MAJOR DEPRESSION IN THE CANADIAN ARMED FORCES:
A STUDY OF INCIDENCE AND MENTAL HEALTH SERVICE USE

FRANÇOIS THÉRIAULT

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School of Epidemiology and Public Health
Faculty of Medicine
University of Ottawa

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ABSTRACT

Major depression is prevalent and impactful in military populations, and not all depressed military personnel access mental health services. However, the rate at which military personnel become depressed, and the likelihood that they will subsequently seek care, remains poorly understood. In this thesis, I present four distinct studies that have helped bridge existing knowledge gaps. First, I used data from a large population-based survey to measure the proportion of depressed Canadian Armed Forces (CAF) personnel who self-reported using mental health services in the past 12 months. Second, I conducted a systematic review to compare the major depression treatment gap uncovered in the first study to the treatment gaps reported in other military organizations. Third, I used data extracted from electronic medical records to measure the rate of new major depression diagnoses in CAF personnel. Results were highly consistent with the treatment gap estimates obtained from the first study, and this helped confirm the quality of the novel electronic medical record data. Fourth, I used data extracted from CAF electronic medical records to measure the temporal association between incident major depression and spinal pain. Because electronic medical records can only identify depression in care-seeking patients, I used quantitative bias analysis methods and the treatment gap estimates obtained from the first study to mitigate the risk of misclassification bias. The results of these four studies suggest that the major depression treatment gap is smaller in the Canadian military than it is elsewhere, but that it could be further reduced with additional mental health literacy interventions. They also suggest that certain subgroups of CAF personnel may benefit from enhanced prevention or screening efforts, including spinal pain patients and individuals newly posted to administrative cells for severely sick or injured personnel. Finally, these studies highlight the importance of using rigorous epidemiological methods in military major depression research.
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CHAPTER 1

Introduction

Major depression is a leading cause of worldwide morbidity [1, 2], and is particularly impactful in military organizations. Military personnel are more likely to experience major depressive episodes than their civilian counterparts [3–6]. During major depressive episodes, military personnel are at increased risk of suicidal behaviours [7], poor job performance and absenteeism [8], and early separation from the military [9]. Major depression is also a threat to operational readiness, preventing soldiers from deploying [10] and causing deployed soldiers to be repatriated [11]. But despite its high prevalence and deleterious consequences, much remains unknown about major depression in the military.

The major depression treatment gap in the military remains poorly understood. There are safe and effective treatment options for major depression – including a number of first-line psychotherapies and pharmacotherapies [12–14]– but a majority of depressed patients never receive the care they need [15]. In most Western countries, military personnel can access major depression treatment at no out-of-pocket cost, but with more stigma than in general adult populations [16]. The treatment barriers preventing depressed military personnel from accessing mental healthcare are therefore different than those driving the major depression treatment gap in civilians. A better understanding of the size and determinants of the major depression treatment gap in military personnel is needed to inform public health interventions aiming to maximize appropriate mental health service utilization in depressed soldiers.
Military personnel are screened for active major depressive episodes at recruitment, but the incidence of major depression in the military remains poorly understood. More specifically, the association of socio-demographic characteristics with major depression incidence in soldiers is unknown. The association between spinal pain and major depression incidence in military populations also remains poorly understood; and yet, spinal pain is the most commonly reported musculoskeletal disorder in military organizations [17] and is co-morbid with major depression in civilian populations [18]. While cross-sectional surveys have provided valuable information on the prevalence of major depression across different military organizations [3, 5, 19], a better understanding of the rate at which at-risk soldiers become depressed, and correlates thereof, is needed to better prepare for the future mental healthcare needs of military personnel. Unfortunately, a historical lack of longitudinal data has prevented most military organizations from measuring the incidence rates of psychiatric disorders.

The Canadian Armed Forces (CAF) recently implemented an electronic medical record system, and thus created a novel opportunity to study major depression incidence. Diagnostic codes extracted from electronic medical records can be used to assemble the longitudinal databases that have long been lacking. But electronic medical records only contain depression-related data for care-seeking patients. If depressed individuals never seek care, they can never be diagnosed, and electronic medical records can therefore not identify them as major depression cases. As a result, electronic medical record data will systematically underestimate the population-level prevalence and incidence of major depression, and the degree of underestimation is directly related to the major depression treatment gap. Fortunately, bias analysis methods [20] can help mitigate this inherent limitation of electronic medical record data, if reliable treatment gap estimates are available.
This doctoral thesis contains four distinct studies that have contributed to closing the knowledge gaps presented above. The rationale, methods, and results of these four studies are presented in Chapters 4, 5, 6, and 7, respectively. Together, they answer the research questions presented in Table 1-1.
### Table 1-1: Research questions corresponding to four distinct thesis studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Research Question</th>
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| 1 (Chapter 4) | • What proportion of CAF personnel who met diagnostic criteria for major depression in the past 12 months also used mental health services over the same time period?  
|             | • Among depressed CAF personnel who used mental health services in the past 12 months, what proportion were treated by a mental health specialist?  
|             | • What socio-demographic, medical, and behavioural factors are associated with mental health service use in CAF personnel who met diagnostic criteria for major depression in the past 12 months? |
| 2 (Chapter 5) | • How many studies have measured mental health service use in military personnel with past-year major depression in Australia, Canada, New Zealand, the United Kingdom, or the United States?  
|             | • What is the median period prevalence of mental health service use among depressed military personnel, across these studies? |
| 3 (Chapter 6) | • What proportion of CAF personnel have a past-year clinician diagnosis of major depression in their electronic medical records?  
|             | • Is the proportion of CAF personnel with past-year diagnosis of major depression consistent with the findings of Chapter 4?  
|             | • What is the incidence rate of new major depression diagnoses in CAF personnel?  
|             | • What socio-demographic and occupational factors are associated with the incidence rate of new major depression diagnoses in CAF personnel? |
| 4 (Chapter 7) | • Are incident diagnoses of spinal pain associated with the likelihood of incident diagnoses of major depression over a 20-month period?  
|             | • Is the observed association between incident diagnoses of spinal pain and incident diagnoses of major depression due to the inherent limitations of electronic medical record data?  
|             | • Is the risk of an incident diagnosis of major depression increased after an incident diagnosis of spinal pain?  
|             | • Is the risk of an incident diagnosis of spinal pain increased after an incident diagnosis of major depression? |
In the first study (Chapter 4), I used data from a large population-based survey to estimate the major depression treatment gap in the Canadian Armed Forces (CAF). In the second study (Chapter 5) I performed a systematic review and compared the CAF major depression treatment gap estimated in Chapter 4 to all major treatment gap estimates that were identified in a literature search for the military populations of Australia, Canada, New Zealand, the United Kingdom, and the United States. In the third study (Chapter 6), I used data extracted from CAF electronic medical records to identify diagnosed cases of major depression. I compared the estimated past-year prevalence of major depression obtained through electronic medical record data to that obtained in Chapter 4 through self-reported survey data. After using database agreement as a quality indicator to show that depression diagnoses in CAF electronic medical records are valid, I used this data source to provide the first estimates of incident major depression diagnosis rates in CAF personnel. Finally, in the fourth study (Chapter 7), I used data extracted from CAF electronic medical records to measure the temporal associations between incident major depression and spinal pain. Because electronic medical record data can only identify depression in care-seeking patients, I used quantitative bias analysis to correct Chapter 7 analyses for the misclassification of depression in individuals who do not use mental health services. The major depression treatment gap uncovered in Chapter 4 was used to inform the bias corrections in Chapter 7.

This doctoral thesis also contains expanded discussions to help interpret the findings of the four studies outlined above. Chapter 2 presents a brief review of the literature on major depression, and Chapter 3 provides a detailed description of the Canadian Armed Forces and their electronic medical record system. Together, Chapters 2 and 3 therefore provide the context needed to fully appreciate the research presented in Chapters 4 to 7. Finally, Chapter 8 provides a general
conclusion for the thesis by proposing directions for future policy and research, given the new evidence generated through Chapters 4 to 7.
References


CHAPTER 2

Major Depression – A Brief Review of the Literature

2.1 Classification

Pathologically low mood has been described as a medical disorder since classical antiquity [1, 2]. Hippocrates (460-377 BC) believed that prolonged episodes of distress were caused by disruptions in normal brain functions, a syndrome he described as “melancholia” [3]. He observed that melancholic patients tended to exhibit “aversion to food, despondency, sleeplessness, irritability, and restlessness” [1]. The Greek physician Aretaeus of Cappadocia (81-138 AD) later described melancholic patients as “dull or stern, dejected or unreasonably torpid, without any manifest cause. They complain of life and desire to die” [1]. These symptoms are reminiscent of current case definitions for major depression.

Explicit diagnostic criteria for major depression were only formulated in 1980, with the adoption of the Diagnostic and Statistical Manual of Mental Disorders, Third Edition (DSM-III) by the American Psychiatric Association [2]. The standardized case definition for major depression has undergone minor revisions since then. Today, the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) defines a major depressive episode as a period of at least two weeks during which at least 5 of the following 9 symptoms are experienced nearly every day [4]:

1. Depressed or irritable mood most of the day
2. Decreased interest or pleasure in daily activities, most of the day
3. Significant weight change, or change in appetite
4. Change in sleep (either insomnia or hypersomnia)

5. Change in activity level (either psychomotor agitation or retardation)

6. Fatigue or loss of energy

7. Feelings of worthlessness, or excessive or inappropriate guilt

8. Diminished ability to think or concentrate

9. Thoughts of death, or suicidal ideation

To receive a diagnosis of major depression, one of the first two symptoms (i.e., depressed mood or decreased interest) must be present. Furthermore, the symptoms must cause clinically significant distress or functional impairment, and cannot be better explained by the presence of general medical conditions, or by substance use [4]. It should be noted that these diagnostic criteria are consistent with those of the World Health Organization’s *International Classification of Disease, 10th Revision* (ICD-10) [5].

### 2.2 Etiology

Major depressive disorders are characterized by recurrent episodes of acute morbidity [6]. By definition, these episodes must last longer than two weeks [4], and often resolve within a few months [7, 8]. For example, the Netherlands Mental Health Survey and Incidence Study (NEMESIS) collected data on 250 Dutch adults with major depression, and found that 50% of major depressive episodes lasted less than three months [7]. Similarly, the National Comorbidity Survey Replication (NCS-R) collected data from a representative sample of 514 American adults with past-year major depressive episodes, and found that mean episode duration was 16 weeks [8].
According to the diathesis-stress model [9–12], the onset of major depressive episodes is triggered by stressors in individuals with a predisposing vulnerability (i.e., diathesis) to depression (Figure 2-1). Stressful life events are indeed a strong causal risk factor for the onset of major depressive episodes [13, 14], and the vast majority of depressed patients report experiencing at least one important stressor in the months preceding the onset of their most recent episode [15–17]. However, not all individuals exposed to a given stressful life event go on to develop a major depressive episode [13, 18]. In other words, stressful life events alone are not a sufficient cause for the onset of a major depressive episode. For this reason, the diathesis-stress model also states that proximal stressors must interact with pre-existing vulnerabilities [9–12] and only cause major depression in individuals who were already vulnerable to this psychopathology (Figure 2-1).

