95% confidence intervals were estimated for each proportion.

4.4.5 Objective 4 - Identify psychosocial workplace factors in the risk of transition from no depression to subthreshold depression

Only participants in the no depression baseline group were included in the analyses. The outcome was development of subthreshold depression after one or two years. The exposures were each of the four psychosocial workplace factors at baseline. Each workplace factor was analyzed independently. The association was determined in the form of a risk ratio (RR). Stratified analyses and binomial regression modeling were conducted to assess for possible modification or confounding by the covariates following the same basic procedures as in Objective 2. Though the covariates were assessed at baseline and each subsequent follow-up stage, as we were interested in the predictive nature of baseline characteristics on the course of depression, we did not allow the covariates to vary in the longitudinal analysis. Baseline measurements of all covariates were used for the longitudinal analyses. Two separate analyses were conducted for the 1-year and the 2-year cumulative risk of transition to subthreshold depression using the same process.

4.4.6 Objective 5 - Identify psychosocial workplace factors in the risk of transition from subthreshold depression to MDD

For these analyses only participants in the subthreshold depression baseline group were included. The exposures were the four psychosocial workplace factors, which were analyzed independently. The outcome was development of MDD (CIDI) after one or two years. Similar to Objective 4, the association was determined in the form of a RR and stratified analyses and binomial regression modeling were conducted to assess for possible modification or confounding by the covariates. Again baseline measurements of the covariates were used for the longitudinal analyses. There were separate analyses conducted for the 1-year and 2-year cumulative risks of transition.

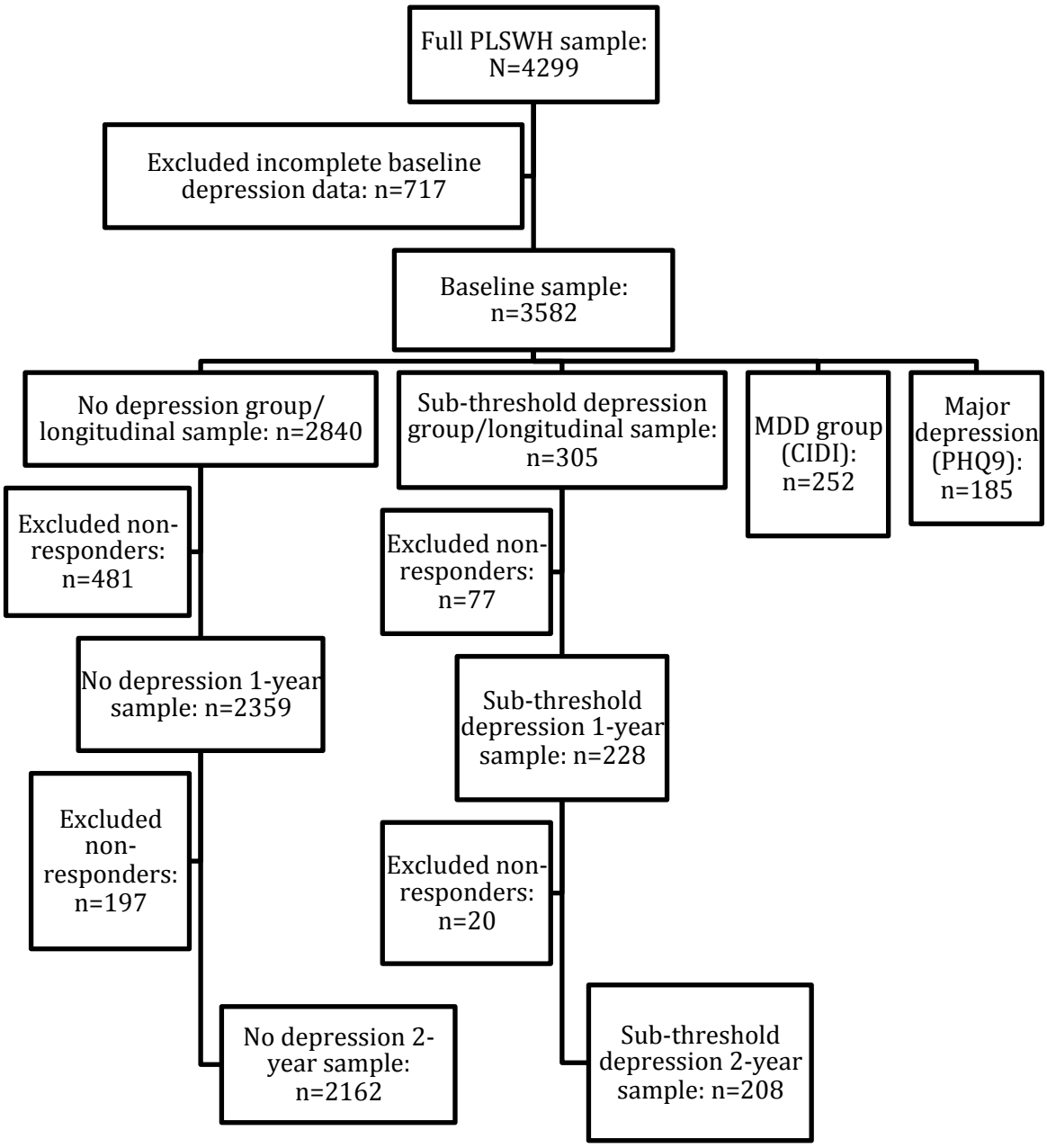
Chapter Five: **Results**

The original baseline sample of the PLSWH included 4299 participants. For the purposes of the current study, the sample was restricted to participants with complete baseline data regarding depression on the PHQ-9 and CIDI-Auto 2.1 (n=3582). Based on the depressive group classifications described previously in Chapter Four: Methods, there were;

- 2840 participants with no depression within the last 12 months
- 305 participants with current subthreshold depression, and
- 252 participants with 12-month MDD based on the CIDI-Auto 2.1.

There were 185 participants who did not meet 12-month MDD criteria based on the CIDI-Auto 2.1 but met current major depression criteria based on the PHQ-9. These participants were not included as part of the three main baseline depressive status groups. Both the no depression and subthreshold depression baseline groups were included in the longitudinal analyses of the 1-year and cumulative 2-year risk of transition to subthreshold depression and MDD, respectively. An overview of the baseline and longitudinal 1 and 2-year samples are presented in Figure 1.

Figure 1 Flow diagram of baseline and longitudinal samples



5.1 Demographic Characteristics

Demographic, socioeconomic, and clinical characteristics at baseline were described for each of the three main depressive status groups. A brief overview is presented in text while detailed tables containing full baseline characteristics can be

found in Appendix A. All estimates are weighted proportions based on baseline sampling weights described previously in Chapter Four: Methods.

In the no depression group, there were slightly more males than females (56.04% vs. 43.97%, respectively) (**Table 17** of Appendix A). The mean age was almost 45 years. The majority of participants were married (76.27%), with a higher percentage of participants who were single or never married (13.75%) compared to participants who were widowed, separated, or divorced (9.98%). Approximately 36% of participants had an annual personal income over $80,000 CAD, while 32.16% had an annual income between $30,000-$59,999 CAD. There was a smaller number of participants (22.41%) with an annual personal income between $60,000-$79,999 CAD, and even less participants (9.47%) with a personal income less than $30,000 CAD a year. The majority of participants were high school graduates (58.22%). Approximately 37% of participants were university educated while 4.39% did not graduate high school. There were 14.90% and 17.90% participants who perceived low social support from their supervisors and co-workers, respectively. The mean weekly work hour was around 41 hours. Approximately 14% of participants had experienced (CIDI) lifetime depression, while around 3% had experienced co-morbid measured mood or anxiety disorders within the last 12 months. In regards to the psychosocial workplace characteristics, approximately 19.28% of participants reported a job strain ratio >1 (i.e. high job strain), 9.09% reported an effort-reward imbalance >1 (i.e. high effort reward imbalance), 27.16% experienced high work to family conflict, and 24.21% experienced high family to work conflict.

In the subthreshold depression group, there were similar proportions of males and females (**Table 18** of Appendix A). The mean age was approximately 44 years. The

majority of participants were married (68.71%) with similar proportions between the other two marital status groups (~15%). There were 41.84% participants with an annual personal income between $30,000-$59,999 CAD. The majority (61.17%) of participants were high school graduates, followed by university graduates at 29.75%, and those who did not graduate high school at 9.08%. Approximately 25% perceived low supervisor support and 31% perceived low co-worker support. The mean weekly work hours was 42.23 hours. Around 27.19% of participants experienced (CIDI) lifetime major depression, and 9.68% of participants had other measured mood or anxiety disorders within the last 12 months. Approximately 32.34% of participants reported high job strain, 12.85% reported high effort-reward imbalance, 44.74% experienced high work to family conflict, and 43.36% experienced high family to work conflict.

In the (CIDI) MDD group, there were more females than males (60.08% vs. 39.92%, respectively) (**Table 19** of Appendix A). The mean age was approximately 45 years. The majority of participants were married, had an annual personal income between $30,000-$59,999 CAD, and were high school graduates. Approximately 25% perceived low supervisor support while 30.51% perceived low co-worker support. The mean weekly work hour was 40.36 hours. Approximately 36.69% participants reported high job strain, 14.62% reported high effort-reward imbalance, 44.11% experienced high work to family conflict, and 39.01% experienced high family to work conflict.

5.2 Longitudinal transitions between depressive states

The classification of depressive states at the 12 and 24-month follow-ups according to baseline depressive group status, showed movement between depressive states in all directions. A brief description is presented in text while detailed tables can be

found in Appendix B. The proportions are un-weighted and non-cumulative in order to show the current distribution among depressive groups at each follow-up stage.

In terms of stability, the highest proportions of participants remaining in the same category at both the 12 and 24-month follow-ups were seen in the no depression baseline group (74.75% and 69.12%, respectively) (**Table 20** and **Table 21** of Appendix B). In those with MDD at baseline the proportion was lower, with 25.00% remaining in the MDD group at the 12-month follow-up, and 18.65% remaining in the MDD group at the 24-month follow-up. For those in the subthreshold depression baseline group, we see the lowest stability with 14.10% remaining in the subthreshold depression group at both the 12 and 24-month follow-ups. Overall, the proportions of transition to more severe depressive states were small. Of those participants with no depression at baseline, 3.91% transitioned to subthreshold depression at the 12-month follow-up (**Table 20** of Appendix B). Similarly, the proportion of participants who transitioned from no depression at baseline to subthreshold depression at the 24-month follow-up was 3.13% (**Table 21** of Appendix B). For the transition from subthreshold depression at baseline to MDD at follow-up, the proportion of participants was 6.23% at the 12-month follow-up and 7.87% at the 24-month follow-up.

In regards to transitions to less severe depressive states, the proportions of transition to no depression were higher than the proportions of transition to subthreshold depression. At the 12-month follow-up, 46.23% of participants in the baseline subthreshold depression group transitioned to no depression, while at the 24-month follow-up 39.67% of the baseline subthreshold group transitioned to no depression. A small proportion of participants with MDD transitioned to subthreshold depression at the

12-month follow-up (9.52%) and the 24-month follow-up (8.33%). A greater proportion of the MDD group transitioned to no depression at the 12-month follow-up (28.57%) and the 24-month follow-up (29.37%). Some participants transitioned from no depression to MDD, although this proportion was much lower than the transition to subthreshold depression (**Table 20** and **Table 21** of Appendix B). The PHQ-9 major depression group showed similar patterns to the MDD group in terms of transition to less severe depressive states, and there was almost equal movement between the two depression groups. The proportion of lost to follow-up was highest for the major depression groups.