![Diathesis-stress model of major depression in adults](image)

**Figure 2-1**: Diathesis-stress model of major depression in adults

### 2.2.1 Genetic Factors

Twin studies offer compelling evidence that major depression vulnerability depends in part on genetic factors (Figure 2-1). In 2000, a meta-analysis of five studies comparing major depression concordance in pairs of monozygotic vs. dizygotic twins concluded that genetic factors account for 37% of major depression risk [19]. Similarly, in a later study, lifetime prevalence of major
depression was assessed in 11,402 dizygotic and 4,091 monozygotic twin pairs from the Swedish Twin Registry; results suggested that heritability of major depression was 38% [20]. However, most genome-wide association studies of major depression have so far failed to identify the genetic mechanisms underlying the heritability observed in twin studies [21, 22]. Emerging evidence over the past decade suggests that the 5-HTTLPR serotonin transporter gene may be associated with a higher risk of major depression onset following exposure to a stressful life event [23, 24]. In a seminal study of 1,037 individuals followed prospectively from age 3 to 26 years, stressful life events experienced between the ages of 21 to 26 years predicted major depression at age 26 years in homozygote and dizygotic carriers of the short 5-HTTLPR allele ($p \leq 0.001$), but not in homozygote carriers of the long 5-HTTPLR allele ($p = 0.24$) [23]. These findings have been replicated in subsequent studies of 5-HTTPLR gene polymorphism [24, 25], but not in others [26]. Negative findings at the molecular level are likely due to the polygenic nature of major depression; if many genetic loci each make a small contribution to major depression vulnerability, statistically significant associations between any single gene locus and major depression risk could be extremely hard to detect without prohibitively large samples [5]. The mechanism through which genetic factors increase the risk of major depression therefore remain poorly understood [27].

2.2.2 Environmental Factors

Vulnerability to major depression onset in adults also depends on cumulative exposure to various environmental factors across the life course (Figure 2-1), including during the perinatal period, early childhood, adolescence, and adulthood [13, 28].

In a recent meta-analysis of 14 eligible studies, low birth weight (i.e., birth weight $\leq 2.5$ kg, an indicator of exposure to stress in-utero [13, 29–31]) was associated with a 1.39-fold higher odds of major depression in adults [32]. According to the fetal programming hypothesis, stressors
experienced during the nine months of intrauterine life (e.g., poor maternal diet, maternal smoking, exposure to alcohol or other drugs, maternal stress, placental insufficiency, and intrauterine growth restriction [33]) can disrupt the development of the hypothalamic-pituitary-adrenal (HPA) axis, and thus impair one’s ability to adapt to stressful situations later in life [34–36]. The HPA axis is indeed a complex neuroendocrine system involved in stress response [37], and stressful life events experienced in adulthood are more likely to trigger the onset of a major depressive episode in individuals with a dysregulated HPA axis [27, 37, 38].

Exposure to adverse childhood events can also dysregulate the HPA axis [39], and further sensitize individuals to major depression onset in adulthood [38]. In adults with no lifetime history of major depression, childhood abuse is associated with hyperactivity of the HPA axis, as measured by increased cortisol secretion in response to stress [40, 41], suggesting that trauma experienced in childhood impairs one’s ability to adapt to stressful life events in adulthood, even in the absence of prevalent clinical psychopathology [38]. In epidemiological studies, adverse childhood events including sexual abuse, physical abuse, parental loss, and family separation are consistently identified among the strongest predictors of major depression onset in adulthood [13, 28, 41–44]. In an analysis of Australian Twin Registry data on 283 same-sex twin pairs with discordant self-reported histories of childhood sexual abuse (CSA), the odds of lifetime major depression were 56% higher in the twin with a past history of CSA [45]; these results confirmed that childhood environmental exposures influence major depression risk above and beyond the potential confounding effect of genetic factors.

Chronic environmental exposures other than childhood events are also strongly associated with vulnerability to major depression onset in adulthood. In epidemiological studies, marital status, educational achievement, and socioeconomic status are consistently associated with a higher risk
of major depression [13, 42, 46–48]. However, the causal mechanisms underlying these associations are contentious, because adverse socio-demographic exposures in adulthood can be conceptualized as both a predictor and a cause of depressed affect and maladaptive stress responses [5, 49–51].

Furthermore, there is evidence that gene-environment interactions modulate the risk of major depression onset, and the risk of major depression chronicity. In 2014, Brown et al found that the association between recent stressful life events and risk of major depression onset was stronger in carriers of the Met allele of the brain-derived neurotrophic factor (BDNF) gene than in homozygote carriers of the Val allele [52]. The same authors also found that homozygote carriers of the short 5-HTTPLR allele were at significantly higher risk of experiencing a major depressive episode lasting over 12 months, but only if they also reported a history of childhood maltreatment [53].

It must also be noted that stressful life events are associated with elevated risk of various physical disorders [54], many of which can in turn increase the risk of major depression. Most notably, stressful life events have been identified as an important risk factor for the onset of back pain. As will be discussed further in section 2.8, physical pain is highly prevalent in military populations, and is strongly associated with major depression.

2.2.3 Recurrence

Finally, past major depressive episodes can be conceptualized as additional environmental risk factors that further exacerbate vulnerability to future depressive episodes (Figure 2-1). After recovering from a major depressive episode, the risk of recurrence is very high. In fact, epidemiological studies consistently find that a past history of major depression is a strong predictor of future major depressive episodes [55]. In a clinical sample of 318 patients who were prospectively followed for 10 years after recovering from an index major depressive episode,
63.5% experienced at least one recurrent episode, and the risk of recurrence increased by 16% with each successive recurrence [56]. In a community-based study of 5,062 Canadian adults followed for 15 years, the risk of experiencing a new major depressive episode increased by 9% for every previous episode [57]. And in a sample of 7,925 Danish patients admitted to a hospital for major depression, the risk of re-admission for major depression in 10 years following discharge increased by 15% for each lifetime depressive episode [58]. According to widely cited estimates from the American Psychiatric Association, 60% of individuals who recover from their first lifetime major depressive episode will eventually experience a second episode, and 90% of individuals who recover from their third lifetime major depressive episode will eventually experience a fourth episode [4]. Furthermore, the association between stressful life events and major depression risk decreases with increasing number of past major depressive episodes [15, 18]. In other words, while relatively severe stressors may be required to trigger a first major depressive episode, increasingly minor events may suffice to trigger subsequent episodes, until the recurrence of major depressive episodes becomes independent of important stressors [59]. This phenomenon was first observed by Emil Kraeplin (1856-1926) who famously described a patient that first became depressed after the death of her husband, and who experienced subsequent depressive episodes after the death of her dog, and then of her dove [60, 61]. The “kindling” and “stress sensitization” hypotheses postulate that major depressive episodes produce lasting changes in the cognitive schema and brain structures of recovered patients, thus increasing their vulnerability to future episodes [60, 62]. For example, longitudinal data from the Virginia Twin Registry suggest that neuroticism levels are higher in females after recovering from a major depressive episode than before episode onset [63].
2.3 Prevalence

Through the World Mental Health (WMH) Survey Initiative, coordinated community surveys were carried out in 21 different countries using a standardized protocol and measurement tool, and results suggested that the 12-month prevalence of major depressive episodes was 5.2% in high-income countries, 4.7% in middle-income countries, and 3.2% in low-income countries [64]. Similarly, a 2013 systematic review and meta-analysis of 116 population-based surveys from across the world reported a 4.7% global point prevalence of major depression [65]. In 2012, the Canadian Community Health Survey – Mental Health (CCHS-MH) collected data from a representative sample of 25,113 adults and found that the past-year prevalence of major depressive episodes was 4.7% across the country [66]; the national past-year prevalence decreased to 3.9% when subjects with bipolar disorder were excluded from analysis [66]. In 2017, major depression was ranked as the 35th most common disorder in the world [67]. Furthermore, population-based surveys consistently find that the lifetime prevalence of major depression is approximately 3 times higher than the 12-month prevalence [22], suggesting that roughly 33% of patients with a lifetime history of major depression experience a first or recurrent major depressive episode in any given year [68].

2.4 Burden

Major depression negatively impacts all aspects of health-related quality of life [69], and is among the most disabling disorders known to humans [70]. In its attempt to compare the morbidity burden associated with different health conditions, the Global Burden of Disease (GBD) study pioneered the concept of “disability weights”. Disability weights were created for each of 220 distinct health states, with input from 30,230 household and web-based survey participants from across the world
The weights represent the degree of health loss associated with various disease experiences. Disability weights can range from 0 to 1, with 0 representing the lived experience of full health, and 1 representing a health state equivalent to death [70]. Based on GBD disability weights, health-related quality of life is more negatively impacted by severe major depression than by severe Parkinson disease, terminal cancer, or severe idiopathic epilepsy [72] (Table 2-1).

Because of its high prevalence and large impact on health-related quality of life, major depression is a leading cause of worldwide morbidity [73]. The GBD 2010 study estimated that major depression accounted for 8.2% of all years lived with disability across the globe, and 2.5% of worldwide disability-adjusted life years (DALY, an aggregate measure of years lived with disability and life years lost to premature mortality) [74]. And yet, DALY calculations only attribute early mortality to proximal causes of death (e.g., suicide), even if major depression was an important contributing factor; some authors have therefore argued that the GBD studies systematically underestimated the true global burden of major depression [73].

Moreover, the burden of major depression extends beyond early mortality and years lived with disability. For instance, depression accounts for roughly 5% of all lost workdays across the world [75]. Workdays lost to major depression cost the USA economy $30 to $50 billion annually [76] (the total economic burden of major depression in the USA, including direct and indirect costs, is currently estimated at $210 billion per year [77]). Furthermore, major depression is co-morbid with a number of physical disorders [78], and is associated with poorer outcomes in patients suffering from coronary artery disease [79], chronic pain [80], type II diabetes [81], heart failure [82], pneumonia [83], acute kidney injury [84], asthma [85], and various types of cancer [86].
2.5 Access to Treatment

There are numerous safe and effective treatment options for major depression. The Canadian Network for Mood and Anxiety Treatments (CANMAT) currently recommends treating depressed patients with any combination of first-line psychotherapies (i.e., cognitive behavioural therapy or inter-personal therapy) and/or first-line anti-depressants (i.e., selective serotonin reuptake inhibitors, serotonin and noradrenaline reuptake inhibitors, or mirtazapine) [87, 88]. Other recent international clinical guidelines have made similar treatment recommendations [89, 90]. There is strong scientific evidence suggesting that these treatment options help depressed patients achieve remission more quickly than they would have on their own [91]. First-line psychotherapies can also be effectively delivered in various formats, to accommodate patient preferences [92].
Table 2-1: Disability weights associated with the lived experiences of select disorders, as calculated for the Global Burden of Disease (GBD) study [72].