5.3 Response and Non-Response

Responders and non-responders were described, in terms of baseline characteristics, after each transitional year for both the no depression and subthreshold depression longitudinal groups. Un-weighted proportions across psychosocial workplace variables and all demographic, socioeconomic, and clinical characteristics were estimated for responders and non-responders at the 12 and 24-month follow-ups. Only demographic, socioeconomic, and clinical characteristics found to have differences at the population level based on 95% confidence intervals are presented. A brief summary is presented in text while detailed tables can be found in Appendix C. There were no differences in terms of any of the baseline psychosocial workplace variables between responders and non-responders, based on the location of their 95% confidence intervals, for both longitudinal groups at any of the follow-ups.

In the no depression group, at the 12-month follow-up, there were 2359 responders and 481 non-responders. Compared to the responders, non-responders were younger in age, had a higher proportion of single and never married participants with a

lower proportion of married participants, had a higher proportion of less than $30,000 annual personal income and a lower proportion of over $80,000, and had a higher proportion of less than high school education with a lower proportion of university graduates (**Table 22** in Appendix C). At the 24-month follow-up, there were 2162 responders and 197 non-responders. On average, non-responders were around 3 years younger in age compared to the responders. No other apparent differences in baseline characteristics were found between the responders and non-responders based on the location of their 95% confidence intervals (**Table 23** in Appendix C).

For the subthreshold depression group, at the 12-month follow-up, there were 228 responders and 77 non-responders. Based on the location of their 95% confidence intervals, there were no differences between the responders and non-responders in regards to any of the baseline characteristics (**Table 24** in Appendix C). At the 24-month follow-up there were 208 responders and 20 non-responders. Compared to the responders, the non-responders had a lower proportion of married participants. There were no other baseline differences between the responders and non-responders at the 24-month follow-up (**Table 25** in Appendix C).

5.4 Objective 1: To estimate the point prevalence of subthreshold depression, overall and by baseline psychosocial workplace variables

Objective 1 was concerned with the point prevalence of subthreshold depression at baseline. Participants were included if they had complete depression data from the PHQ-9 and CIDI-Auto 2.1 at baseline (N=3582). The four psychosocial workplace variables were job strain ratio, effort-reward imbalance ratio, work to family conflict, and family to work conflict. The overall and stratified point prevalence estimates of

subthreshold depression at baseline are presented in Table 2. All estimates were weighted proportions based on baseline sampling weights described previously in Chapter Four: Methods. The overall point prevalence estimate of subthreshold depression was 8.42% (95% CI: 7.50-9.43%). The point prevalence estimate of subthreshold depression increased with higher work stress, for each psychosocial workplace variable. Furthermore, the subthreshold depression prevalence for low and high work stress differed by job strain ratio, work to family conflict, and family to work conflict, based on their 95% confidence intervals (Table 2).

By job strain ratio, the point prevalence estimate was 8.84% (95% CI: 8.58-9.05%) in the low job strain group. In the high job strain group, the point prevalence estimate appeared to be higher, 11.64% (95% CI: 9.52-14.15%) and there was no overlap between their 95% confidence intervals (Table 2). When stratified by effort-reward imbalance ratio, the point prevalence estimate was 8.99% (95% CI: 8.65-9.26%) in the low effort-reward imbalance group, while the estimate was 10.07% (95% CI: 7.46-13.46%) in the high effort-reward imbalance group. The low work to family conflict group had a subthreshold point prevalence estimate of 8.79% (95% CI: 8.57-8.99%) while the high work to family conflict group had a prevalence estimate of 12.07% (95% CI: 10.16-14.29%). Similarly, the point prevalence estimate of the low family to work conflict group was 8.72% (95% CI: 8.47-8.93%) while the estimate for the high family to work conflict group was 12.81% (95% CI: 10.74-15.22%). There was no overlap between 95% confidence intervals of subthreshold depression prevalence estimates between high and low conflict for both work to family and family to work conflicts (Table 2).

Table 2 Point prevalence estimates of subthreshold depression overall, and by baseline psychosocial workplace variables

Workplace Variables	Point prevalence of subthreshold depression (N=3582)	
	n with subthreshold depression	Weighted proportion % (95% CI)
Overall	305	8.42 (7.50-9.43)
Job Strain Ratio		
≤ 1	190	8.84 (8.58-9.05)
>1	100	11.64 (9.52-14.15)
Effort-Reward Imbalance Ratio		
≤ 1	255	8.99 (8.65-9.26)
>1	45	10.07 (7.46-13.46)
Work to family conflict		
Low	173	8.79 (8.57-8.99)
High	132	12.07 (10.16-14.29)
Family to work conflict		
Low	177	8.72 (8.47-8.93)
High	123	12.81 (10.74-15.22)

5.5 Objective 2: To assess the associations between subthreshold depression and job performance, job satisfaction, and intent to leave employment

Objective 2 was concerned with the independent, cross-sectional associations between subthreshold depression and each of job performance, job satisfaction, and intent to leave employment. For these analyses, those in the subthreshold depression baseline group were compared to those in the no depression baseline group (n=205 vs. n=2840). Participants in the MDD group (n=252) were excluded from these analyses, as we were only interested in the associations with subthreshold depression specifically. All estimates are weighted based on baseline sampling weights described previously in Chapter Four: Methods.

5.5.1 Job Performance

For the purposes of analysis the measurement of job performance was divided into two dimensions, presenteeism in avoiding distraction and presenteeism in completing work. Binary subthreshold depression was observed to be significantly associated with binary presenteeism in avoiding distraction. The weighted proportion of those with subthreshold depression reporting presenteeism in avoiding distraction was high, with more than half the participants reporting presenteeism (58.33%). The weighted proportion of those with no depression reporting presenteeism in avoiding distraction was lower, 33.27% (Table 3). In 1744 participants, the estimate of the association between subthreshold depression and presenteeism in avoiding distraction showed a strong association with a fairly narrow confidence interval suggesting a precise estimate (OR=2.81, 95% CI: 2.07-3.81). Those with subthreshold depression were 2.81 times more likely to experience presenteeism in avoiding distraction than those with no depression. The relationship between subthreshold depression and presenteeism in avoiding distraction was not modified or confounded by any of the analyzed covariates.

There was no evidence to support a significant association between binary subthreshold depression and binary presenteeism in ability to complete work The weighted proportions of those with presenteeism in completing work were similar for those with no depression and those with subthreshold depression (47.53% vs. 45.07%, respectively), though the proportion was slightly higher in those with no depression contributing to an odds ratio of less than 1 which was not significant at the 5% level of significance (OR=0.91, 95% CI: 0.66-1.23) (Table 4). The relationship between

subthreshold depression and presenteeism in completing work was not modified or confounded by any of the covariates.

Table 3 Association between binary subthreshold depression and binary presenteeism in avoiding distraction (n=1744)

	Avoiding distraction by Standford-Presenteeism-Scale-6			
Depressive status	**Weighted proportion of participants reporting presenteeism in avoiding distraction (%)**	**OR**	**95% CI LL**	**95% CI UL**
No depression	33.27	2.81	2.07	3.81
Subthreshold depression	58.33			

Table 4 Association between binary subthreshold depression and binary presenteeism in completing work (n=1742)

	Completing work by Standford-Presenteeism-Scale-6			
Depressive status	**Weighted proportion of participants reporting presenteeism completing work (%)**	**OR**	**95% CI**	**95% CI**
No depression	47.53	0.91	0.66	1.23
Subthreshold depression	45.07			

5.5.2 Job Satisfaction

Binary job satisfaction was found to be significantly associated with binary subthreshold depression. Though the weighted proportions of an unsatisfied response to job satisfaction were fairly low, the proportion in those with subthreshold depression was more than double the proportion in those with no depression. In 3138 participants, participants with subthreshold depression had a weighted proportion of 12.28% for reporting that they were unsatisfied with their job while the proportion was 5.59% in those with no depression. The association between subthreshold depression and job satisfaction was strong, and those with subthreshold depression were 2.36 times more likely to report an unsatisfied response than those with no depression (OR=2.36, 95% CI:

1.57-3.56) (Table 5). The relationship between subthreshold depression and job satisfaction was not modified or confounded by any of the analyzed covariates.

Table 5 Association between binary subthreshold depression and binary job satisfaction (n=3138)

	Job Satisfaction			
Depressive status	**Weighted proportion of an "Unsatisfied" response (%)**	**OR**	**95% CI**	**95% CI**
No depression	5.59	2.36	1.57	3.56
Subthreshold depression	12.28			

5.5.3 Intention to leave current employment

The crude association between binary subthreshold depression and binary intent to leave current employment showed a significant association (Table 6). The weighted proportions of those with a "Very likely" intent to leave current employment were quite different based on whether they had subthreshold depression or no depression. In those experiencing subthreshold depression, 22.79% reported a "Very likely" response while 9.88% reported a "Very likely" response in those with no depression. Subthreshold depression was strongly associated with intent to leave current employment (Crude OR= 2.69, 95% CI: 1.94-3.73), however his relationship was modified by age and significant associations were observed in those less 45 years of age. Though age was measured and analyzed as a quantitative variable in the binomial regression modeling, for ease of comparisons results were stratified by age category. Stratum specific estimates by age group are presented Table 7. Subthreshold depression was associated with a significant increase in odds of reporting a "Very likely" response in intending to leave employment compared to no depression but only in individuals belonging to the lowest two age

categories (i.e. 25-34 years and 35-44 years). For those in the oldest two age categories (i.e. 45-54 years and 55-64 years), subthreshold depression was not significantly associated with intent to leave current employment.

For the 602 participants aged 25-34 years, the odds of indicating a "Very likely" response to intent to leave current employment in those with subthreshold depression was 3.82 times the odds in those with no depression (OR=3.82, 95% CI: 2.18-6.67). In 841 participants aged 35-44 years, the odds of a "Very likely" response in those with subthreshold depression was 3.17 times the odds in those with no depression (OR=3.17, 95% CI: 1.73-5.77). Since there was overlap in their 95% confidence intervals, we cannot say whether the population parameters are the same or different. The overlap in all the 95% confidence intervals may be due to imprecise estimates likely caused by small sample sizes. However, the location of the confidence intervals and the increasing point estimate appear to show an increasing strength in association with decreasing age. In the binomial regression model, the interaction term between subthreshold depression and quantitative age on intent to leave current employment was significant at the 5% level of significance (p=0.037).

Table 6 Crude association between binary subthreshold depression and binary intent to leave current employment (n=3126)

	Intent to Leave Current Employment			
Depressive status	**Weighted Proportion of a "Very Likely" response (%)**	**OR**	**95% CI LL**	**95% CI UL**
No depression	9.88	2.69	1.94	3.73
Subthreshold depression	22.79			

Table 7 Association between binary subthreshold depression and binary intent to leave current employment, stratified by age group (n=3126)

	Intent to Leave Current Employment					
Age group	**Depressive status**	**Weighted Proportion of a "Very Likely" response (%)**	**OR**	**95% CI LL**	**95% CI UL**	**P-value associated with interaction term**
25-34 years (n=602)	No depression	14.18	3.82	2.18	6.67	0.037*
	Subthreshold depression	38.67				
35-44 years (n=841)	No depression	8.99	3.17	1.73	5.77	
	Subthreshold depression	23.82				
45-54 years (n=1103)	No depression	9.03	1.47	0.76	2.83	
	Subthreshold depresssion	12.76				
55-65 years (n=580)	No depression	5.76	1.01	0.27	3.66	
	Subthreshold depression	5.83				

*P-value from subthreshold depression-quantitative age interaction term in binomial regression model

5.6 Objective 3: To estimate the proportions of transition to subthreshold depression and MDD

The proportions of transition were stratified by all baseline characteristics but only the four psychosocial workplace variables and any demographic, socioeconomic, and clinical characteristics with different proportions based on their 95% confidence intervals are presented. All estimates are weighted proportions based on 12-month and 24-month longitudinal weights described previously in Chapter Four: Methods.

5.6.1 Objective 3.1: To estimate the 1-year and cumulative 2-year proportions of transition to subthreshold depression in the no depression baseline group, overall, and by baseline characteristics

The 1-year and 2-year cumulative proportions of transition to subthreshold depression were estimated in the no depression baseline group (n=2840), overall, and by

baseline characteristics. Details of the overall and stratified proportion estimates are presented in Table 8, Table 9, and Table 26 of Appendix D. The overall estimate of the 1-year proportion of subthreshold depression was 4.57% (95% CI: 3.77-5.54%) while the estimate of the 2-year cumulative proportion was almost double at 8.23% (95% CI: 7.05-9.57%) (Table 8 and Table 9). When estimated by levels of each psychosocial workplace variable, overall the 1-year and 2-year proportions of subthreshold depression appear to resemble each other (Table 26).

Only the 2-year cumulative proportions of subthreshold depression by work to family conflict appeared to be different. Those reporting low work to family conflict had a 2-year cumulative proportion of 7.25% (95%CI: 5.97-8.78%), while those reporting high work to family conflict had a 2-year proportion of 10.13% (95% CI: 7.79-13.08%). Though their 95% confidence intervals overlapped, the chi-squared test of significance showed that the 2-year subthreshold depression proportions by level of work to family conflict were significantly different ($\chi^2 = 4.67\ (df = 1), p = 0.04$). The 1-year estimate of sub-threshold depression proportion was higher for high work to family conflict than low work to family though the difference was smaller and did not achieve statistical significance.

Of the observed baseline characteristics, only two presented with differences in proportion estimates for subthreshold depression. For 1-year proportion estimates, subthreshold depression increased from 4.21% (95%CI: 3.43-5.16 %) to 15.37% (95% CI: 8.46-26.31%) with the presence of any measured comorbid 12-month mood or anxiety disorder (Table 8). Similar results were found for the 2-year cumulative risk of transition to subthreshold depression in regards to measured co-morbid disorders (Table

9). The 2-year cumulative proportion estimate for participants with no measured comorbid 12-month disorder was 7.59% (95% CI: 6.47-8.90%), which increased to 26.17% (95% CI: 15.97-39.81%) for participants with any measured comorbid mood or anxiety disorder within the last 12 months. Two-year proportion estimates also differed by level of co-worker support though the differences were smaller (Table 9). For participants reporting high co-worker support, the 2-year cumulative proportion estimate of subthreshold depression was 7.45% (95%CI: 6.23-8.89%). Participants who reported low co-worker support had a higher proportion estimate of 12.05% (95% CI: 8.92-16.07%).

Table 8 One-year proportion estimates of transition to subthreshold depression in the no depression baseline group, overall, and by baseline presence of any measured comorbid 12-month disorder

Baseline Characteristics	**1 – year proportion estimates (n=2359)**	
	n with subthreshold depression	**Weighted Proportion (95% CI)**
Overall	111	4.57 (3.77-5.54)
No other measured disorder	100	4.21 (3.43-5.16)
Any other measured disorder	11	15.37 (8.46-26.31)

*Measured 12-month disorders: GAD, social phobia, panic disorder, dysthymia and mania.

Table 9 Two-year cumulative proportion estimates of transition to subthreshold depression in the no depression baseline group, overall, and by baseline characteristics

Baseline Characteristics	**2- year cumulative proportion estimates (n=2162)**	
	n with subthreshold depression	**Weighted Proportion (95% CI)**
Overall	174	8.23 (7.05-9.57)
High co-worker support	130	7.45 (6.23-8.89)
Low co-worker support	44	12.05 (8.92-16.07)
No other measured disorder	159	7.59 (6.47-8.90)
Any other measured disorder	15	26.17 (15.97-39.81)

*Measured 12-month disorders: GAD, social phobia, panic disorder, dysthymia and mania.

5.6.2 Objective 3.2: To estimate the 1-year and cumulative 2-year proportions of transition to MDD in the subthreshold depression baseline group, overall, and by baseline characteristics

The 1-year and 2-year cumulative proportions of transition to MDD were estimated in the subthreshold depression baseline group, overall, and by baseline characteristics (n=305). Overall and stratified estimates by baseline psychosocial workplace variables are presented in **Table 27** of Appendix D. The overall estimate of the 1-year proportion of transition to MDD from subthreshold depression was 8.43% (95% CI: 5.26-13.23%). The 2-year cumulative proportion estimate of transition to MDD from subthreshold depression was 15.85% (95%CI: 11.15-22.03%).

When estimated by levels of each psychosocial workplace variable, we see higher 1-year and 2-year proportion estimates of MDD with high stress compared to low stress (**Table 27**). However, there was overlap between their 95% confidence intervals and therefore we cannot say whether the population parameters are different or the same by levels of each psychosocial workplace variable. The largest differences in proportions were seen for effort-reward imbalance, specifically the 1-year proportion estimates. The estimate of the 1-year MDD proportion for those with low effort-reward imbalance was 6.99% (95%CI: 3.93-12.13%) while the estimate of the 1-year MDD proportion for those with high effort-reward imbalance was 21.49% (95%CI: 9.64-41.24%). The difference in 1-year MDD proportions by level of effort-reward imbalance was found to be significant at the 5% level of significance ($\chi^2 = 5.94$ ($df = 1$), p= 0.02). The 2-year estimates of MDD proportion were higher for high effort-reward imbalance than low effort-reward imbalance though the difference was smaller and did not achieve statistical significance.

5.7 Objective 4: To identify psychosocial workplace factors associated with the 1-year and cumulative 2-year risk of transition to subthreshold depression from no depression

Each of the four main psychosocial workplace variables was analyzed independently as a risk factor for the transition to subthreshold depression in the no depression baseline group (n=2840). The demographic, socioeconomic, and clinical characteristics described previously were analyzed as covariates. The outcome was development of subthreshold depression, based on the PHQ-9, after one or two years. All estimates are weighted based on 12-month and 24-month longitudinal weights described previously in Chapter Four: Methods.

In regards to the 1-year risk of transition to subthreshold depression, the proportion of subthreshold depression was higher for those with high work to family conflict compared to those with low work to family conflict though the difference was minimal. The crude RR showed an increased risk in transition to subthreshold depression in those with high work to family conflict compared to low work to family conflict but this was not statistically significant as the 95% confidence interval contained the null value of 1 (Table 10). Similar results are seen for the gender and age adjusted estimates (Table 11).

The crude analysis showed a significant increase in 2-year risk of transition to subthreshold depression from no depression in those with high work to family conflict compared to those with low work to family conflict. In 2144 participants with no depression at baseline, the estimated risk ratio (RR) was 1.40 (95% CI: 1.01-1.93) and was significant at the 5% level of significance (Table 10). Gender and age adjusted estimates are presented in Table 11 and work to family conflict remained a significant

factor for the 2-year risk of transition to subthreshold depression (Adjusted RR = 1.47, 95% CI: 1.05-2.05, p=0.02) (Table 11). In the no depression baseline group, those with high work to family conflict had 1.47 times the risk of developing subthreshold depression compared to those with low work to family conflict.

There was no evidence to support job strain ratio, effort-reward imbalance ratio, and family to work conflict as significant factors in the 1 or 2-year risk of transition to subthreshold depression in those with no depression at baseline (**Table 28**, **Table 29**, **Table 30**, **Table 31**, **Table 32**, & **Table 33**, in Appendix E).

Table 10 Crude RR estimate of 1-year and cumulative 2-year subthreshold depression, by binary work to family conflict in the no depression baseline group

Workplace Variable	**Subthreshold depression by PHQ-9**			
	1-year (n=2341)			
Work to family conflict	**Weighted Proportion (%)**	**RR**	**95% CI LL**	**95% CI UL**
Low	4.03	1.29	0.85	1.96
High	5.20			
	2-year (n=2144)			
Work to family conflict	**Weighted Proportion (%)**	**RR**	**95% CI LL**	**95% CI UL**
Low	7.25	1.40	1.01	1.93
High	10.13			

Table 11 Adjusted RR estimate of 1-year and cumulative 2-year subthreshold depression, by work to family conflict in the no depression baseline group

	Subthreshold depression by PHQ-9				
Workplace Variable	**1-year (n=2341)**				
	RR	**z**	**p**	**95% CI LL**	**95% CI UL**
Work to family conflict	1.35*	0.29	0.17	0.88	2.07
	2-year (n=2144)				
	RR	**z**	**p**	**95% CI LL**	**95% CI UL**
Work to family conflict	1.47*	0.25	0.02	1.05	2.05

*Adjusted for gender and age

5.8 Objective 5: To identify psychosocial workplace factors associated with the 1-year and cumulative 2-year risk of transition to MDD from subthreshold depression

Each of the four psychosocial workplace variables was analyzed independently as a risk factor for MDD in the subthreshold depression baseline group (n=305). The demographic, socioeconomic, and clinical characteristics described previously were analyzed as covariates. The outcome was development of MDD, based on the CIDI-Auto 2.1, after one and two years. All estimates are weighted based on 12-month and 24-month longitudinal weights described previously in Chapter Four: Methods.

There was evidence for two of the four psychosocial workplace variables as significant factors in the risk of transition to MDD from subthreshold depression. Crude estimates of binary effort-reward imbalance are presented in Table 12. As seen previously in Objective 3.2, in participants with baseline subthreshold depression, both 1-year and 2-year proportions of MDD increased with high effort-reward imbalance compared to low effort-reward imbalance, a difference that was significant for the 1-year proportions. The crude RR point estimates for both one and two year transitions showed strong associations that were statistically significant, though the width of the 95% confidence intervals were quite wide (Table 12). Similar results are seen when adjusted by gender and age though the estimates were no longer statistically significant at the 5% level of significance (Table 13).

Though crude analyses showed an increased risk in the 1-year and 2-year transitions to MDD with high work to family conflict compared to low conflict, the results were not statistically significant at the 5% level of significance (Table 14). After controlling for confounding by marital status, the estimate of the association between

work to family conflict and the 1-year risk of transition to MDD increased and was statistically significant (Adjusted RR=2.88, 95% CI: 1.08-7.62) (Table 15). The final regression model for the 1-year risk of transition to MDD with work to family conflict as the exposure, marital status confounder, and adjustment for gender and age is presented in Table 16. Those with high work to family conflict had 2.88 times the risk of MDD than those with low work to family conflict (p=0.03). Results remained the same for the 2-year risk of MDD and work to family conflict when adjusted for gender and age.

There was no evidence to support that job strain ratio and family to work conflict were significant risk factors in the 1-year or 2-year risk of transition to MDD in those with baseline subthreshold depression (**Table 34**, **Table 35**, **Table 36**, & **Table 37** in Appendix F).