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Lived experience</th>
<th>Disability Weight</th>
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<tbody>
<tr>
<td>Major depression, severe</td>
<td>• Overwhelming and constant sadness. • Cannot function in daily life.</td>
<td>0.658</td>
</tr>
<tr>
<td>Ischemic stroke, severe</td>
<td>• Confined to bed or wheelchair. • Depends on others for feeding, toileting, and dressing. • Difficulty speaking, thinking clearly, and remembering things.</td>
<td>0.588</td>
</tr>
<tr>
<td>Parkinson disease, severe</td>
<td>• Severe tremors and moves very slowly • Difficulty walking, talking, swallowing, sleeping, and remembering things</td>
<td>0.575</td>
</tr>
<tr>
<td>Idiopathic epilepsy, severe</td>
<td>• Sudden seizures ≥ once each month, with violent muscle contraction and loss of bowel control • Between seizures, memory loss and difficulty concentrating</td>
<td>0.552</td>
</tr>
<tr>
<td>Cancer, terminal phase</td>
<td>• Confined to bed with nausea and no appetite • Regular use of strong medications to avoid constant pain</td>
<td>0.540</td>
</tr>
<tr>
<td>Major depression, moderate</td>
<td>• Constant sadness and loss of interest • Difficulty sleeping and concentrating</td>
<td>0.396</td>
</tr>
<tr>
<td>Alzheimer disease, moderate</td>
<td>• Memory problems and confusion • Feels disoriented, and sometimes hear voices • Needs help with some daily activities</td>
<td>0.377</td>
</tr>
<tr>
<td>Low back pain, severe</td>
<td>• Constant back pain • Difficulty dressing, sitting, standing, walking, lifting things, and sleeping</td>
<td>0.372</td>
</tr>
<tr>
<td>Major depression, mild</td>
<td>• Persistent sadness and loss of interest • Sometimes sleeps badly, feels tired, or has trouble concentrating</td>
<td>0.145</td>
</tr>
<tr>
<td>Ebola</td>
<td>• High fever and pain • Feels very weak, which causes great difficulty with daily activities</td>
<td>0.133</td>
</tr>
</tbody>
</table>
Unfortunately, less than half the adults suffering from mental disorders ever access mental healthcare services [93]. The World Mental Health (WMH) Survey collected data from 51,547 respondents in 21 different countries, and found that only 56.7% of individuals with past-year major depression had perceived the need for mental healthcare [64]. Of those recognizing the need for care, 71.1% had actually accessed services. In other words, only 40.3% of all WMH respondents with past-year major depression had accessed mental healthcare services over the same time period [64]. A 2004 systematic review of 37 population-based surveys from around the world found large variations in reported depression treatment gaps; on average, 54% of individuals with major depression remain untreated, but this estimated gap ranged from 16% in some reviewed surveys to 84% in others [94]. In Canada, it is estimated that only 56% of adults suffering from major depression seek professional mental healthcare over a 12-month period [95].

Among depressed individuals who recognize the need for professional help, reasons for not accessing mental health services include availability barriers (e.g., treatment is not available locally or during convenient hours), accessibility barriers (e.g., services are too expensive), and acceptability barriers (e.g., fear of professional repercussions and stigmatizing beliefs) [96–98]. The resulting treatment gap is an important public health issue. In Australia, treatments offered to care-seeking patients are estimated to avert 22% of the national major depression burden; however, simulation studies suggest that up to 45% of the national major depression burden could be averted if all depressed Australians accessed mental health services [99].

It must be noted that not all depressed patients require intensive treatment, and that closing the treatment gap would not necessarily pose a prohibitively large burden on current mental healthcare systems. Indeed, watchful waiting can be an appropriate clinical course of action for uncomplicated cases of major depression when symptoms are only causing mild functional
impairment [100, 101]. Among depressed patients who are currently not accessing any form of care, some may simply need periodic check-ins with a primary care clinician to monitor symptom progression.

In most Western nations, military personnel face unique barriers to mental health services. Accessibility barriers are typically absent, because military organizations facilitate access to mental health services for their depressed personnel. However, in military healthcare systems, medical officers are both care providers and company physicians, and fear of negative career repercussions is often cited as an acceptability barrier to mental healthcare among depressed soldiers [102]. Stigma is another important acceptability barrier in military populations [103]; after adjusting for sociodemographic characteristics and need for mental healthcare, Canadian military personnel are 70% more likely to perceive mental health stigma (e.g., feeling that someone held negative opinions about them because of current or past mental health issues) than civilians [104].

It should also be noted that depressed patients do not always receive guideline-concordant care for major depression when they access mental health services. For example, a systematic review of 41 studies suggested that general practitioners fail to recognize major depression in 52.7% of their depressed patients in primary care settings [105]. Furthermore, primary care physicians often lack the time and resources required to provide guideline-concordant treatments to depressed patients who are correctly diagnosed [106]. High-quality measurement-based care for major depression can be provided in primary care settings [107], but depressed patients are 4.7 times more likely to receive appropriate treatment if they are seen by a mental health specialist [108].
2.6 Routinely Collected Data

When depressed patients access mental healthcare services, data are often generated in various clinical and administrative databases. Electronic medical records, hospital discharge databases, patient appointment lists, physician claims, and disease registries are all examples of data that are routinely-collected for purposes other than scientific research [109], in volumes exceeding the capacities of common software tools [110], but that are increasingly used to study major depression [111].

Routinely collected data offer numerous advantages to researchers. Most notably, they allow researchers to access longitudinal data on very large populations, at a fraction of the costs associated with more traditional data collection methods [112].

However, routinely collected data also have serious limitations. First, they can only be used to identify care-seeking patients; depressed individuals who never access mental health services cannot be identified through clinical and health administrative databases, and this can lead to misclassification and selection bias. Second, clinical and health administrative databases tend to contain a disproportionately large volume of information on the sickest patients (i.e., patients suffering from severe major depression, and/or serious co-morbid conditions), because these individuals have more frequent clinical encounters [113]. On the other hand, patients diagnosed with milder cases of major depression may only require sporadic clinical encounters to manage their condition, and may therefore only generate sparse data signals in clinical and health administrative databases [113]. Third, routinely collected data are sometimes inaccurate. For example, diagnostic codes are sometimes recorded in error [114]; in Ontario, 13% of patients with a diagnostic code for diabetes in their primary care records are not actually diabetic [115]. In a systematic review of 39 validation studies, Davis et al [116] reported a median positive predictive
value (PPV) of only 76% for mental health diagnoses in health administrative databases; in other words, 24% of psychiatric cases identified using health administrative data were, in fact, false positives [116]. These results highlight the limitations of using health administrative databases for research, but do not necessarily imply an alarmingly high rate of clinical misdiagnoses at the point of care. Misleading codes can be generated even when physicians correctly diagnose their patients and provide them with guideline-concordant care (e.g., a billing code generated for a psychiatric assessment that ruled out major depression, or an inaccurate diagnostic code generated because a coder misinterpreted physician documentation) [109, 117, 118]. Fourth, depressed patients may generate no depression-related information in routinely collected databases, even if they seek care. Indeed, primary care physicians often fail to identify major depression in their depressed patients and only record diagnostic codes for physical disorders when their depressed patients have co-morbid physical and psychiatric conditions [105]. Other health professionals providing care to depressed patients, such as social workers and mental health nurses, may not have the professional authority to record diagnostic codes in the electronic files of depressed patients under their care. According to a recent systematic review, diagnostic codes extracted from routinely collected data can only identify 28-35% of major depression cases in clinical (i.e., care-seeking) populations [119]. In another systematic review of 11 clinical studies, most methods used for identifying depression with administrative data failed to correctly classify over 50% of real major depression cases [120]. For the reasons outlined above, researchers are now strongly encouraged to validate any case definition derived from routinely collected data against a robust reference standard before using it for scientific research [109, 115]. In fact, reporting guidelines adopted in 2015 (i.e., the REporting of studies Conducted using Observational Routinely-collected health Data statement, or RECORD) explicitly states that all observational studies conducted using routinely collected
health data should describe “any validation studies of the codes or algorithms used to select the population” [121].

2.7 Major Depression in the Military

Major depression is at least twice as prevalent in military personnel compared to civilians, and this finding has been independently replicated in Australia, Canada, the United Kingdom, and the United States [122–125]. In 2010, the Australian Defence Force (ADF) surveyed a representative sample of 24,481 of its members, and compared their findings to data from the Australian Bureau of Statistics’ 2007 National Survey of Mental Health and Wellbeing; the 12-month prevalence of major depressive episodes was 6.4% in ADF personnel, compared to 3.1% in employed civilians of serving age [122]. In 2013, Statistics Canada collected cross-sectional data from representative samples of 6,696 Canadian Armed Forces (CAF) personnel and 25,113 members of the general Canadian population; the 12-month prevalence of major depression was 8.0% in CAF personnel compared to 3.5% in civilians matched on age, sex, marital status, race, education, personal income, province of residence, and adverse childhood experiences [123]. In 2015, British researchers compared data that had recently been collected from 14,090 military males between the ages of 18 to 44 years, to data that had recently been collected from 15,623 employed British civilian males in the same age group; after adjusting for social class, education, and marital status, the odds of screening positive for depression or anxiety were over two times higher in the military population [124]. And in a 2012 meta-analysis, Gadermann et al [125] pooled data from 26 eligible studies of US military personnel, and estimated that past-month prevalence of major depression was 12.0% among currently deployed, 13.1% among previously deployed, and 5.7% among never deployed. The authors then obtained data from 9,282 civilians participants in the National
Comorbidity Survey – Replication (NCS-R), and re-weighted the survey responses of participants meeting criteria for military service to match the distribution of socio-demographic characteristics in military personnel included in their meta-analysis; only 1.3% of comparable US civilians met criteria for past-month major depression [125].

Reasons for the excess burden observed in military personnel remain unclear. To date, research on military-specific exposures potentially associated with major depression has focused almost exclusively on overseas deployments. In a landmark 2004 study, Hoge et al [126] administered the Patient Health Questionnaire depression screening tool to 2,530 U.S. Army soldiers one week before a combat deployment to Iraq, and to 3,671 U.S. Army soldiers and U.S. Marines from three brigades returning from a combat deployment to Iraq or Afghanistan. The point-prevalence of major depression was slightly lower in the brigade that had not yet deployed (5.3%) than in the three brigades that had already deployed (6.9%, 7.9%, and 7.1%), and differences remained statistically significant at the 95% confidence level after adjusting for age, rank, educational level, marital status, and ethnic group differences [126]. Results of this study therefore suggested that deploying in support of a combat mission had a moderate impact on major depression risk. However, the study failed to distinguish between soldiers that were exposed to important stressors such as traumatic combat experiences during their deployment, and those that were not. As argued by Vanderploeg et al, military populations consist of multiple cohorts, each with a unique mental health risk profile [127]. For example, the lived experience of a war-zone deployment is likely very different for cooks who mostly remain inside operating bases, compared to combat specialists who routinely operate in more hazardous environments. In 2010, Wells et al analyzed data from 40,219 U.S. military personnel who had participated in two consecutive waves of the Millennium Cohort Study, and who were free of depression at baseline. Three years later, the prevalence of
depression was 5.7% in men who had deployed with combat exposure since baseline, 2.3% in men who had deployed without combat exposure since baseline, and 3.9% in men who had never deployed [128]. Similarly, the prevalence of depression was 15.7% in women who had deployed with combat exposure, 5.1% in women who had deployed without combat exposure, and 7.7% in women who had never deployed [128]. And in 2012, Shen et al linked operational and health administrative data on 678,382 U.S. Armed Forces personnel; they reported that the odds of a clinical diagnosis of major depression between 2001 and 2006 was 3.52-fold higher in personnel who had deployed to Iraq or Afghanistan over the same period compared to personnel who had not deployed, after adjusting for military occupation (i.e., combat specialist vs support roles) and other demographic characteristics [129].

Exposure to traumatic combat experiences undoubtedly increases the risk of major depression, even in highly-trained military personnel [130]. But war-zone deployments only account for a small proportion of the major depression burden observed in military populations [131], and most soldiers who attempt suicide have never deployed [132]. Even among military personnel who have never deployed, the prevalence of major depression remains substantially higher than in civilians matched on socio-demographic characteristics [125]. Unfortunately, this increased risk remains unexplained, partly because of a dearth of evidence on potential risk factors for major depression in military populations other than war-zone deployments.

The exclusive focus on deployment-related exposures – and the lack of research on other exposures potentially associated with major depression in military personnel – is somewhat of a historical artefact. Military psychology is a field of research that first emerged in the United States in the late 19th and early 20th centuries [133], when the U.S. military consisted of a very small standing force that was augmented through the mass mobilization and conscription of citizen-soldiers to
meet the operational demands of specific campaigns [134]. In wartime, the vast majority of soldiers were citizens who had been recruited or conscripted for a specific deployment, and who returned to their civilian lives as soon as their combat tours were over. Military service was therefore entirely defined by deployment, and any difference in psychiatric risk profile observed between military personnel and matched civilians had to be explained by deployment-related exposures. But the advent of the All-Volunteer Force era across Western nations caused a fundamental demographic shift. Today, the U.S. military consists of a large standing force, with highly-trained personnel ready to deploy at a moment’s notice [134]. The same can be said of the Canadian Armed Forces, where military careers can no longer be defined exclusively by deployments. In fact, long military careers can be spent training in-garrison, living in remote areas, conducting field exercises, and participating in domestic operations without ever deploying to a war-torn region. In 2014, 32.5% of Canadian military personnel reported having never deployed overseas [135]. Arguably, research agendas in the field of military psychology have not yet fully adapted to this new reality.

There must exist hitherto unrecognized occupational factors that put military personnel at elevated risk of major depression. For example, soldiers may already be more vulnerable to major depression when they join the military (i.e., more diathesis; see Figure 2-1). In fact, most U.S. Army soldiers currently struggling with suicidal ideation had their first lifetime suicidal thoughts before enlisting [136]. Adverse childhood experiences – a significant risk factor for onset of adult psychiatric disorders [137] – are more often reported by individuals who volunteer for military service than in members of the general population [138, 139]. But even after adjusting for adverse childhood experiences, military personnel remain at increased risk of major depression compared to civilians [123].
Occupational factors other than deployments could also contribute to the risk of major depression in military personnel. For example, military personnel experience frequent relocations [140], and are forced to move cities more frequently than members of the general population [141]. Military personnel also often experience temporary separations from their family because of deployments, field exercises, or isolated postings [140]. On average, CAF personnel spend approximately 25% of the year away from home, and the most important contributors to time spent away from home are courses and military exercises [135]. Furthermore, relocation and separation occur in the context of a rigorous hierarchical organization; military personnel are legally bound to complete their periods of obligation, and they must subordinate themselves to the needs and demands of their chain of command. Finally, over a quarter of U.S. Armed Forces personnel report significant work stress [103]. The association between the occupational factors outlined above and the risk of major depression in military personnel has never been investigated. Unfortunately, a dearth of longitudinal research has limited our current understanding of risk factors for the onset of mental health disorders in military populations [142]. Identifying such risk factors is needed to better inform prevention strategies and screening programs.

2.8 Physical Pain and Major Depression

Spinal pain is an understudied risk factor for major depression in military populations. Because of the physically demanding nature of military employment, musculoskeletal pain originating from the spine is very common in military personnel. From 2010 to 2014, nearly 700,000 U.S. Armed Forces members sought clinical care for low back pain, making this condition the leading cause of outpatient encounters in the U.S. military [143]. In 2013, two independent cross-sectional surveys
found that between 16-23% of CAF personnel were suffering from activity-limiting back pain at the time of survey completion [135, 144].

In 1982, depressed mood was identified as the most common psychological characteristic of low back pain patients [145]. More recent evidence has confirmed the strong association between spinal pain and major depression. In primary care settings, over 75% of depressed patients complain of painful physical symptoms, including neck and back pain [146]. In 2001, a population-based survey estimated that the past-year prevalence of major depression was approximately 5% in Canadian adults who did not experience back pain in the previous 12 months, compared to approximately 20% and 25% in adults who suffered from moderate and severe pain, respectively [147]. And after adjusting for demographic factors, back pain was the strongest predictor of past-year major depression in the Canadian civilian population [147]. In the Canadian military, 34% of service members who self-reported back problems in a cross-sectional survey also met the diagnostic criteria for past-year major depression [144].

Moreover, recent evidence suggests that first-line treatment options for major depression are effective for treating spinal pain. In 2015, a double-blind randomized controlled trial was conducted with 342 chronic low back pain patients in Washington State [148]. An eight-week course of either cognitive behavioural therapy or mindfulness-based stress reduction therapy was associated with significant reductions in pain symptoms compared to usual care, and the effects persisted for at least one year [148]. A recent meta-analysis of 17 randomized controlled trials also concluded that cognitive behavioural therapy is associated with moderate improvements of pain levels among chronic spinal pain patients [149].

Numerous mechanisms have been proposed to explain the strong association between spinal pain and major depression. There is evidence of a neurobiological association: the nociceptive pathways
that modulate the sensation of pain and the emotional suffering of major depression involve many of the same brain regions and neurotransmitters, including serotonin, norepinephrine, and 5HT1 receptors [150]. As such, the neurobiological changes caused by major depression could increase vulnerability for the onset of chronic pain symptoms, and vice-versa [146, 150]. Some authors have even suggested a potential genetic association, observing that chronic pain patients with no lifetime history of major depression have more depressed first-degree relatives than other members of the general population [146]. But negative findings from twin studies have cast doubt on the proposed genetic association, suggesting instead that unmeasured shared environmental factors may have explained the observed association between chronic pain and depression in past family studies [151, 152].

Finally, some authors have proposed psychosocial mechanisms to explain the strong association between spinal pain and major depression [146, 150]. Activity-limiting pain can reduce social and professional functioning, and the resulting isolation and role loss can represent a stressful life event triggering a major depressive episode [150]. In a cross-sectional study of 307 former professional soccer players, high athletic identity, injury as a cause of retirement, and high pain levels were all strongly and independently associated with depression risk [153]. In another cross-sectional study of 630 U.S. veterans with chronic pain, pain-related functional impairment was a stronger predictor of suicidal ideation than pain intensity [154].

Unfortunately, longitudinal data are lacking to investigate the temporal association between major depression and spinal pain in serving military personnel. A better understanding of this association could help inform screening programs and multidisciplinary clinical management strategies for spinal pain and major depression – two of the most important public health issues in modern military organizations.
References

   https://doi.org/10.1016/j.mppsy.2008.10.019

2. Gruenberg AM, Goldstein RD, Pincus HA Classification of Depression: Research and  
   GmbH, Weinheim, Germany, pp 1–12

   https://doi.org/10.1192/bjp.80.328.1

   Disorders. American Psychiatric Association

5. Kopala-Sibley DC, Klein DN (2017) Depressive Disorders: Presentation, Classification,  
   Developmental Trajectories, and Course. In: Cohen NL (ed) Public Health Perspectives on  
   Depressive Disorders. Johns Hopkins University Press, p 442

   psychological interventions in preventing recurrence of depressive disorder: Meta-analysis  
   https://doi.org/10.1016/j.jad.2014.12.016

   general population: results from The Netherlands Mental Health Survey and Incidence  
   Study (NEMESIS). Br J Psychiatry 181:208–13


    perspective: Evaluations of the models of Beck and of Abramson, Seligman, and  


https://doi.org/10.1016/j.cpr.2007.04.007


59. Post RM (2016) Epigenetic basis of sensitization to stress, affective episodes, and


Nicholls SG, Langan SM, Benchimol EI (2017) Routinely collected data: the importance


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Chapter 2: Literature Review


Chapter 3: Research Setting

3.1 Canadian Armed Forces

The Canadian Armed Forces (CAF) are Canada’s unified military organization, and consist of sea, air, and land elements. CAF personnel are posted to military bases across Canada, from which they are deployed to support domestic and international operations. There are currently 71,500 authorized positions within the CAF Regular Force, and an additional 30,000 authorized positions within the CAF Primary Reserve Force [1]. Regular Force personnel are full-time service members. Reservists receive the same military training as their Regular Force counterparts, but are primarily employed on a part-time basis and can be called up to help sustain CAF operations, as needed.

Unlike most Canadians, CAF personnel are excluded from the universal single-payer health insurance systems administered by Canada’s 13 provincial and territorial governments. Instead, the Canada Health Act designates the Canadian Armed Forces as the country’s 14th health jurisdiction. The Canadian Forces Health Services therefore provide complete medical coverage to all Regular Force personnel. They also provide medical coverage to Reservists for all health concerns that are directly related to their military employment. However, Reservists largely receive primary and specialty mental healthcare from the civilian health insurance system in their province or territory of residence.

3.2 CAF Mental Healthcare System

The Canadian Forces Health Services operate a comprehensive system of outpatient mental healthcare. At the heart of this system are CAF Medical Clinics, located on military bases across
Canada and abroad, and staffed by a multidisciplinary team of salaried civilian and military healthcare providers. Every CAF Medical Clinic includes a primary care clinic, which can be accessed through either booked appointments or walk-in visits. Personnel must also report to their local primary care clinic for mandatory health assessments at least once every five years, but sometimes much more frequently, depending on their age and military occupation (for example, personnel over the age of 40 years must undergo health assessments every two years, and Royal Canadian Air Force pilots must complete medical exams annually). Patients diagnosed with major depression during these clinical encounters may be treated within the primary care clinic, or be referred to mental health specialists (Figure 3-1).

Most CAF Medical Clinics also include a specialty mental health clinic. These clinics are usually accessed by referral from a primary care clinician, but self-referring patients are always assessed. Whenever possible, patients needing specialized mental healthcare are treated in-house by a CAF mental health clinician. However, patients are referred to a civilian mental health specialist in the surrounding community if: (a) care is not available within the local CAF Medical Clinic, (b) care cannot be provided within the CAF Medical Clinic in timely fashion, or (c) the patient has valid reasons to request external treatment. For example, CAF healthcare professionals may be reluctant to receive specialty mental healthcare from their colleagues, and CAF personnel on the verge of retirement may prefer initiating treatment with a civilian specialist with whom treatment can continue post-release. The CAF reimburses civilian mental health specialists for services provided to externally referred patients, but payments can only be pre-approved for a maximum of ten sessions at a time. Case files of externally referred patients must be reviewed by a CAF clinician after every ten external sessions, to re-evaluate the need for continuing treatment (Figure 3-1).
Figure 3-1: Flow of depressed patients through the CAF mental health system, and electronic data elements recorded at various stages of treatment
3.3 CAF Electronic Medical Record System

Until 2012, CAF medical records were entirely paper-based, and stored as hard-copy files within local CAF Medical Clinics. In 2012, the CAF implemented an organization-wide electronic health record system, which at first simply allowed scanning of paper documents into the electronic files of CAF patients. Paper forms then started to be replaced by electronic ones. Unlike their paper-based predecessors, electronic forms allowed the capture of structured data elements.