Table 12 Crude RR estimate of 1-year and cumulative 2-year MDD, by binary effort-reward imbalance ratio in the subthreshold depression baseline group

Workplace variable	**MDD by CIDI-Auto 2.1**			
	1-year (n=223)			
Effort-Reward Imbalance Ratio	**Weighted Proportion (%)**	**RR**	**95% CI LL**	**95% CI UL**
</= 1	6.99	3.08	1.21	7.80
>1	21.49			
	2-year (n=204)			
Effort-Reward Imbalance Ratio	**Weighted Proportion (%)**	**RR**	**95% CI LL**	**95% CI UL**
</= 1	14.44	2.14	1.03	4.46
>1	30.96			

Table 13 Adjusted RR estimate of 1-year and cumulative 2-year MDD, by binary effort-reward imbalance in the subthreshold depression baseline group

Workplace variable	**MDD by CIDI-Auto 2.1**				
	1-year (n=223)				
	RR	**z**	**p**	**95% CI LL**	**95% CI UL**
Effort-Reward Imbalance Ratio	2.38*	1.14	0.07	0.92	6.14

	2-year (n=204)				
	RR	**z**	**p**	**95% CI LL**	**95% CI UL**
Effort-Reward Imbalance Ratio	1.98*	0.77	0.08	0.91	4.27

*Adjusted for gender and age

Table 14 Crude RR estimate of 1-year and cumulative 2-year MDD, by binary work to family conflict in the subthreshold depression baseline group

Workplace variable	**MDD by CIDI-Auto 2.1**			
	1-year (n=228)			
Work to family conflict	**Weighted Proportion (%)**	**RR**	**95% CI LL**	**95% CI UL**
Low	5.54	2.20	0.80	5.98
High	12.18			
	2-year (n=208)			
Work to family conflict	**Weighted Proportion (%)**	**RR**	**95% CI LL**	**95% CI UL**
Low	13.28	1.42	0.71	2.84
High	18.92			

Table 15 Adjusted RR estimate of 1-year and cumulative 2-year MDD, by binary work to family conflict in the subthreshold depression baseline group

Workplace variable	**MDD by CIDI-Auto 2.1**				
	1-year (n=227)				
	RR	**z**	**p**	**95% CI LL**	**95% CI UL**
Work to family conflict	2.88*	1.42	0.03	1.08	7.62
	2-year (n=208)				
	RR	**z**	**p**	**95% CI LL**	**95% CI UL**
Work to family conflict	1.55**	0.52	0.20	0.79	3.02

*Adjusted for gender, age, marital status **Adjusted for gender and age

Table 16 Final regression model for 1-year risk of MDD and work to family conflict exposure, in the subthreshold depression baseline group

	1-year MDD by CIDI-Auto 2.1 (n=228)				
Variable	**RR**	**SE**	**p**	**95% CI LL**	**95% CI UL**
Work to family conflict	2.88	1.42	0.03	1.08	7.62
Gender	2.20	1.12	0.13	0.80	6.01
Age	1.05	0.03	0.04	1.00	1.11
Marital Status	1.52	0.35	0.07	0.96	2.40

Chapter Six: **Discussion**

6.1 Cross-sectional Results

6.1.1 Prevalence of subthreshold depression

6.1.1.1 Key findings

The data showed that subthreshold depression was prevalent in the general working population with an overall prevalence estimate of 8.42% (95% CI: 7.50-9.43%). Subthreshold depression was defined as endorsing two to four depressive symptoms on the PHQ-9, without meeting criteria for PHQ-9 major depression and CIDI major depressive disorder (MDD). The prevalence estimate of subthreshold depression in those with high stress was higher than the prevalence estimate in those with low stress, a finding that was observed for all four psychosocial workplace variables. Furthermore, population prevalence of subthreshold depression by levels of job strain, work to family conflict, and family to work conflict, appeared to differ based on comparisons of their 95% confidence intervals.

6.1.1.2 Comparison to previous literature

Although the majority of general population studies estimated a lifetime or 12-month prevalence of subthreshold depression, one study found a point prevalence of subthreshold depressive disorders of 5.4% (Martin et al., 2006). The higher estimate observed in the present study may be due to differences in how subthreshold depression was defined. Though both studies defined subthreshold depression with the endorsement of 2-4 depressive symptoms on the PHQ-9, the Martin study also required that at least one of the symptoms was a core symptom.

Another explanation for the difference could be that this study involved a specific sub-set of the general population, i.e. those currently employed, which may potentially have a higher prevalence of subthreshold depression due to factors such as work stress. Unfortunately there are no studies comparing prevalence of subthreshold depression in the employed and the unemployed. Higher point prevalence estimates of subthreshold depression were observed in studies of specific populations involving the elderly (27.7%), and patients in primary care (35.2%) (Adams & Moon, 2009; da Silva Lima & de Almeida Fleck, 2007). This may also be the case for those who are employed, though to a much lesser extent since these individuals were sampled from the general population. Despite differences in defining subthreshold depression and differences in population characteristics, the point prevalence estimate in this study was similar to that of the Martin study. Overall, the similarity in estimates of prevalence between this study and others lends some support to a valid measurement of the concept of subthreshold depression despite the lack of consensus on how it is defined.

By including the 185 participants that could not be classified into one of the three main groups (i.e. those who had a continuous score of ≥ 10 on the PHQ-9) in the denominator of our prevalence calculation, we may have underestimated the true prevalence of sub-threshold depression. The longitudinal transitions in this group suggest a closer resemblance to the pattern of movement seen in the MDD group. Descriptive analyses of this group (results not presented) reveal a mixture of characteristics between the subthreshold depression and MDD groups. Since the point prevalence estimate of subthreshold depression observed in this study was higher than reported in other studies, the effects of including this group are likely minimal.

In this study the prevalence of subthreshold depression was higher than that of major depression, which has been seen previously in other studies (Judd et al., 1997; Martin et al., 2006; Rucci et al., 2003). A higher proportion of individuals experiencing subthreshold depression would be consistent with subthreshold depression representing a less severe intermediate step towards major depression. Some studies have observed a lower prevalence of subthreshold depression compared to major depression (Ayuso-Mateos et al., 2010; Baumeister & Morar, 2008; Stansfeld, Shipley, Head, & Fuhrer, 2012). However, these studies used the CIDI to measure subthreshold depression, which may miss subthreshold cases due to the skipping logic of the interview in regards to the core symptoms. As mentioned previously the interest of this study was in a broader concept of subthreshold depression regardless of whether core symptoms are endorsed.

Concerning the point prevalence of subthreshold depression by levels of psychosocial workplace variables, direct comparisons to studies of subthreshold depression cannot be made. Similar to the results of the present study, an increase in prevalence with high work stress compared to low work stress has been previously observed in major depression. Using data from the Whitehall II study, the 12-month prevalence of MDD increased with increasing levels of job strain (Stansfeld et al., 2012). Using data from the Canadian Community Health Survey – Mental Health and Well-Being, the prevalence of 1-month MDD increased with decreasing levels of work and family balance (Wang, 2006).

6.1.2 Subthreshold depression in the workplace

6.1.2.1 Key findings

Participants with subthreshold depression were more likely to have reported presenteeism, unsatisfied feelings with their job, and a very likely intent to leave current employment, compared to participants with no depression. Experiencing subthreshold depression was significantly associated with presenteeism in avoiding distraction, while the association with presenteeism in completing work was not significant. Subthreshold depression was a significant factor for low job satisfaction. The relationship between subthreshold and a very likely intent to leave employment was modified by age. When stratified by age group subthreshold depression was associated with an increase in a very likely intent to leave current employment compared to no depression, which was only statistically significant in the two youngest age categories.

6.1.2.2 Comparison to previous literature

Though the focus was not on subthreshold depression specifically, two studies looking at the outcome of presenteeism have found associations with minor levels of depression. In employed patients initiating depression treatment loss of productivity in terms of presenteeism increased with depression symptom severity (Beck et al., 2011). Similarly, in a study of full-time US employees reporting physician diagnoses of depression, decreased work productivity in terms of presenteeism worsened with severity of depression (Jain et al., 2013). This lends support for the increased presenteeism in terms of avoiding distraction associated with subthreshold depression that was seen in the present study. It is unknown why we observed a significant association between subthreshold depression and only one dimension of presenteeism. One possible

explanation may be that since subthreshold depression is less severe than major depression, individuals may experience problems with work processes but not with work outcomes.

Previous studies on the relationship between subthreshold depression and job satisfaction are less common and have been conducted in specific populations. In a study of Swiss males between the ages of 18-25 years the proportion experiencing low job satisfaction in those with subthreshold depression was 16.53%, (Barth et al., 2014), compared to a proportion of 12.28% in the current study. The higher proportion in the Barth study is likely due to the fact that they also included school and technical training satisfaction for participants who were not employed. In their study, those with subthreshold depression had over 2.64 (95% CI: 1.61-4.33) times the odds of low satisfaction compared to those with no depression, which is comparable to the odds ratio of 2.36 (95% CI: 1.57-3.56) in the current study. A study of hospital-employed nurses showed that a decrease in job satisfaction was significantly associated with an increase in PHQ-9 total depression scores (Letvak, Ruhm, & McCoy, 2012). The similarity of results despite large variations in study populations shows a consistent association between subthreshold depression and low job satisfaction.

To our knowledge there have been no previous studies of subthreshold depression and intent to leave current employment. In a study of soldiers a higher proportion of intending to leave current employment was observed in those who screened positive for depression on the PHQ-9 compared to those who did not screen positive for depression (Wright, Kim, Wilk, & Thomas, 2012). Overall similar results were found in the present

study though the relationship was modified by age. This will be discussed further in the following section.

6.1.2.3 Effect of modification by age

The association between subthreshold depression and intent to leave current employment varied significantly by age. In the two lowest age categories (<45 years), those with subthreshold depression had significantly higher odds of intending to leave current employment than those with no depression. Based on the point estimate alone, the strength of the relationship between subthreshold depression and intent to leave current employment appeared to increase with decreasing age.

One possible explanation may be that younger employees may have more flexibility in terms of leaving current employment and finding new opportunities, while older employees may be more established and would not want the disruption and uncertainty of finding new employment. Some of the oldest participants may even be close to retirement. In older employees these other factors may be more important in relation to the intent to leave current employment than experiencing subthreshold depression. Though there are no studies examining all three factors directly, some studies may support in part this possible explanation. Several studies have found that intending to leave employment was a greater issue in younger workers than older workers (Boyas, Wind, & Kang, 2012). Though the specific factors affecting intention to leave employment in younger and older employees were not compared, these results suggest that there may be other important factors in addition to subthreshold depression that may increase in importance with increasing age.

When providing possible explanations for the observed effect modification by age, it should be acknowledged that these analyses are cross-sectional and the direction of effect cannot be established. While we are assuming that those with subthreshold depression are more likely to report a high intent of leaving employment, it is equally plausible that those with a high intent of leaving employment are more likely to experience subthreshold depression. Longitudinal studies are needed to clarify the direction of the relationship.

6.2 Longitudinal Results

6.2.1 Longitudinal transitions among depressive groups

6.2.1.1 Key findings

Looking at the longitudinal outcomes of baseline depressive groups, we see the dynamic and fluctuating nature of depressive symptoms. The highest stability (remaining in the same depressive group at follow-up) was seen for the no depression baseline group. The lowest stability was seen for the subthreshold depression baseline group. The transitions from subthreshold depression to (CIDI) MDD at both 12 and 24-month follow-ups were almost double the transitions from no depression to subthreshold depression. The highest proportion of transition for subthreshold depression was to no depression. There were also individuals in the MDD baseline group who transitioned to less severe depressive states, though stability in MDD was higher than in subthreshold depression.

6.2.1.2 Comparison to previous literature

Similar to the results of a study in community subjects from 3 sites of the NIMH Epidemiological Catchment Area, we observed a high degree of change in depressive

symptom and disorder diagnoses at the 1 year follow-up (Judd et al., 1997). Furthermore, movement between depressive groups occurred in all directions. In subthreshold subjects at Wave 1, 4% met criteria for major depression after 1 year, compared to a proportion of 6.23% in the present study. Their study also showed greater stability for major depression than subthreshold depression, with 28% remaining in the major depression group and 17% remaining in the subthreshold depression group. The proportions in this study were 25% and 14%, respectively. While stability for the sub-threshold and major depression groups were similar across studies, the Judd study showed much less stability in the no depression baseline group.

Contrary to the present study, the Judd and colleagues study showed a higher proportion of transition from no depression to subthreshold depression than the transition from subthreshold depression to major depression. Differences in the number and the definitions of depressive categories may have contributed to the results observed. Overall results from both studies show that individuals move from one depressive sub-category to another over time, supporting the view of depression existing as a dimensional illness with depressive subtypes as stages along the continuum of symptomatic severity.

6.2.2 Transition from no depression to subthreshold depression

6.2.2.1 Key findings

The overall 1-year proportion estimate of transition to subthreshold depression in those with no depression was 4.57% (95% CI: 3.77-5.54%), and the overall 2-year cumulative proportion estimate of transition was 8.23% (95% CI: 7.05-9.57%). The results support high work to family conflict as a significant risk factor in the 2-year transition from no depression to subthreshold depression. The 2-year cumulative

proportion estimates of sub-threshold depression differed significantly by work to family conflict. There was no evidence to support a significant association between work to family conflict and the 1-year risk of transition to subthreshold depression.

The 1-year and 2-year cumulative proportion estimates of subthreshold depression differed by the presence of measured comorbid 12-month mood and anxiety disorders, with almost four times the proportion when a co-morbid disorder was present compared to when there was no co-morbid disorder. In addition, the 2-year cumulative proportion estimates of subthreshold depression differed by level of social support, with low support from co-workers associated with twice the proportion of subthreshold depression when compared to those with high social support. These two variables did not play a modifying or confounding role in the relationships identified.

6.2.2.2 Comparison to previous literature

Although direct comparisons for the 1-year and cumulative 2-year transition estimates of subthreshold depression from no depression cannot be made, there were two studies that have looked at the non-cumulative proportions of transition at a 3-year follow-up. In a 2012 study of the US general population, 5.8% of respondents with no depression at baseline developed subthreshold depression at the 3-year follow-up (Pietrzak et al., 2013). Subthreshold depression was defined as depression not meeting the minimum symptom requirement for major depression on the AUDADIS-IV. Similarly in a study of the Swedish general population the transition to subthreshold depression from no depression at the 3-year follow-up was 4.0% (Forsell, 2007). Subthreshold depression was defined as in the current study with the addition of the social impairment requirement using the Major Depression Inventory (MDI).

As can be seen from the results of this study and those of previous studies, major depression is a dynamic and fluctuating condition with individuals moving in and out of depressive sub-types over time. Considering a cumulative proportion of individuals who transition from no depression to subthreshold depression over time would result in a higher estimate than only considering those with subthreshold depression at any given point in time. There were likely individuals who transitioned to subthreshold depression during the time period of interest but who may have remitted to no depression or fully transitioned to major depression at the time of the assessment.

6.2.3 Transition from subthreshold depression to major depressive disorder

6.2.3.1 Key findings

The main objective of this study was to identify psychosocial workplace factors associated with the transition from subthreshold depression to MDD. MDD was defined using DSM-IV criteria based on data from the CIDI-Auto 2.1. The overall 1-year proportion estimate of MDD in those with subthreshold depression was 8.43% (95% CI: 5.26-13.23%) while the overall 2-year cumulative proportion estimate was 15.85% (95% CI: 11.15-22.03%). In terms of psychosocial workplace factors that affect the transition from subthreshold depression to MDD, there was evidence for a relationship between effort-reward imbalance and MDD for both 1 and 2-year transitions though it failed to achieve statistical significance when adjusted for gender and age.

The 1-year proportion estimate in those with high effort-reward imbalance (21.49%) was almost triple the 1-year proportion estimate in those with low effort-reward imbalance (6.99%) representing a significant difference in proportion ($p=0.02$). Although the 2-year cumulative proportion estimate for high effort-reward imbalance was higher

than the proportion in low effort-reward imbalance, the difference was not statistically significant. The crude associations between work to family conflict and the 1-year and 2-year risk of transition to MDD, although showing an increase risk with higher work to family conflict, were not significant. Similarly, the 1-year and cumulative 2-year proportion estimates of MDD did not differ significantly by work to family conflict. When the association was adjusted for confounding by marital status, high work to family conflict was found to be a significant risk factor in the 1-year transition to MDD from subthreshold depression.

6.2.3.2 Comparison to previous literature

The estimate of the 1-year transition to MDD in the subthreshold depression baseline group was 8.43%, while the 2-year cumulative transition estimate was 15.85%. Comparing these results to studies conducted specifically in subthreshold depression populations, we see that both 1 and 2-year transition estimates are lower than those found in previous studies. The estimate of the 1-year transition to MDD seen in the present study was less than half the estimate of the 1-year transition seen in a 2005 study by Cuijpers and colleagues. Their study used 4 depressive symptoms as the cut-off for subthreshold depression, and the CIDI to determine major depression consistent with current research (Cuijpers et al., 2005). However, the study sample of the Cuijpers study consisted of participants from the control arm of an RCT of subthreshold depression intervention in primary care patients. As these were individuals actively seeking treatment, they may have more severe subthreshold depression than individuals in the general population. As such, their risk of subsequent development of major depression would presumably be higher.

Similarly, our cumulative 2-year proportion of transition to MDD estimate of 15.85% was lower than the 2-year cumulative proportion of transition estimate of 27.6% found in a previous Netherlands cohort study (Karsten et al., 2011). The Inventory of Depressive Symptomatology-Self Report was used to determine subthreshold depression, which was defined as meeting a cut-off score of at least 14 on the measure but not meeting requirements for full major depression. MDD was determined with the CIDI Version 2.1 as in the current study. In addition to differences in the definition of subthreshold depression employed, estimates may differ due to differences in study populations. Recruitment in their study was based mostly on the presence of or risk of depressive disorders and proportions of occurrence may therefore be higher. On the other hand, Forsell and colleagues observed a lower proportion of transition from subthreshold depression to major depression at the 3-year follow-up, 13.8% (Forsell, 2007). As mentioned previously, this was not a cumulative proportion of transition and therefore cases of major depression that have been resolved at the time of assessment would not have been captured.

This study found evidence in support of work to family conflict as a significant factor in the risk of transition from subthreshold depression to MDD. As seen previously, work to family conflict was also a significant factor in the risk of transition from no depression to subthreshold depression. Previous studies have looked at the transition from no depression to major depression in general but have not broken down the transition to include subthreshold depression as an intermediate step in the developmental pathway. Those studies have observed each workplace factor to be significantly associated with the risk of major depression, although the strength of the associations may vary (Netterstrom

et al., 2008). High stress may increase the risk of major depression when compared to low stress, a relationship that has been found for all four psychosocial workplace variables. It is conceivable that these workplace factors would also be associated with the likelihood of subthreshold depression as it may be a less severe sub-type of major depression.

A systematic review from 2008 found that there was solid evidence of a prospective moderate association between psychosocial work stress, as defined by the job strain and the effort-reward imbalance models, and depression (Siegrist, 2008). The authors found that the effects of effort-reward imbalance on depression were more consistent and generally stronger, though there were fewer studies examining this factor. In this study there was insufficient statistical evidence to support effort-reward imbalance and job strain as significant factors in the risk of transition to MDD, and future studies with larger sample sizes are needed.

Other studies have found that work to family conflict was a stronger predictor for major depression compared to components of the demand-control model, though the analyses were cross-sectional and work-family conflict was assessed with one question (Wang, Lesage, Schmitz, & Drapeau, 2008). The results of this study are therefore consistent with previous studies in that it was able to detect significant associations with work to family conflict despite small sample sizes, suggesting a potentially stronger effect compared to the other psychosocial workplace factors. Although the results showed a significant role of work to family conflict in the risk of transition to subthreshold and MDD, the strength of the associations observed were weaker than observed in previous studies (Frone, 2000; Wang, 2006). The measurements for work to family conflict

differed between the studies, which may have contributed to the observed differences. Additionally, the transitions observed in the previous studies were from no depression to major depression while the associations in this study were broken down into two stages of transition. The strength of the relationship between depression and work to family conflict may be weaker during a shorter transition.

Furthermore, the associations observed in the current study appeared to be stronger for the 1-year transition from subthreshold depression to MDD than the cumulative 2-year transition from no depression to subthreshold depression. High work to family conflict in comparison to low work to family conflict may differentially increase the risk of major depression than the risk of subthreshold depression. Another contributing factor to the observed difference in strength may be that the predictive power for baseline psychosocial workplace variables may be higher for a 1-year prediction than for a 2-year prediction. After a certain period of time, workplace characteristics at baseline may lose relevance in terms of predicting future outcomes when compared to more recent workplace characteristics.

6.2.3.3 Confounding by marital status

The association between the 1-year risk of transition to MDD and work to family conflict, in those with subthreshold depression at baseline, was confounded by marital status. Previous research has found marital status, specifically divorced/widowed/separated status, to be an independent risk factor for major depression. The high prevalence of major depression in widowed, divorced, or separated individuals has been well documented and results from an increase in marital disruption as a result of major depression and a higher risk of the disorder in those with this particular marital

status (Bulloch, Williams, Lavorato, & Patten, 2009). Other studies have observed a correlation between marital status and work to family conflict (Nomaguchi, 2012). Those who were married or in common-law relationships may experience more work to family conflict due to the added family responsibilities associated with having a spouse, partner, or child. Furthermore, those with marital strain may have added work to family conflict compared to those with more supportive relationships. On the other hand, having high work to family conflict may also affect marital status. When work interferes with family roles, such as the role of a spouse, this may lead to marital strain and the disruption of marital relationships.

In this study, the strength of the relationship between work to family conflict and transition to MDD in those with baseline subthreshold depression increased when the effects of marital status were controlled. By chance there could have been an uneven distribution of participants by marital status leading to the confounding effects seen. If perhaps there was a smaller proportion of participants who were widowed, divorced, or separated, in the high work to family conflict group who were also more likely to develop MDD, we would see an increase in the magnitude of effect when we control for the effects of marital status.

6.3 Bias due to missing data

Missing data are a common issue for many studies, especially longitudinal studies. The main contributor to missing data is non-response after a follow-up period, though responders may also have missing data if certain questions are not answered completely. When responders differ in terms of their exposure-outcome relationship to non-responders, selection bias may occur and result in a distortion of estimates.

The first occurrence of missing data that could potentially lead to selection bias would be due to the fact that the PHQ-9 and CIDI-Auto 2.1 sections of the baseline survey were completed at two separate times. As a result there were 4290 participants who had complete PHQ-9 data but a proportion of individuals who screened positive for the CIDI (n=657) did not respond when they were contacted at a later time for that portion of the baseline survey. These individuals were removed from the baseline sample as it is unknown whether they would have met criteria for MDD based on the CIDI. Since these participants screened positive for potential major depression, it is reasonable to expect that this particular group of participants would be more likely to experience depression or to develop depression in the future when compared to participants who did not screen positive. If it happened that these participants were also exposed to high stress according to any of the psychosocial workplace variables, our estimates of the risk of transition to depression may be an underestimate of the true population risk.

Concerning lost to follow-up over the study period, responders and non-responders were analyzed in terms of each of the conceptualizations of psychosocial workplace exposure at baseline and no differences in regards to any of these exposure variables were found. Responders and non-responders were also compared on baseline demographic, socioeconomic, and clinical characteristics. This was done for both no depression and subthreshold depression baseline groups for both 12-month and 24-month follow-up periods. Certain differences in baseline characteristics were observed between responders and non-responders.

For the no depression baseline group, those who responded and those who did not respond at the 1-year follow-up differed in regards to age, marital status, annual personal

income, and education. On average, non-responders were younger, had a higher proportion of single and never married participants, had a higher proportion of less than $30,000 and lower proportion of over $80,000 annual personal income, and had a higher proportion with less than high school education with a lower proportion of university graduates when compared to non-responders. Responders and non-responders at the 2-year follow-up for the no depression baseline group differed by age, in that non-responders were around 3 years younger. In the subthreshold depression group, the only differences were in marital status at the 2-year follow up with a lower proportion of married individuals in non-responders. Differences between responders and non-responders in terms of demographic characteristics would only result in bias if these variables were associated with both the exposure (psychosocial workplace variables) and the outcome (subthreshold depression or MDD).