In March 2012, electronic forms to document clinical encounters within CAF primary care clinics (including walk-in visits, booked appointments, and periodic health assessments) became available in all CAF Medical Clinics. These electronic forms allowed primary care clinicians to record diagnoses as structured data elements, using International Classification of Diseases, 10th revision (ICD-10) diagnostic codes. In fact, the electronic forms were designed such that primary care clinicians could not complete them without recording at least one ICD-10 code to describe the patient’s condition or the purpose of their visit. It should be noted that the ICD-10 dictionary includes codes such as encounter for general examination without complaint (Z00.00) and unhappiness, not elsewhere classified (R45.2); an ICD-10 code can therefore be recorded, even in the absence of a clinical diagnosis. From March 2012 to December 2015, CAF primary care clinicians generated ICD-10 codes in the electronic medical records of their depressed patients, but CAF mental health specialists continued to document their clinical diagnoses on scanned paper forms.

In January 2016, fourteen electronic forms to document care provided in CAF specialty mental health clinics were added to the CAF electronic medical record system. Most of these electronic forms allowed select care providers (i.e. CAF psychiatrists and psychologists) to record diagnoses using the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) list of codes.
However, specialty mental health care is often provided to CAF personnel by professionals who do not have the regulated authority to assign ICD-10 or DSM-5 diagnoses (e.g. social workers, counselors, and mental health nurses). Epidemiologists from the Canadian Forces Health Services therefore developed a list of standardized clinical impressions that can be used by any health professional to describe their patients without violating the scope of practice defined by their respective professional colleges. The list includes 15 clinical impressions related to personal problems, including adjustment to stress, anger, anxiety and stress symptoms, depressive symptoms, PTSD symptoms, other mental health symptoms, chronic pain, malingering, phase of life problem, spiritual issues, sexual issues, sexual identity issues, acculturation difficulty, unwanted pregnancy, and other. The electronic forms used in CAF specialty mental health clinics were created such that clinicians cannot complete them without recording at least one DSM-5 code or selecting at least one clinical impression code from the standardized list.

Three types of discrete data elements related to major depression can therefore be extracted from the CAF electronic medical record system: (1) ICD-10 codes for major depression recorded in primary care clinics, (2) DSM-5 codes for major depression recorded in specialty mental health clinics, and (3) depressive symptoms codes recorded in specialty mental health clinics. It should be noted that not all patients with clinical impression codes for depressive symptoms meet the diagnostic criteria for major depression. For example, social workers could select the code for depressive symptoms to indicate that their patients are experiencing low mood in the context of a marital breakdown. However, depressive symptoms codes are extremely useful for identifying the dates of clinical encounters with healthcare providers other than primary physicians, psychologists, or psychiatrists, for patients with an existing diagnosis of major depression.
Furthermore, two types of electronic notes are used to summarize patient progress since the start of treatment: (1) the Periodic Case Review electronic form, completed every three months for patients receiving in-house treatment, and (2) the External Provider Review electronic form, completed after every ten sessions with an external provider (Figure 3-1). On these two types of note, treatment start date is captured as a structured data element, providing additional information to differentiate between incident and follow-up clinical encounters. In Chapter 6, I provide further details on how data extracted from electronic forms were linked over time to identify prevalent and incident cases of diagnosed major depression.

### 3.4 Canadian Forces Mental Health Survey

Statistics Canada is Canada’s national statistical office. Its mandate is to produce information to help Canadians better understand their country’s population, resources, economy, society, and culture. To fulfill this mandate, Statistics Canada conducts a number of national surveys to collect health information from the general adult population. These surveys have been widely used by researchers to shed new light on major depression in Canada [2–4], but have typically excluded serving CAF personnel from their sampling frame.

In 2013, Statistics Canada collaborated with the Department of National Defence to conduct a population-based mental health survey of serving CAF personnel. The survey’s content was largely based on the 2012 Canadian Community Health Survey – Mental Health and Well-Being (a survey of the general Canadian population), and a previous population-based survey of mental health in the CAF. The sampling frame was drawn in September 2012, and included all currently serving CAF Regular Force personnel (n = 67,776) and all currently serving CAF Reservists who had ever deployed in support of the combat mission in Afghanistan (n = 4,578). Data were
collected between April and August 2013, through face-to-face computer-assisted interviews with trained Statistics Canada personnel. In total, 6,996 Regular Force personnel and 1,469 Reservists participated in the survey, respectively representing 79.6% and 78.8% of all sampled individuals. Additional details on the survey methodology have been published in the Canadian Journal of Psychiatry [5] and on Statistics Canada’s website.

In Chapter 4, I describe how the 2013 Canadian Forces Mental Health Survey data were used to measure the major depression treatment gap in CAF Regular Force personnel.
References


CHAPTER 4

Mental health service utilization in depressed Canadian Armed Forces personnel

Preface

By implementing an organization-wide electronic medical record system, the Canadian Armed Forces (CAF) created new opportunities to study major depression in their personnel (Chapter 3). But data extracted from electronic medical records can only identify major depression in depressed individuals who use mental health services. Individuals who do not seek care for their symptoms do not generate any data signals in electronic medical records, and are systematically classified as false negatives in any epidemiological study relying on electronic medical record databases. Before using electronic medical record data to estimate the incidence rate of major depression in CAF personnel (Chapter 6) and its association with incident spinal pain (Chapter 7), I therefore had to quantify the size of the major depression treatment gap in this population.

The main objective of the study presented in this chapter was to estimate the past-year prevalence of self-reported mental health service use in CAF personnel with past-year major depression. Secondary objectives included estimating the proportion of past-year service users who reported being treated by mental health specialists rather than general practitioners, and identifying correlates of service use in CAF personnel with past-year major depression. The study was published in the Canadian Journal of Psychiatry in January 2019, and is cited as: Thériault FL, Garber GB, Momoli F, Gardner W, Zamorski MA, Colman I (2019). Mental health service utilization in depressed Canadian Armed
Forces personnel. *Canadian Journal of Psychiatry*. 64(1): 59-67. The journal acceptance letter is included in Appendix 4A, and proof of ethical approval is included in Appendix 4B. Tables and figures were re-numbered to avoid confusion with other thesis chapters (i.e., the table labeled “Table 1” in the *Canadian Journal of Psychiatry* article is labeled “Table 4-1” here, to clearly distinguish it from tables in other chapters).

**Contribution Statement**

I was responsible for generating the study objectives and design, with guidance from my supervisor and co-authors. I conducted all statistical analyses presented herein. I drafted preliminary and final versions of the manuscript. I also responded to all comments arising from the peer-review process.
Chapter 4: Mental health service use in depressed CAF personnel

ABSTRACT

Background

Major depression is prevalent, impactful, and treatable in military populations, but not all depressed personnel seek professional care in a given year. Care-seeking patterns (including the use of primary vs. specialty care), and factors associated with the likelihood of mental health service utilization in depressed military personnel are poorly understood.

Methods

Our sample was 520 Regular Force participants to the 2013 Canadian Forces Mental Health Survey, with past-year major depression. Participants reported whether they had spoken about their mental health with at least one health professional in the past 12 months. We used multivariate Poisson regression to explore factors associated with past-year mental health service use.

Results

Three-quarters of Canadian military personnel with past-year depression had sought mental health care in the previous 12 months. Among care-seeking personnel, 70% had seen a psychologist or psychiatrist, while 5% had exclusively received care from a primary care physician. Belief in the effectiveness of mental health care was the factor most strongly associated with care-seeking. Female gender, functional impairments, and psychiatric comorbidities were also associated with care-seeking. Surprisingly, stigma perceptions had no independent association with care-seeking.
Chapter 4: Mental health service use in depressed CAF personnel

**Conclusions**

The proportion of depressed Canadian Armed Forces personnel who seek professional care, and who access specialty mental health care, is higher than in most other populations. However, an important minority of patients are not accessing health services. Efforts to further increase mental health service utilization in the Canadian military should continue to target beliefs about the effectiveness of mental health care.
Chapter 4: Mental health service use in depressed CAF personnel

INTRODUCTION

Major depression is the most common mental disorder in the Canadian Armed Forces [1]; annually, 8% of their personnel suffer from a major depressive episode, compared to 4% of carefully-matched Canadian civilians [2]. A disproportionate risk of major depression has also been reported in military personnel from Australia, the United Kingdom, and the United States [3–5]. In the Canadian Armed Forces, major depression is identified as the primary cause of medical release from military service in 150 individuals per year [6].

There are numerous effective treatment options for major depression [7, 8]. Unfortunately, many adults suffering from major depression never seek professional care, and therefore cannot benefit from effective treatment [9]. In 2002, a telephone survey of 304 community-dwelling Canadian adults with probable major depression estimated that only 56% had sought mental health care in the past year [9]. Similarly, a 2002 survey of 8,441 Canadian military personnel estimated that only 37% of those with a lifetime history of major depression had sought mental health care within 12 months of depressive symptoms onset [10]. Furthermore, a longitudinal study of over 22,000 U.S. infantrymen found that, from 2003 to 2011, the annual prevalence of past-year mental health service utilization among depressed soldiers only ranged from 20% to 42% [11].

The majority of military personnel with untreated mental disorders do not recognize the need for professional help [12]. Among depressed patients who recognize the need for help, the failure to receive timely care could be explained by any combination of factors from three broad treatment barrier categories, namely: availability barriers (e.g., services not available locally), accessibility barriers (e.g., services too expensive), and acceptability barriers (e.g., stigma) [10, 13]. Since the early 2000s, the Canadian Armed Forces made
substantial investments to renew their mental health system, by establishing novel treatment centres and prevention programs, doubling the number of their mental health clinicians, and intensifying screening efforts for common mental disorders [14]. As a result, availability and accessibility barriers should now have little impact on members of the Regular Forces, who are entitled to free and unlimited mental health care through the Canadian Forces Health Services, as well as transportation to and from treatment centres as required [15]. Nevertheless, acceptability barriers remain a concerning issue; a recent study found higher mental health stigma in the Canadian military than in a comparable civilian population [16].

Previous research has identified several factors associated with increased likelihood of care-seeking in patients suffering from mental health disorders, including: female sex [17], older age [17], marital status [17], high education status [18], co-morbid disorders [17], severity of psychiatric symptoms [18], and awareness of treatment history in family members and friends [19]. In military populations, high levels of social support [20], previous military deployment [21], overcoming perceived stigma [20], and positive attitude towards mental health treatment [22] have also been associated with increased likelihood of mental health service utilization. However, the association between each of these factors and the health service utilization of depressed patients, in the context of recent Canadian Armed Forces mental health initiatives [14], remains unclear.

In civilian populations, depressed patients who seek care are often treated exclusively in primary care settings [23]. Previous studies have shown that, in general, depressed patients receive more adequate care when they are treated by mental health specialists than by primary care physicians alone [24, 25]. High-quality measurement-based care can,
however, be provided to depressed patients by primary care physicians, and, when treatment adheres to best-practice guidelines, patient outcomes are identical between primary care and specialty mental health settings [26]. Unfortunately, primary care physicians often lack the time and resources required to provide guideline-concordant treatments to their depressed patients [25, 27]. Indeed, major depression is often missed or misdiagnosed in primary care settings [28]. Furthermore, primary care physicians tend to treat their depressed patients with pharmacotherapy alone, rather than a combination of pharmacotherapy and psychotherapy, even when there are mental health specialists on-site [29].

The objectives of this study were to: (1) estimate the prevalence of past-year mental health service use in Canadian Armed Forces personnel who had suffered from a major depressive episode over the same time period, (2) estimate the proportion of care-seeking personnel who were treated by mental health specialists, and (3) identify correlates of care-seeking behaviour.
METHODS

Data source

We used data from the Canadian Forces Mental Health Survey, conducted by Statistics Canada in 2013 [14]. Briefly, a random sample was selected from a sampling frame of over 72,000 Canadian Armed Forces personnel. Trained Statistics Canada interviewers then conducted face-to-face, computer-assisted interviews with 6,996 Regular Force members (80% response rate) and 1,469 reservists (79% response rate).

Study sample

Regular Force personnel are full-time service-members and receive complete medical coverage from the Canadian Forces Health Services. On the other hand, Reservists are mostly part-time personnel, and are usually only eligible to receive care through the Canadian Forces Health Services for medical issues directly related to their military service. We therefore only included Regular Force personnel in our sample, because availability and accessibility should not vary within this sub-population.

We further restricted our sample to personnel with past-year depression (8% of all Regular Force members [1]), as identified using the WHO CIDI 3.0 structured interview. This fully structured diagnostic interview can be administered by lay personnel, and is based on ICD-10 and DSM-IV diagnostic criteria [30]. It is a valid tool for measuring past-year mood disorders [31].

Our study sample therefore consisted of 520 survey participants, weighted to represent 5,120 Regular Force personnel with past-year depression.
Past-year mental health care-seeking

Using a single item from the WHO CIDI 3.0 module on health services use, all participants were asked if they had talked about their “emotions, mental health, or use of alcohol or drugs” to a psychiatrist, family doctor, general practitioner, psychologist, nurse, social worker, and/or counsellor in the past 12 months. Participants who responded positively to this item were classified as having sought mental health care in the past year. We further categorized care-seekers as having sought care from a primary care physician (family doctor or general practitioner), mental health specialist (psychiatrist or psychologist), and/or other care provider (nurse, social worker, or counsellor).

Perceived need for mental health care

Using a single item from the WHO CIDI 3.0 module on health services use, all participants were asked if there was ever time in the past 12 months when they felt they needed help for their “emotions, mental health, or use of alcohol or drugs”, but did not receive it. Non care-seekers who responded positively to this item were considered to have perceived the need for mental health care.

Demographic information

The survey collected information on the sex, age group (i.e.: 18-29 years, 30-39 years, or 40-60 years), marital status (i.e.: married/common-law, widowed/separated/divorced, or single), and service element (i.e.: Navy, Army, or Air Force) of each participant. Participants were also asked if they had ever deployed in support of Canada’s combat mission to Afghanistan.
Co-morbid psychiatric conditions

The WHO CIDI 3.0 structured interview [30], described above, was also used to measure past-year post-traumatic stress disorder (PTSD), general anxiety disorder, panic disorder, and alcohol use disorder. Our analyses adjusted for past-year PTSD – a disorder that disproportionately affects military personnel, especially those who have deployed in support of a combat mission [32] – and any other past-year mental health disorder as two dichotomous variables.

Functional Impairment Level

The Sheehan Disability Scale [33] was used to measure the functional impairment of depressive symptoms across five domains. Using a 10-point scale, participants reported how much their feelings of depression had interfered with their ability to: (1) assume family responsibilities, (2) attend school, (3) work, (4) form and maintain close relationships, and (5) engage in social activities, over the past 12 months. As recommended by previous author [33], scores were categorized as no impairment (score = 0), mild impairment (score = 1-3), moderate impairment (score = 4-6), marked impairment (score = 7-9) or severe impairment (score = 10), for each of the five domains. The highest impairment level reported by each participant was retained for our analysis.

We also computed the mean impairment score across all applicable life domains for each individual. Mean scores ranged from 0 to 10, and were categorized into one of five impairment levels, as described above. Sensitivity analyses using mean impairment scores yielded highly concordant results to those of primary analyses using maximum impairment scores; for brevity, results of these sensitivity analyses are not presented herein.
Chapter 4: Mental health service use in depressed CAF personnel

Social Support

Social support was measured using a modified version of the Social Provision Scale [34]. Using a four-point scale, participants were asked to rate their endorsement of 10 items such as “there are people I can depend on to help me if I really need it” and “I feel a strong emotional bond with at least one other person”. Ratings were summed into a total score ranging from 10 to 40. For the purposes of our study, we categorized scores into quartiles.

Awareness of Treatment History in Family and Friends

Participants who reported that a close family member or a close friend had “ever been treated for an emotional or mental health problem” were considered aware of mental health treatment history in family or friends.

Mental Health Treatment Barriers

All participants were asked if they felt that: (1) their military unit leaders would encourage them to use mental health services, if ever they needed care, (2) they would be seen as weak if ever they sought mental health care, (3) they could get time off work if ever they needed mental health treatment, (4) seeking mental health care would harm their military career, and (5) treatments would be effective if ever they experienced a mental health problem. Response options included: “strongly agree”, “agree”, “neither agree nor disagree”, “disagree”, and “strongly disagree”. Each of the five treatment barriers listed above was operationalized as a dichotomous variable, with “strongly agree” and “agree” responses considered as positive endorsement of the survey item.
Chapter 4: Mental health service use in depressed CAF personnel

Analyses

We estimated the proportion of Regular Force personnel with past-year depression who had sought mental health care in the past 12 months. Using purposeful selection methods [35], we fitted 15 bivariate Poisson regression models to describe the association between past-year mental health care-seeking and each of the 15 independent variables described above and listed in Table 1. Significant variables at the $\alpha = 0.25$ level were added to a multivariate Poisson model. Variables were then iteratively removed from this model if they were non-significant at the $\alpha = 0.1$ level, and if their removal did not cause remaining parameters to change from more than 10% of their original value. It should be noted that robust Poisson regression is a valid modelling approach for common binomial outcomes in cross-sectional studies [36].

Sampling weights were used to obtain estimates representative of the source population while accounting for the survey’s stratified sampling design. Confidence intervals were obtained through 500 Bootstrap replicate samples. All analyses were conducted using Stata, version 14 [37].

Ethical Considerations

This study was approved by the University of Ottawa’s Research Ethics Board, and by relevant bodies within Statistics Canada. Survey participation was strictly voluntary, and participants provided written consent. To protect the confidentiality of military personnel, Statistics Canada requires that all raw cell counts be rounded to the nearest 20, and that weighted population counts be rounded to the nearest 20 before being converted to proportions.
Chapter 4: Mental health service use in depressed CAF personnel

RESULTS

Most Regular Force personnel with past-year depression were male, under the age of 40 years, and serving with the Army (Table 4-1), which broadly reflects the demographic profile of the Canadian Armed Forces population. Most personnel with past-year depression said that their unit leaders encourage the use of mental health services, but 49% reported that they would be seen as weak for seeking mental health care, and 58% reported that seeking mental health care would impact their career. Nevertheless, 86% reported that mental health care is effective (Table 4-1).

In the previous 12 months, 75% (95% CI: 70%, 79%) of personnel with past-year depression had sought professional mental health care, while another 7% (95% CI: 5%, 10%) had perceived the need for care, but had not received treatment.

The prevalence of past-year care-seeking differed significantly across levels of sex, age category, marital status, past-year psychiatric co-morbidities, depression-related impairment level, and social support quartiles (Table 4-2). Endorsing the effectiveness of professional mental health care was associated with a higher proportion of past-year care-seeking (Table 4-2). However, the prevalence of past-year care-seeking was similar between depressed personnel who did and did not report other treatment barriers, including stigma concerns (Table 4-2).

In the previous 12 months, depressed personnel who sought mental health care did so from a variety of health professionals. Among care-seekers, 70% had talked to a psychologist or psychiatrist, and only 5% had been treated exclusively in primary care (Table 4-3). Depression-related impairment was associated with the type of mental health care sought; 75% of personnel extremely impaired by their depressive symptoms had consulted a
psychiatrist or psychologist in the past 12 months, compared to 54% of personnel markedly impaired, and 32% of personnel moderately impaired ($P < 0.001$).

Our final multivariate Poisson regression model included sex, age, impairment level, past-year PTSD and other psychiatric co-morbidities, and belief in the effectiveness of mental health treatments as significant determinants of past-year care-seeking. After adjusting for covariates retained in the final model, belief in the effectiveness of mental health care was the strongest predictor of past-year care-seeking in Regular Force personnel with past-year depression, associated with a 52% increase in the past-year prevalence of health service utilization for mental health issues (Table 4-4).
DISCUSSION

Results from this large population-based study have shown that three-quarters of Canadian military personnel with past-year depression sought professional mental health care in the past 12 months, and only a small proportion sought care exclusively from primary care physicians. Belief in the effectiveness of mental health care was the factor most strongly associated with care-seeking. Stigma concerns were not associated with care-seeking.

The care-seeking rate reported herein is substantially higher than what has been observed elsewhere [9, 11]. Depressed Canadian military personnel therefore seem to access mental health care in greater numbers than depressed patients in other populations. This finding could be partly explained by unique aspects of the CAF mental health system, including: (1) access to unlimited mental health care, free of charge, (2) frequent mental health literacy training, to teach personnel how to recognize the progression of mental health symptoms and where to turn to for help, and (3) routine screening for mental disorders during mandatory periodic health assessments, and upon return from overseas deployments. The latter two of these health system components were renewed and improved over the decade preceding data collection for this study [14], which could partly explain why the care-seeking rate reported herein is substantially higher than what has been observed in previous Canadian military studies [10]. Nevertheless, the remarkably high care-seeking rate reported in our study is not entirely without precedent; in some civilian communities, as many as 84% of depressed individuals have been found to seek care [38]. Among UK veterans receiving war pensions for PTSD or physical disabilities, 72% of individuals who suffered from major depression at some point during their military careers had sought mental health care before retiring from military service [39].
The majority of care-seeking personnel with past-year depression had received care from a psychologist or psychiatrist. This finding contrasts with care-seeking patterns observed in civilian populations, where depressed patients are often treated exclusively in primary care settings [23]. The relatively high use of specialty mental health services among care-seekers may be due to the Canadian Armed Forces’ integrated health care system, where primary care and mental health clinics are part of single care delivery units. This finding is also encouraging, because guideline-concordant care is more likely to be administered to depressed patients in specialty mental health clinics than in primary care settings [25]. Future research may be needed to ensure that all care-seeking depressed Canadian Armed Forces personnel are receiving adequate treatment, particularly patients who are severely impacted by their symptoms and who do not access specialist care.

Belief in the effectiveness of mental health treatment was the strongest predictor of past-year mental health services utilization among depressed personnel. This finding is consistent with results of the WHO World Mental Health Surveys, where desire to handle mental health problems on one’s own and perceived ineffectiveness of mental health care were the most commonly cited barriers to initiating and maintaining treatment, in individuals with past-year psychiatric disorders [40]. Indeed, population-based studies from multiple different countries have consistently reported a significant association between mental health literacy and care-seeking attitudes [41]. The present study has found a relatively high level of mental health literacy in the Canadian Armed Forces, with 86% of depressed personnel recognizing the potential effectiveness of mental health treatment. Nevertheless, continuing mental health education efforts along those lines may further reduce the major depression treatment gap. Although results were not significant at the
95% confidence level, this study found a higher prevalence of past-year mental health service utilization in personnel who were aware of mental health treatment history among family or friends, mirroring findings among the Canadian general population [19].