In the no depression baseline group, none of the covariates found to have differences (age, marital status, annual personal income, and education) were related to the outcome of 1-year subthreshold depression. Similarly, age was not related to the outcome of 2-year subthreshold depression. In the subthreshold depression baseline group, marital status was not related to the 2-year outcome of MDD. Furthermore, none of these demographic characteristics were associated with any of the psychosocial workplace variables. Bias due to these differences is therefore unlikely. Still, original longitudinal weights accounting for differences (age, marital status, income, and the presence of mental disorders) between responders and non-responders were used in all analyses to help reduce any bias introduced by attrition.

6.4 Misclassification bias

The erroneous classification of a participant into a category other than that to which it should be assigned is known as misclassification bias (Porta, 2014). This can occur for both the exposure and the outcome. In this study, the main exposure would be the psychosocial workplace variables while the outcomes would be subthreshold or MDD. Furthermore, since we were interested in the exposure-outcome relationships in specific subsets of individuals, there was potential for misclassification when the participants were placed into their respective depressive status groups. Misclassification bias occurs in two forms, differential and non-differential. Differential misclassification occurs when the probability of misclassification based on the true value varies between groups of exposure or outcome (Porta, 2014). This results in either an under or over-estimation of the true association. On the other hand, non-differential misclassification occurs when the probability of misclassification is the same in all study groups by exposure or outcome (Porta, 2014). Non-differential misclassification bias tends to bias the estimate towards the null value.

6.4.1 Misclassification of subthreshold depression

The PHQ-9 was used to classify subthreshold depression using similar definitions to previous studies (Judd et al., 1994; Martin et al., 2006; Morgan et al., 2012a; Pietrzak et al., 2013). The formal definition of subthreshold depression has yet to be established and there are no measurement instruments that have been designed specifically for subthreshold depression. However, the original PHQ has been designed to detect subthreshold disorders in addition to threshold disorders, with a diagnosis of other depression given if two to four symptoms on the PHQ-9 have been present at least "most

of the days" for a period of two weeks, and at least one of those symptoms is depressed mood or anhedonia (Kroenke et al., 2001). It was found that the PHQ-9 was valid for measuring subthreshold levels of depression and was consistent with other measures of depression (Martin et al., 2006). Therefore in this study, misclassification of subthreshold depression would likely be due to the definition used as opposed to the measurement instrument.

The criteria for subthreshold depression classification may be less stringent than the one used in other studies (Judd et al., 1994; Pietrzak et al., 2013). The two main differences are the lack of the requirement for one of the core depressive symptoms, and the lack of requirement for social and functional impairment. Similar to this study, several other studies have looked at the presence of any of the depressive symptoms and have found significant associations with harmful dysfunction and a significant increase in relative and attributable risk of major depression (Judd et al., 1997; Horwath, Johnson, Klerman, & Weissman, 1992). Furthermore, non-dysphoric depression was also associated with significant functional impairment and may be as important as major depression in terms of functional disability and long term outcomes (Gallo, Rabins, Lyketsos, Tien, & Anthony, 1997). In regards to the impairment criterion, subsyndromal episodes that were not characterized by indicators of seriousness (distress, dysfunction, suicidal thoughts) were associated with an increased risk of recurrence of major depressive episode, though to a lesser extent than full episodes of MDE (Patten, Williams, Lavorato, Bulloch, & MacQueen, 2012).

Considering that there is no standard definition for subthreshold depression and many studies have used similar definitions, we would not expect a high proportion of

misclassification in terms of the goals of the current study. Since it seems unlikely that a misclassification of subthreshold depression is related to either psychosocial workplace variables or the development of MDD, the bias would be non-differential and bias the estimate towards the null. Thus estimates seen in this study may be an underestimation of the true association.

6.4.2 Misclassification of work stress

The JCQ, the ERI questionnaire, and the WFC questionnaire were used to measure the four psychosocial workplace variables. These instruments have been tested in a variety of settings and have been shown to be reliable and valid. Misclassification of the exposure would be unlikely due to the measurement instruments used. One potential cause for misclassification of the exposure may be recall or reporting bias. Since the questions referred to the past 12-months, participants may have had difficulties remembering those specific aspects of their workplace. Another issue with self-report is the tendency to under-report perceived negative responses. This may be especially true if the participants fear that their employers will find out about their responses. In the current study, participants were informed of the identity of the investigators, assured that their responses would be anonymous and confidential, and that any results presented would be aggregated. Thus the likelihood of under-reporting work stress is reduced. In the case that those with high work stress are incorrectly classified as having low work stress due to the previously mentioned factors, it should not depend on whether they develop subsequent depression. Again this would be non-differential misclassification and bias the observed estimates towards the null.

6.4.3 Misclassification of major depression

The CIDI-Auto 2.1 was used to determine MDD. The CIDI is a fully structured diagnostic interview designed for administration by trained lay interviewers. Having been replicated in many populations and epidemiological studies, it has shown good validity and reliability. There is still the possibility of potential misclassification due to the common stigmatization of mental health outcomes such as major depression and the self-report nature of the questionnaire. To help with this, the CIDI-Auto is designed in a way that asks a series of hierarchical questions to determine the presence of major depression based on the two core symptoms, in contrast to asking participants if they have major depression directly. Despite this, there may be participants who choose to respond in a way that indicates they do not have major depression when in fact they do. Individuals who are experiencing depression may also be more likely to perceive high work stress and vice versa. There would be incorrect classification of depressed participants who also experienced high work stress into the no depression category. This would be differential misclassification bias that would cause the two exposure groups to resemble each other, and would lead to an underestimation of the true association.

Given the possible bias mechanisms due to misclassification of subthreshold depression, work stress, and MDD, the overall result would be a bias of the estimate towards the null. Therefore, the estimates observed in the study would be underestimates of the true population associations.

6.5 Strengths and Limitations

One of the strengths of the study is the longitudinal study design. This allows the observation of the course of major depression and depressive sub-types over time, as well

as the identification of factors affecting the transition. Another strength is the selection of the sample from the general working population contributing to the generalizability of the findings. Most studies on workplace factors and health have focused on specific occupations or sectors, and therefore applicability to other occupations or sectors is limited. Finally, another strength is the four psychosocial workplace variables and the various stress conceptualizations used in the study. Since all conceptualizations of stress have been shown to have an association with major depression, this allows us to study the general concept of work related stress in a more detailed way.

As with any other study, there are some limitations that need to be addressed. The first limitation is the small sample size of our main population of interest, participants with subthreshold depression. Although the original sample was large, when it was restricted to subthreshold depression the sample size dropped considerably. This limited how strict we were with the definition of subthreshold depression and how the analyses were conducted. Those with lifetime depression were not excluded from the longitudinal sample since the proportion was fairly high. As a result, any cases of major depression that subsequently developed could not be differentiated as new or recurrent cases. Incident cases are needed to calculate risk based on the traditional epidemiological sense. However, as has been observed in this and many other studies, major depressive disorder is a recurring condition that fluctuates from periods of no symptoms, subthreshold symptoms, to threshold symptoms over time. Only looking at incident cases of depression may underestimate the total burden of disease. Instead of excluding those with lifetime depression, the presence of lifetime depression was examined as a covariate in all

analyses and did not play a modifying or confounding effect in any of the relationships observed.

As with most cohort studies, lost to follow-up is a potential problem. Analyses revealed that the responders and non-responders did not differ in regards to the psychosocial workplace exposures or depression outcomes. Furthermore, longitudinal weights developed in the original PLSW were used in all analyses. Although a priori hypotheses were made and significance tests were limited to the most important hypotheses, type I error is always a potential problem in studies with many analyses. As the number of tests increases, we may find significant associations as a result of chance. Interpretations based on 95% confidence intervals were used instead of significance tests whenever possible, and interpretation of results included informed judgments and previous literature instead of relying solely on p-values.

Though significant associations were observed in one of the four psychosocial variables, there is the potential for type II error for the other three variables. As mentioned previously the longitudinal sample for subthreshold depression was fairly small and follow-up occurrences of MDD were smaller than seen in previous studies. Since all four workplace variables have been shown to be associated with major depression, the lack of support from this study is likely due to inadequate power.

One final concern to mention would be that a reliable change index (RCI) on the PHQ-9 was not calculated (Jacobson, Roberts, Berns, & McGlinchey, 1999). Since the difference between a classification of subthreshold depression and no depression could be as small as one depressive symptom, a more conservative approach to take would be to distinguish this change from natural fluctuations of PHQ-9 scores over time. As has been

used with other assessment instruments, the RCI would provide a statistical method to determine if observed changes are greater than that due to chance, given the reliability of the instrument (Currie, Hodgins, & Casey, 2013).

6.6 Implications and Significance

The findings of this study will aid in increasing our understanding of subthreshold depression and the development of MDD in the general working population. Although there have been two previous studies that looked at risk factors in the transition from subthreshold depression to MDD, this is the first study to look at psychosocial workplace factors specifically. Given that the majority of adults spend a considerable time in the workplace these findings may help identify important targets for preventive interventions. Through its longitudinal nature, the study helps clarify the role of psychosocial workplace factors in the transitions to subthreshold depression and MDD. By breaking down the MDD transition to include the intermediate step of subthreshold depression, it reduces the potential that any "preclinical" depressive symptoms would affect the self-report of psychosocial workplace variables further establishing the temporal direction of the relationship.

Implications of this study are that subthreshold depression is prevalent in the working population and is often associated with impairments and negative outcomes in the workplace. Similar risk factors appear to exist for the transitions to subthreshold depression and MDD, although the strength of the factors may vary depending on the stage of the pathway. As was observed in a high proportion of individuals, subthreshold depression resolved spontaneously over time and did not develop into MDD. Certain risk factors may therefore predict whether an individual with subthreshold depression

develops MDD. Findings from this study are consistent with subthreshold depression lying on the major depression pathway, but also show that it exists as a separate state requiring attention and further study. The proportion of transition from no depression to subthreshold depression was much lower than the proportion of transition from subthreshold depression to MDD. Instead of pointing to treatment of individuals with subthreshold depression specifically, the evidence supports the importance of preventive interventions in helping to reduce the potential for major depression development.

Early intervention efforts aimed at preventing new cases of mental disorders in people who have not met criteria for the disorder has been a growing focus of attention all over the world (Cuijpers, Beekman, & Reynolds, III, 2012). Primary interventions directed at individuals with subthreshold depression may offer new possibilities for reducing the total disease burden of depressive disorders. In clinical practice, these findings may help identify which patients are at highest risk for depression and are most likely to benefit from preventive interventions. In the workplace these findings may help identify aspects of the workplace that may be improved to promote employee health and consequently employee productivity.

This study suggests potential psychosocial workplace targets for early interventions of major depression. While there was sufficient evidence to support work to family conflict as an important target for early intervention efforts, more evidence is needed to confirm whether the other psychosocial workplace factors (especially effort-reward imbalance) are important risk factors in the multi-step transition to major depression. Reducing work to family conflict may therefore help reduce the number of individuals who transition to major depression. One workplace initiative that has been

shown to reduce work to family conflict in white-collar organizations functions primarily by increasing employee's schedule control and helping them manage the work-family interface (Kelly, Moen, & Tranby, 2011). Another study has found that employer supported child-care was related to lower work-family conflict (Goff, Mount, & Jamison, 1990). While employers may help reduce work to family conflict by modifying the work environment, employees also play an important role in how they manage the work-family interface. Co-operation between both parties will be key in increasing work-family balance. While it is possible to reduce work to family conflict, the next step will be to examine whether a reduction in work to family conflict also results in a reduction of cases of major depression.