As expected, severity of functional impairment caused by depressive symptoms was another strong predictor of past-year care-seeking in personnel who suffered from depression in the last 12 months. Depressive symptoms range in severity among individuals who meet the clinical definition of major depression [42], and patients most impacted by their symptoms are the most likely to seek care [18]. It should be noted that interference with daily activities is one of the diagnostic criteria used by the WHO CIDI 3.0 to define past-year depression [30]. As a result, depressive symptoms must have caused at least moderate impairment to all participants included in our sample.

Somewhat surprisingly, stigma concerns and other perceived barriers to mental health care were not associated with past-year care-seeking in depressed personnel. This finding is consistent with a growing body of literature documenting the absence of an association between perceived stigma and mental health services use in military populations [15, 22]. A recent study reported that, despite experiencing a greater burden of mental health stigma than their civilian counterparts, Canadian Armed Forces personnel were more likely to seek mental health care than members of the general Canadian population; the study’s authors concluded that factors specific to the military, such as enhanced mental health literacy programs, may have counterbalanced the negative effects of stigma on care-seeking [16]. However, these and other authors have highlighted the pitfalls of using cross-sectional data to study the relationship between perceived stigma and care-seeking [43]. Indeed, stigma
may become more noticeable after patients enter treatment, such that care-seeking could be a predictor, rather than an outcome, of perceived stigma [16, 43].

Limitations

Our cross-sectional design did not permit us to study temporal relationships between variables of interest. Therefore, it is unclear if the major depressive episodes experienced by participants over the last 12 months truly preceded their decision to seek mental health care, and if factors found to be associated with care-seeking were already present before participants received treatment, so we cannot be certain that these factors influence care-seeking. For example, depressed patients may have only learned that treatments are effective after seeking care. In fact, a previously published longitudinal study found no association between the perceived usefulness of particular treatments, and subsequent care-seeking actions in depressed individuals [44]. Furthermore, all care seekers were grouped into a single category, regardless of their level of adherence to treatment, or the time elapsed between the onset of their depressive symptoms and their decision to seek care.

Limitations notwithstanding, our results are based on a large, representative sample of Regular Force members of the Canadian Armed Forces. Our results have important implications for health promotion and policy. First, the high proportion of mental health service use – particularly from mental health specialists – reported herein may speak to opportunities to reinforce other mental health systems. Second, we have found that, despite a high care-seeking rate, a quarter of all depressed personnel do not seek care in a given year; while very few depressed patients were treated exclusively by primary care physicians, primary care clinics may provide opportunities to identify depressed personnel who must undergo periodic health examinations but wouldn’t otherwise seek care, and
redirect them towards primary or secondary treatment. Finally, even if the associations we reported in our final multivariate model are not causal, they could be used to identify population sub-groups at higher risk of undiagnosed major depression, and inform efforts to further facilitate care-seeking in depressed personnel.
CONCLUSION

Three quarters of all Canadian Armed Forces personnel suffering from major depression seek professional mental health care within a given year. This mental health service utilization rate is remarkably higher than what has been reported in several other depressed patient populations, and highlights opportunities to improve civilian mental health care systems. Nevertheless, a significant minority of depressed soldiers remain untreated. Of all the care-seeking determinants examined in our study, belief in the effectiveness of mental health care was the strongest determinant of health service utilization among depressed military personnel. Additional mental health literacy campaigns may therefore help to further reduce the remaining major depression treatment gap.
### Table 4-1: Characteristics of Regular Force personnel with past-year major depression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>Percent (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>81.3 (77.5, 84.8)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>18 to 29</td>
<td>28.5 (24.3, 32.8)</td>
</tr>
<tr>
<td></td>
<td>30 to 39</td>
<td>37.1 (32.5, 41.7)</td>
</tr>
<tr>
<td></td>
<td>40 to 60</td>
<td>34.4 (30.0, 38.6)</td>
</tr>
<tr>
<td>Marital status</td>
<td>Single</td>
<td>28.9 (24.6, 33.3)</td>
</tr>
<tr>
<td></td>
<td>Married, Common-Law</td>
<td>56.3 (51.8, 60.6)</td>
</tr>
<tr>
<td></td>
<td>Widowed, Divorced, Separated</td>
<td>14.8 (11.6, 18.1)</td>
</tr>
<tr>
<td>Element</td>
<td>Navy</td>
<td>15.2 (12.0, 18.3)</td>
</tr>
<tr>
<td></td>
<td>Army</td>
<td>60.5 (56.2, 64.9)</td>
</tr>
<tr>
<td></td>
<td>Air Force</td>
<td>24.2 (20.5, 28.1)</td>
</tr>
<tr>
<td>Past-year PTSD</td>
<td>Yes</td>
<td>29.3 (24.3, 33.2)</td>
</tr>
<tr>
<td>Other past-year co-morbidities</td>
<td>Yes</td>
<td>49.6 (44.7, 54.3)</td>
</tr>
<tr>
<td>Functional impairment</td>
<td>Moderate</td>
<td>27.7 (23.7, 31.8)</td>
</tr>
<tr>
<td></td>
<td>Marked</td>
<td>52.0 (47.4, 56.7)</td>
</tr>
<tr>
<td></td>
<td>Extreme</td>
<td>20.3 (16.1, 24.3)</td>
</tr>
<tr>
<td>Awareness of treatment history in family or friends</td>
<td>Yes</td>
<td>92.1 (88.9, 94.2)</td>
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<tr>
<td>Social provision</td>
<td>Lowest quartile</td>
<td>23.1 (19.0, 27.1)</td>
</tr>
<tr>
<td></td>
<td>2nd quartile</td>
<td>28.7 (24.6, 33.0)</td>
</tr>
<tr>
<td></td>
<td>3rd quartile</td>
<td>25.9 (21.8, 29.9)</td>
</tr>
<tr>
<td></td>
<td>Highest quartile</td>
<td>22.3 (18.5, 26.2)</td>
</tr>
<tr>
<td>Deployed to Afghanistan</td>
<td>Yes</td>
<td>54.7 (50.0, 59.1)</td>
</tr>
<tr>
<td>Unit leaders encourage the use of mental health services</td>
<td>Yes</td>
<td>57.9 (52.7, 62.2)</td>
</tr>
<tr>
<td>Would be seen as weak for seeking mental health care</td>
<td>Yes</td>
<td>49.2 (44.1, 53.8)</td>
</tr>
<tr>
<td>Seeking mental health care would impact career</td>
<td>Yes</td>
<td>57.6 (52.8, 62.1)</td>
</tr>
<tr>
<td>Could get time off work for mental health treatment</td>
<td>Yes</td>
<td>72.0 (67.6, 75.8)</td>
</tr>
<tr>
<td>Mental health care is effective</td>
<td>Yes</td>
<td>85.5 (81.9, 88.6)</td>
</tr>
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### Table 4.2: Row percentage of Regular Force personnel with past-year major depression who sought mental health care in the last 12 months, by demographics and reported treatment barriers

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>Percent (95% CI)</th>
<th>P value for ( \chi^2 ) test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>76.9 (67.2, 86.1)</td>
<td>0.889</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>73.5 (68.4, 79.4)</td>
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<td></td>
<td></td>
<td>75.8 (66.4, 83.4)</td>
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</tr>
<tr>
<td>Age (years)</td>
<td>Yes</td>
<td>72.8 (70.0, 75.5)</td>
<td>0.001</td>
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<td></td>
<td>No</td>
<td>70.5 (65.2, 75.8)</td>
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<td></td>
<td>69.0 (67.2, 70.8)</td>
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<td></td>
<td>67.5 (66.7, 68.2)</td>
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<td></td>
<td>66.0 (65.2, 66.8)</td>
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<td>64.5 (63.7, 65.2)</td>
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<td>63.0 (62.3, 63.7)</td>
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<td>61.5 (60.8, 62.1)</td>
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<td>60.0 (59.3, 60.7)</td>
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<td>58.5 (57.8, 58.9)</td>
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<td>54.0 (53.3, 54.7)</td>
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<td>52.5 (51.8, 52.9)</td>
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<td>49.5 (48.8, 49.9)</td>
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<td>48.0 (47.3, 48.7)</td>
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<td>46.5 (45.8, 46.9)</td>
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<td>45.0 (44.3, 45.7)</td>
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<td>43.5 (42.8, 43.9)</td>
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<td>42.0 (41.3, 42.7)</td>
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<td>40.5 (40.0, 40.8)</td>
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<td>39.0 (38.5, 39.7)</td>
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<td>19.5 (19.0, 19.8)</td>
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**Note:** By demographics and reported treatment barriers.
### Chapter 4: Mental health service use in depressed CAF personnel

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**Table 4-3**: Percentage of Regular Force personnel with past-year major depression who sought mental health care from various combinations of professionals over the last 12 months

<table>
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<th>Health professional consulted</th>
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<td>Psychologist and/or psychiatrist</td>
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### Adjusted prevalence ratios, from a multivariate Poisson regression model, comparing past-year mental health care seeking between levels of select variables, in Regular Force personnel with past-year major depression

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<th>P value</th>
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<tr>
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<tr>
<td>Female</td>
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<td></td>
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<tr>
<td>Age (years)</td>
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</tr>
<tr>
<td>18 to 29</td>
<td>1.23 (1.03, 1.46)</td>
<td>0.023</td>
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<tr>
<td>30 to 39</td>
<td>1.18 (0.99, 1.41)</td>
<td>0.059</td>
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<td>40 to 60</td>
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<td>0.084</td>
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<td>Functional impairment</td>
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<tr>
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<tr>
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*Note: The table is extracted from the document and formatted for better readability.*
Chapter 4: Mental health service use in depressed CAF personnel

References


systematic review and meta-analysis of population surveys. World Psychiatry 16:50–61. https://doi.org/10.1002/wps.20383


Appendix 4A: Screenshot of manuscript acceptance letter from the Canadian Journal of Psychiatry

On 2018-06-05, 1:46 PM, “The Canadian Journal of Psychiatry/La Revue canadienne de psychiatrie” <onbehalfof@manuscriptcentral.com> wrote:

09-Jun-2018

CJP-2018-049-OR-R1: Mental health service utilization in depressed Canadian Armed Forces personnel

Dear Dr. Collman,

I am pleased to advise you that the above-noted manuscript has been accepted for publication in The Canadian Journal of Psychiatry/La Revue canadienne de psychiatrie.

Once we have verified that the format of all files meet submission guidelines and all necessary forms have been received, the manuscript will be forwarded to the Publisher. You will soon be receiving a manuscript proof via an email PDF file from SAGE Publications. The timely review and return of the proof is essential in maintaining our publication schedule.

If you have any questions or if our Editorial Office staff can be of further assistance, please do not hesitate to contact us.

Thank you for publishing in The Canadian Journal of Psychiatry.