6.7 Future Research

Although this study provides important information on the relationship between psychosocial workplace factors and the transition to subthreshold and major depression, additional population based studies with larger sample sizes are needed to replicate the findings and further explain this complex association. While it was not possible in this study, future studies could analyze all four psychosocial factors simultaneously to compare the strength of each as well as any interacting effects. In addition psychosocial factors at each assessment should be analyzed to determine whether changes in work related stress affect the risk of future depression. This study examined a variety of related factors, however there may be other factors that could affect the observed associations including exact occupation, negative life events, a family history of depression, and whether depressive symptoms are being treated. Longitudinal studies are also needed to

examine the effects of subthreshold depression on workplace function in order to clarify the direction of the relationships seen.

Although the present study's focus was on the transition to more severe depressive states on the depression pathway, non-linear transitions between the various states also exist. As was seen from the findings of the study, participants did not always move in the order from no depression, to subthreshold depression, to major depression. Individuals moved in and out of each of these different sub-types and there exist other statistical methods to study these multi-directional transitions. Multinomial approaches with multi-state outcomes could take into account movement to more severe states, movement to less severe states, and no movement at all. These approaches may lead to a better understanding of the complex and dynamic nature of the course of major depression as well as identify any potential protective factors. In addition, as was suggested in previous studies to aid research and advancement in the body of knowledge on subthreshold depression, it is important to develop generally accepted criteria for its classification.

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APPENDIX A: DEMOGRAPHIC TABLES

Table 17 Baseline characteristics of the no depression group (n=2840)

Baseline Characteristics	**n**	**Weighted % (95% CI)**
Sex		
Male	1332	56.03 (54.13-57.91)
Female	1508	43.97 (42.09-45.87)
Age (weighted mean, 95%CI)	2840	44.87 (44.50-45.23)
Marital Status		
Married	2154	76.27 (74.58-77.88)
Single, Never Married	348	13.75 (12.42-15.20)
Widowed/Divorced/Separated	336	9.98 (8.95-11.12)
Personal Annual Income (CAD $)		
<$30,000	283	9.47 (8.42-10.65)
$30,000-$59,999	902	32.16 (30.34-34.03)
$60,000-$79,999	590	22.41 (20.78-24.13)
>$80,000	926	35.95 (34.05-37.90)
Education		
University	1048	37.39 (35.52-39.29)
High School graduate - College	1667	58.22 (56.29-60.12)
Less than high school	122	4.39 (3.66-5.27)
Supervisor Support		
High	2372	85.10 (83.69-86.41)
Low	448	14.90 (13.59-16.31)
Co-worker Support		
High	2317	82.10 (80.56-83.53)
Low	516	17.90 (16.47-19.44)
Weekly work hours (weighted mean, 95% CI)	2840	41.00 (40.56-41.45)
Lifetime Depression (CIDI)		
No	2404	85.86 (84.50-87.12)
Yes	436	14.14 (12.88-15.50)
Any other measured 12-month disorder (CIDI)		
No	2750	96.95 (96.23-97.55)
Yes	90	3.05 (2.45-3.77)
Job Strain Ratio		
≤1	2216	80.72 (79.15-82.20)
>1	565	19.28 (17.80-20.85)
Effort-Reward Imbalance Ratio		
≤1	2548	90.91 (89.75-91.95)
>1	272	9.09 (8.05-10.25)
Work to family conflict		

Low	2086	72.84 (71.05-74.56)
High	728	27.16 (25.44-28.95)
Family to work conflict		
Low	2153	75.79 (74.07-77.43)
High	668	24.21 (22.57-25.93)

Table 18 Baseline characteristics of the subthreshold depression group (n=305)

Baseline Characteristics	**n**	**Weighted % (95% CI)**
Sex		
Male	124	50.15 (44.22-56.08)
Female	181	49.85 (43.92-55.78)
Age (weighted mean, 95%CI)	305	44.10 (42.95-45.26)
Marital Status		
Married	208	68.71 (62.96-73.94)
Single, Never Married	43	15.45 (11.48-20.48)
Widowed/Divorced/Separated	54	15.84 (12.14-20.41)
Personal Annual Income (CAD $)		
<$30,000	37	11.10 (7.95-15.31)
$30,000-$59,999	119	41.84 (35.88-48.05)
$60,000-$79,999	53	19.19 (14.77-24.56)
>$80,000	73	27.86 (22.57-33.85)
Education		
University	86	29.75 (24.56-35.52)
High School graduate - College	192	61.17 (55.19-66.83)
Less than high school	27	9.08 (6.15-13.20)
Supervisor Support		
High	226	75.37 (69.92-80.10)
Low	78	24.63 (19.90-30.08)
Co-worker Support		
High	217	69.06 (63.18-74.38)
Low	87	30.94 (25.62-36.82)
Weekly work hours (weighted mean, 95% CI)	305	42.23 (40.76-43.70)
Lifetime Depression (CIDI)		
No	223	72.81 (67.18-77.80)
Yes	82	27.19 (22.20-32.82)
Any other measured 12-month disorder (CIDI)		
No	277	90.32 (85.95-93.43)
Yes	28	9.68 (6.57-14.05)
Job Strain Ratio		

≤1	190	67.66 (61.76-73.04)
>1	100	32.34 (26.96-38.24)
Effort-Reward Imbalance Ratio		
≤1	255	87.15 (82.89-90.47)
>1	45	12.85 (9.53-17.11)
Work to family conflict		
Low	173	55.26 (49.26-61.11)
High	132	44.74 (38.89-50.74)
Family to work conflict		
Low	177	56.64 (50.57-62.51)
High	123	43.36 (37.49-49.43)

Table 19 Baseline characteristics of the (CIDI) MDD group (n=252)

Baseline Characteristics	**n**	**Weighted % (95% CI)**
Sex		
Male	80	39.92 (33.54-46.65)
Female	172	60.08 (53.35-66.46)
Age (weighted mean, 95%CI)	252	45.18 (44.07-46.28)
Marital Status		
Married	142	58.36 (51.86-64.58)
Single, Never Married	43	18.74 (14.06-24.53)
Widowed/Divorced/Separated	67	22.90 (18.09-28.54)
Personal Annual Income (CAD $)		
<$30,000	41	17.06 (12.57-22.73)
$30,000-$59,999	97	39.48 (33.16-46.18)
$60,000-$79,999	45	19.87 (14.98-25.87)
>$80,000	54	23.59 (18.33-29.80)
Education		
University	73	29.45 (23.86-35.74)
High School graduate - College	163	64.08 (57.61-70.08)
Less than high school	16	6.46 (3.90-10.52)
Supervisor Support		
High	186	74.92 (68.81-80.17)
Low	63	25.08 (19.83-31.19)
Co-worker Support		
High	177	69.49 (63.12-75.20)
Low	74	30.51 (24.80-36.88)
Weekly work hours (weighted mean, 95% CI)	252	40.36 (38.68-42.04)
Lifetime Depression (CIDI)		
No	0	----
Yes	252	100

Any other measured 12-month disorder (CIDI)		
No	163	64.34 (57.88-70.32)
Yes	89	35.66 (29.68-42.12)
Job Strain Ratio		
≤1	153	63.31 (56.84-69.34)
>1	96	36.69 (30.66-43.16)
Effort-Reward Imbalance Ratio		
≤1	206	85.38 (80.26-89.36)
>1	40	14.62 (10.64-10.74)
Work to family conflict		
Low	140	55.89 (49.34-62.24)
High	111	44.11 (37.76-50.66)
Family to work conflict		
Low	155	60.99 (54.46-67.15)
High	96	39.01 (32.85-45.54)

APPENDIX B: LONGITUDINAL TRANSITION TABLES

Table 20 Depression status classification at 12-month follow-up, by baseline depression group

	12-Month Follow-up (n, un-weighted %)				
Baseline (n=3582)	*No depression (n=2387)*	*Subthreshold depression (n=198)*	*MDD CIDI (n=192)*	*Major depression PHQ-9 (n=131)*	*Lost to follow-up (n=674)*
No depression (n= 2840)	2123 (74.75)	111 (3.91)	84 (2.96)	41 (1.44)	481 (16.94)
Subthreshold depression (n= 305)	141 (46.23)	43 (14.10)	19 (6.23)	25 (8.20)	77 (25.25)
MDD (CIDI) (n= 252)	72 (28.57)	24 (9.52)	63 (25.00)	26 (10.32)	67 (26.59)
Major depression (PHQ-9) (n=185)	51 (27.57)	20 (10.81)	26 (14.05)	39 (21.08)	49 (26.49)

Table 21 Depression status classification at 24-month follow-up, by baseline depression group

	24-Month Follow-up (n, un-weighted %)				
Baseline (n=3582)	*No depression (n=2211)*	*Subthreshold depression (n=172)*	*MDD CIDI (n=173)*	*Major depression PHQ-9 (n=101)*	*Lost to follow-up (n=925)*
No depression (n= 2840)	1963 (69.12)	89 (3.13)	84 (2.96)	26 (0.92)	678 (23.87)
Subthreshold depression (n= 305)	121 (39.67)	43 (14.10)	24 (7.87)	20 (6.56)	97 (31.80)
MDD (CIDI) (n= 252)	74 (29.37)	21 (8.33)	47 (18.65)	24 (9.52)	86 (34.13)
Major depression (PHQ-9)	53 (28.65)	19 (10.27)	18 (9.73)	31 (16.76)	64 (34.59)

APPENDIX C: RESPONSE AND NON-RESPONSE TABLES

Table 22 Baseline characteristics of completers and non-completers at the 12-month follow-up, in the no depression baseline group (n=2840)

	Responders (n=2359)		Non-responders (n=481)	
Variable at Baseline	**n**	**Un-weighted (95% CI)**	**n**	**Un-weighted (95% CI)**
Age (mean, 95%CI)	2359	45.26 (44.86-45.66)	481	42.92 (42.00-43.85)
Marital Status				
Married	1845	78.28 (76.56-79.90)	309	64.24 (59.84-68.41)
Single, Never Married	248	10.52 (9.34-11.83)	100	20.79 (17.39-24.66)
Widowed/Divorced/ Separated	264	11.20 (9.98-12.54)	72	14.97 (12.04-18.45)
Personal Annual Income (CAD $)				
<$30,000	218	9.72 (8.56-11.03)	65	14.16 (11.25-17.67)
$30,000-$59,999	738	32.92 (31.00-34.90)	164	35.73 (31.46-40.23)
$60,000-$79,999	493	21.99 (20.32-23.76)	97	21.13 (17.63-25.12)
>$80,000	793	35.37 (33.42-37.38)	133	28.98 (25.00-33.31)
Education				
University	908	38.54 (36.59-40.53)	140	29.11 (25.21-33.34)
High School graduate - College	1360	57.72 (55.71-59.71)	307	63.83 (59.42-68.01)
Less than high school	88	3.74 (3.04-4.59)	34	7.07 (5.09-9.74)
Job Strain Ratio				
≤1	1856	80.21 (78.53-81.79)	360	77.09 (73.04-80.69)
>1	458	19.79 (18.21-21.47)	107	22.91 (19.31-26.96)
Effort-Reward Imbalance Ratio				
≤1	2108	90.05 (88.76-91.20)	440	91.86 (89.04-94.00)
>1	233	9.95 (8.80-11.24)	39	8.14 (6.00-10.96)
Work to family conflict				
Low	1720	73.47 (71.64-75.23)	366	77.38 (73.38-80.94)
High	621	26.53 (24.77-28.36)	107	22.62 (19.06-26.62)
Family to work conflict				
Low	1789	76.39 (74.62-78.07)	364	75.99 (71.95-79.62)
High	553	23.61 (21.93-25.38)	115	24.01 (20.38-28.05)

Table 23 Baseline characteristics of completers and non-completers at the 24-month follow-up, in the no depression baseline group (n=2359)

	Responders (n=2094)		Non-responders (n=195)	
Variable at Baseline	**n**	**Un-weighted (95% CI)**	**n**	**Un-weighted (95% CI)**
Age (mean, 95%CI)	2162	45.56 (45.14-45.97)	197	42.04 (40.62-43.46)
Job Strain Ratio				
≤1	1703	80.37 (78.62-82.01)	153	78.46 (72.11-83.69)
>1	416	19.63 (17.99-21.38)	42	21.54 (16.31-27.89)
Effort-Reward Imbalance Ratio				
≤1	1931	89.94 (88.59-91.15)	177	91.24 (86.33-94.50)
>1	216	10.06 (8.85-11.41)	17	8.76 (5.50-13.67)
Work to family conflict				
Low	1586	73.97 (72.07-75.79)	134	68.02 (61.16-74.18)
High	558	26.03 (24.21-27.93)	63	31.98 (25.82-38.84)
Family to work conflict				
Low	1651	76.97 (75.13-78.71)	138	70.05 (63.27-76.05)
High	494	23.03 (21.29-24.87)	59	29.95 (23.94-36.73)

Table 24 Baseline characteristics of completers and non-completers at the 12-month follow-up, in the subthreshold depression baseline group (n=305)

	Responders (n=228)		Non-responders (n=77)	
Variable at Baseline	**n**	**Un-weighted (95% CI)**	**n**	**Un-weighted (95% CI)**
Job Strain Ratio				
≤1	147	68.06 (61.50-73.97)	43	58.11 (46.51-68.88)
>1	69	31.94 (26.03-38.50)	31	41.89 (31.12-53.49)
Effort-Reward Imbalance Ratio				
≤1	193	86.55 (81.37-90.46)	62	80.52 (70.03-87.97)
>1	30	13.45 (9.54-18.63)	15	19.48 (12.03-29.97)
Work to family conflict				
Low	130	57.02 (50.46-63.33)	43	55.84 (44.52-66.59)
High	98	42.98 (36.67-49.54)	34	44.16 (33.41-55.48)
Family to work conflict				
Low	128	56.89 (50.29-63.25)	49	65.33 (53.81-75.30)
High	97	43.11 (36.75-49.71)	26	34.67 (24.70-46.19)

Table 25 Baseline characteristics of completers and non-completers at the 24-month follow-up, in the subthreshold depression baseline group (n=228)

	Responders (n=208)		Non-responders (n=20)	
Variable at Baseline	**n**	**Un-weighted (95% CI)**	**n**	**Un-weighted (95% CI)**
Marital Status				
Married	145	69.71 (63.07-75.62)	8	40.00 (20.94-62.66)
Single, Never Married	26	12.50 (8.62-17.78)	5	25.00 (10.50-48.64)
Widowed/Divorced/ Separated	37	17.79 (13.13-23.64)	7	35.00 (17.26-58.15)
Job Strain Ratio				
≤1	137	69.54 (62.70-75.62)	10	52.63 (30.46-73.81)
>1	60	30.46 (24.38-37.30)	9	47.37 (26.19-69.54)
Effort-Reward Imbalance Ratio				
≤1	178	87.25 (81.89-91.21)	15	78.95 (54.54-92.14)
>1	26	12.75 (8.79-18.11)	4	21.05 (7.86-45.46)
Work to family conflict				
Low	114	54.81 (47.94-61.50)	16	80.00 (56.36-92.53)
High	94	45.19 (38.50-52.06)	4	20.00 (7.47-43.64)
Family to work conflict				
Low	116	56.31 (49.40-62.98)	12	63.16 (39.55-81.79)
High	90	43.69 (37.02-50.60)	7	36.84 (18.21-60.45)

APPENDIX D: ADDITIONAL RESULTS FOR OBJECTIVE 3

Table 26 One and cumulative two-year proportion estimates of subthreshold depression in the no depression baseline group, by baseline psychosocial workplace variables

Baseline workplace Variables	**1 – year proportion estimates (n=2359)**		**2- year proportion estimates (n=2162)**	
	n with subthreshold depression	**Weighted proportion % (95% CI)**	**n with subthreshold depression**	**Weighted proportion % (95% CI)**
Job strain ratio ≤1	87	4.65 (3.74-5.77)	134	8.15 (6.85-9.68)
Job strain ratio >1	21	3.94 (2.53-6.09)	37	8.34 (5.96-11.53)
Effort-reward imbalance ratio ≤1	100	4.51 (3.68-5.52)	153	8.04 (6.82-9.45)
Effort-reward imbalance ratio >1	8	4.00 (1.96-7.99)	19	9.30 (5.82-14.52)
Low work to family conflict	71	4.03 (3.16-5.13)	111	7.25 (5.97-8.78)
High work to family conflict	35	5.20 (3.70-7.26)	58	10.13 (7.79-13.07)
Low family to work conflict	85	4.80 (3.85-5.96)	124	7.90 (6.59-9.45)
High family to work conflict	25	3.76 (2.50-5.60)	48	9.12 (6.80-12.12)

Table 27 One and cumulative two-year proportion of MDD in the subthreshold depression baseline group, overall and by baseline psychosocial workplace variables

	1 – year proportion estimates (n=228)		**2- year proportion estimates (n=208)**	
Baseline workplace variables	**n with MDD**	**Weighted proportion (95% CI)**	**n with MDD**	**Weighted proportion (95% CI)**
Overall	19	8.43 (5.26-13.23)	33	15.85 (11.15-22.03)
Job strain ratio ≤1	9	6.51 (3.32-12.37)	19	13.95 (8.77-21.46)
Job strain ratio >1	8	11.51 (5.39-22.87)	12	21.26 (11.81-35.26)
Effort-reward	13	6.99 (3.93-12.13)	25	14.44 (9.63-21.08)
Effort-reward imbalance	6	21.49 (9.64-41.24)	8	30.96 (15.53-52.25)
Low work to family	6	5.54 (2.35-12.51)	14	13.28 (7.71-21.92)

High work to family	13	12.18 (6.96-20.44)	19	18.92 (11.86-28.82)
Low family to work	9	7.48 (3.68-14.59)	18	15.74 (9.69-24.54)
High family to work	10	9.95 (5.27-17.99)	15	16.42 (9.76-26.30)

APPENDIX E: NON-SIGNIFICANT RESULTS FOR OBJECTIVE 4

Table 28 One and two-year crude RR estimate of subthreshold depression by binary job strain ratio in the no depression baseline group

Workplace variable	Subthreshold depression by PHQ-9			
	1-year (n=2314)			
Job strain ratio	Weighted Proportion	RR	95% CI	95% CI
≤ 1	4.65	0.85	0.51	1.39
>1	3.94			
	2-year (n=2119)			
Job strain ratio	Weighted Proportion	RR	95% CI	95% CI
≤ 1	8.15	1.02	0.70	1.49
>1	8.34			

Table 29 One and two-year adjusted RR estimates of subthreshold depression, by binary job strain ratio in the no depression baseline group

	Subthreshold depression by PHQ-9				
	1-year (n=2314)				
	RR	z	p	95% CI	95% CI
Job Strain Ratio	0.82*	0.21	0.43	0.50	1.34
	2-year (n=2119)				
Job Strain Ratio	0.99*	0.19	0.94	0.67	1.44

*Adjusted for gender and age

Table 30 One and two-year crude RR estimates of subthreshold depression, by binary effort-reward imbalance in the no depression baseline group

Variable	Subthreshold depression by PHQ-9			
	1-year (n=2341)			
Effort-Reward Imbalance Ratio	Weighted	RR	95% CI	95% CI
≤1	4.51	0.89	0.42	1.85
>1	4.00			
	2-year (n=2147)			
Effort-Reward Imbalance Ratio	Weighted	RR	95% CI	95% CI
≤ 1	8.04	1.16	0.71	1.88
>1	9.30			

Table 31 One and two-year adjusted RR estimates of subthreshold depression, by binary effort-reward imbalance in the no depression baseline group

	Subthreshold depression by PHQ-9				
	1-year (n=2341)				
	RR	**z**	**p**	**95% CI**	**95% CI**
Effort-Reward Imbalance	0.87*	0.33	0.72	0.41	1.83
	2-year (n=2147)				
Effort-Reward Imbalance	1.15*	0.29	0.59	0.70	1.87

*Adjusted for gender and age

Table 32 One and two-year crude RR estimates of subthreshold, by family to work conflict in the no depression baseline group

Variable	**Subthreshold depression by PHQ-9**			
	1-year (n=2342)			
Family to work conflict	**Weighted Proportion**	**RR**	**95% CI**	**95% CI**
Low	4.80	0.78	0.49	1.24
High	3.76			
	2-year (n=2145)			
Family to work conflict	**Weighted Proportion**	**RR**	**95% CI**	**95% CI**
Low	7.90	1.15	0.82	1.63
High	9.12			

Table 33 One and two-year adjusted RR estimates of subthreshold depression by family to work conflict in the no depression baseline group

	Subthreshold depression by PHQ-9				
	1-year (n=2342)				
	RR	**z**	**p**	**95% CI**	**95% CI**
Family to work conflict	0.78*	0.18	0.30	0.48	1.25
	2-year (n=2145)				
Family to work conflict	1.13*	0.20	0.48	0.80	1.61

APPENDIX F: NON-SIGNIFICANT RESULTS FOR OBJECTIVE 5

Table 34 One and two-year crude RR estimates of MDD, by binary job strain ratio in the subthreshold depression baseline group

Variable	**MDD by CIDI-Auto 2.1**			
	1-year (n=216)			
Job Strain Ratio	**Weighted Proportion (%)**	**RR**	**95% CI**	**95% CI UL**
≤ 1	6.51	1.77	0.66	4.74
>1	11.51			
	2-year (n=197)			
Job Strain Ratio	**Weighted Proportion (%)**	**RR**	**95% CI**	**95% CI UL**
≤1	13.95	1.52	0.74	3.11
>1	21.26			

Table 35 One and two-year adjusted RR estimates of MDD, by binary job strain ratio in the subthreshold depression baseline group

	MDD by CIDI-Auto 2.1				
	1-year (n=216)				
	RR	**z**	**p**	**95% CI LL**	**95% CI UL**
Job Strain Ratio	1.43*	0.73	0.49	0.52	3.93
	2-year (n=197)				
	RR	**z**	**p**	**95% CI LL**	**95% CI UL**
Job Strain Ratio	1.32	0.49	0.45	0.63	2.74

*Adjusted for gender and age

Table 36 One and two-year crude RR estimates of MDD, by binary family to work conflict in the subthreshold depression baseline group

Variable	**MDD by CIDI-Auto 2.1**			
	1-year (n=225)			
Family to work conflict	**Weighted Proportion (%)**	**RR**	**95% CI LL**	**95% CI UL**
Low	7.48	1.33	0.52	3.37
High	9.95			
	2-year (n=206)			
Family to work conflict	**Weighted Proportion (%)**	**RR**	**95% CI LL**	**95% CI UL**
Low	15.74	1.04	0.52	2.07
High	16.42			

Table 37 One and two-year adjusted RR estimates of MDD, by family to work conflict in the subthreshold depression baseline group

	MDD by CIDI-Auto 2.1				
	1-year (n=225)				
	RR	**z**	**p**	**95% CI**	**95% CI**
Family to work conflict	1.49*	0.67	0.38	0.61	3.60
	2-year (n=206)				
Family to work conflict	1.02	0.36	0.96	0.51	2.04

*Adjusted for gender & age