Sincerely,

Scott Patten

Scott B. Patten, MD, PhD
Editor-in-Chief, The Canadian Journal of Psychiatry
Professor, Depts. of Community Health Sciences & Psychiatry,
Cumming School of Medicine, University of Calgary
Appendix 4B: Ethics approval from the University of Ottawa’s Research Ethics Board

File Number: H04-17-04
Date (mm/dd/yyyy): 05/30/2017

Université d’Ottawa
Bureau d’éthique et d’intégrité de la recherche
Office of Research Ethics and Integrity

Ethics Approval Notice
Health Sciences and Science REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

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<th>Last Name</th>
<th>Affiliation</th>
<th>Role</th>
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<td>Colman</td>
<td>Medicine / Medicine</td>
<td>Supervisor</td>
</tr>
<tr>
<td>François</td>
<td>Thériault</td>
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<td>Student Researcher</td>
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File Number: H04-17-04
Type of Project: PhD Thesis
Title: Care-seeking for major depression in the Canadian Armed Forces

Approval Date (mm/dd/yyyy) 05/30/2017
Expire Date (mm/dd/yyyy) 05/29/2018
Approval Type Approval

Special Conditions / Comments: N/A
CHAPTER 5

Mental health service use in depressed military personnel: a systematic review

Preface

In Chapter 4, I reported that 75% of Canadian Armed Forces (CAF) personnel with past-year major depression reported using mental health services in the past 12 months. This point estimate is a valuable public health indicator for CAF officials. But to fully appreciate its implications, this point estimate must be compared to findings from other military populations. Is the 25% treatment gap found in CAF personnel lower or higher than in the armed forces of allied nations? Is the Canadian military a leader in terms of mental health service coverage for depressed personnel, or should it seek to learn lessons from other militaries with smaller treatment gaps?

The main objective of the study presented in this chapter was to systematically review the scientific literature, and summarize the findings of all published studies on mental health service use in depressed military personnel. At the time of this writing, the study had been submitted to the journal Military Medicine, and was under review. Email confirmation of manuscript submission is provided in Appendix 5A. Tables and figures were re-numbered to avoid confusion with other thesis chapters (i.e., the table labeled “Table 1” in the manuscript submitted to Military Medicine is labeled “Table 5-1” here, to clearly distinguish it from tables in other chapters).


**Contribution Statement**

I was responsible for generating the study objectives and design, with guidance from my supervisor and co-authors. I conducted the literature search, and reviewed all abstracts and full texts considered for inclusion in this study. I conducted all statistical analyses presented herein. I drafted preliminary and final versions of the manuscript.
ABSTRACT

Introduction

Major depression is a leading cause of morbidity in military personnel and an important impediment to operational readiness in military organizations. Although treatment options are available, a large proportion of individuals with depression do not access mental health services. Quantifying and closing this treatment gap is a public health priority. However, the scientific literature on the major depression treatment gap in military organizations has never been systematically reviewed.

Methods

We systematically searched the EMBASE, MEDLINE, and PsychINFO databases for studies measuring recent mental health service use in personnel serving in the armed forces of a Five-Eye country (Australia, Canada, New Zealand, United Kingdom, or United States). We excluded studies conducted with retired veterans. Because of the substantial heterogeneity in included studies, we did not pool their results. Instead, we computed median period prevalence of mental health service use.

Results

Twenty-eight studies were included in the systematic review; 12 had estimated mental health service use in personnel with depression, and another 16 had estimated mental health service use in personnel with depression or another mental health disorder. The period prevalence of mental health service use in depressed military personnel ranged from 20-75% in 12 included studies, with a median of 48%, over 2 to 12 months. The other 16 studies yielded similar conclusions; they reported period prevalence of mental health
service use in personnel with any mental health disorder ranging from 14-75%, with a median of 36%, over 1 to 12 months. The median was higher in studies relying on diagnostic interviews to identify depressed personnel, compared to studies relying on screening tools (60% vs 44%).

Conclusions

There is a large treatment gap for major depression in particular, and for mental health disorders in general, among military personnel. However, our results highlight the association between the use of measurement tools and treatment gaps: estimated treatment gaps were larger when depressed patients were identified by screening tools instead of diagnostic interviews. Researchers should be wary of overestimating the mental health treatment gap when using screening tools in future studies.
INTRODUCTION

Major depression is a leading cause of worldwide morbidity [1]. Although effective treatment options exist [2, 3], most adults who suffer from major depression do not receive professional mental health care [4, 5].

Closing the major depression treatment gap could substantially improve population mental health. For example, treatments offered to Australia’s care-seeking patient population are estimated to avert 22% of the national burden of depression; however, if all depressed Australians sought care, up to 45% of the national depression burden could be averted [6]. In military populations, where the annual prevalence of major depression is two times higher than in comparable civilian populations, [7–10] the need to measure and reduce the major depression treatment gap is important. Indeed, major depression is an important impediment to operational readiness [11], a leading cause of premature separation from the military [12, 13], and a major contributing factor to suicide mortality in military personnel [14]. Furthermore, most Western nations provide unlimited mental health care to their military personnel at no out-of-pocket expense. While financial costs are frequently cited as an important treatment barrier in civilian settings [15], they should not impact access to mental health services among soldiers. And yet, large treatment gaps continue to be observed.

One widely-cited study reported that only 23–40% of US combat infantry troops suffering from mental health disorders sought professional help in a 12-month period [16]. But a recent study from our group found that 75% of Canadian Armed Forces personnel with major depression had sought mental health care in the previous year [17]. Such wide variations in treatment gap estimates across nations and over time complicate the prioritization of military mental health resources. They also impede the interpretation of recent major depression surveillance projects; military
organizations are increasingly relying on electronic medical record data to measure trends in major depression prevalence and incidence among their personnel [18], but these surveillance efforts cannot identify personnel who never use health services. The major depression treatment gap must therefore be understood before data extracted from the electronic medical records of care-seeking patients can be used as indicators of major depression burden at the population level.

Evidence on the major depression treatment gap in military personnel has never been systematically reviewed and synthesized. Our objective was therefore to summarize the findings of all published studies having measured the period prevalence of mental health service use in military personnel suffering from depression.
METHODS

Inclusion and Exclusion Criteria

We sought to identify all original research studies reporting on the recent mental health service use of military personnel with major depression. Studies were included in our review if they met the following inclusion criteria: (1) subjects were serving in the armed forces of Australia, Canada, New Zealand, the United Kingdom, or the United States at the time of the study; (2) depression within the past year was measured in all subjects; and (3) mental health service utilization within the past year was measured in all subjects. We excluded studies if: (1) subjects were sampled from a clinical setting; (2) depression was measured using diagnostic codes, self-reported clinical diagnoses, or any other indicator dependent on previous interactions with healthcare professionals, or (3) mental health service utilization was not stratified by any mental health outcomes. Mental health service use can include pharmacotherapy, psychotherapy, and/or counselling from a wide variety of care providers; we therefore excluded studies that only reported on a single limited indicator of mental health service use (e.g., filled antidepressant prescription, psychiatric hospitalization, clinical diagnosis of major depression in a specialist clinic, etc.).

The Five Eyes (commonly abbreviated as FVEY) is an intelligence alliance comprising Australia, Canada, New Zealand, the United Kingdom, and the United States. All five countries are English-speaking, and their militaries often collaborate on international missions, training exercises, and mental health research initiatives [19]. In all five countries, active service members have access to mental health care through their employer. Furthermore, all military personnel from these five countries voluntarily signed up for military service, and often remain in service for extended professional careers; unlike some other Western nations, the armed forces of Five Eyes countries do not contain large groups of young men completing mandatory, short-term service before
returning to their civilian lives. To reduce heterogeneity in study samples and treatment barriers, we restricted our systematic review to military personnel from Five Eyes countries.

**Search Strategy**

We conducted a systematic search of the EMBASE, MEDLINE, and PsychINFO databases, using a combination of search terms related to the military (soldier, army, sailor, navy, military, militaries, active duty, armed force, air force, coast guard, marines, Department of Defense, Ministry of Defense, service member, submariner, troops, paratrooper, special force) and major depression (depression, MDD, dysthymia, depressed), from date of inception to July 24th 2018. Duplicate records were identified and removed using methods proposed by Bramer et al. [20]. Titles and abstracts of all unique studies were then screened by the primary author and one co-author; studies that were clearly irrelevant to our research question were excluded. The full texts of all remaining studies were retrieved and reviewed by the primary author and one co-author. Observed inter-rate agreement was 93%, with Cohen’s kappa = 0.62; this represents “substantial” inter-rater agreement [21]. Discrepancies were resolved by consensus.

**Data Analysis**

The primary author extracted data on sample characteristics, mental health assessment methods, and mental health service use from the all included studies. Corresponding authors of included studies were contacted to clarify methodological details, as needed. Methods used to assess major depression were dichotomized as either structured diagnostic interviews or screening tools. Structured diagnostic interviews are generally considered more reliable than screening tools for the assessment of major depression [22, 23]; we therefore considered that studies relying on structured diagnostic interviews to measure major depression were at lower risk of misclassification bias than studies relying on screening tools.
There was substantial heterogeneity in study methodologies and sample characteristics. There were also large variations in the diagnostic accuracy of tools used to assess depression status, and time periods over which depression and mental health service use were assessed. Under such circumstances, meta-analysis is not advisable [24]. We therefore summarized mental health service use across included studies using medians. Similar methods were also used to synthesize results in a large systematic review of the depression treatment gap in civilian populations [5]. We conducted our study and reported our findings according to the PRISMA guidelines [25] (see PRISMA checklist in Appendix 5B).
RESULTS

We identified 5,369 unique records, 4,622 of which were clearly irrelevant to our research question. We conducted a full review of the remaining 747 studies, 24 of which satisfied all inclusion and exclusion criteria listed above. Four additional studies were identified by searching the reference lists of included studies (Figure 4-1). All studies were reviewed by the primary author and one of the other co-authors.

We found 12 studies measuring mental health service use in military personnel with depression (Table 4-1). Four of these studies measured depression using structured diagnostic interviews [17, 26–28] while the other eight relied on various screening tools. Most studies measured service use over a 12-month period, but two used a recall period of 2-4 months [29, 30]. Six studies were conducted with subjects who were deployed or had recently deployed [27, 29–33], and the other six sampled subjects irrespective of past or current deployment status (Table 4-1). Seven studies completed data collection before 2010 [26–29, 31, 33, 34] and the other five studies completed data collection in 2010 or later.

Across the 12 studies, the estimated period prevalence of mental health service use in depressed military personnel ranged from 19.6% to 74.7%, with a median of 47.6% (Table 4-1). The median was higher in studies that relied on diagnostic interviews rather than screening tools to measure depression (60.3% vs. 44.4%). The median was higher in the two studies conducted in the Canadian Armed Forces (69.4%) compared to the 10 studies conducted in various branches of the U.S. Armed Forces (44.4%). The median was higher in studies having completed data collection in 2010 or later (56.0%) compared to studies having completed data collection before 2010 (43.7%).
We found another 16 studies that measured mental health service use in military personnel who had depression and/or at least one other psychiatric disorder. These studies reported only the prevalence of mental health service use in military personnel with any measured mental health disorder (Table 4-2). Definitions of “need for mental health care” ranged from screening positive for either depression or PTSD [35–37] to meeting diagnostic criteria for past-year depression, PTSD, generalized anxiety, panic disorder, social phobia, alcohol misuse, or suicidal ideation [38]. Only two of these 16 additional studies sampled subjects irrespective of past or current deployment status [38, 39] the other 14 only included personnel who were preparing to deploy [40], were currently deployed [41, 42], or had recently returned from deployment [16, 35–37, 43–49]. Time periods over which mental health service use was assessed ranged from 1 to 12 months (Table 4-2).

Across the additional 16 studies, the estimated period prevalence of mental health service use in military personnel with any mental health disorder ranged from 14.1% to 75.0%, with a median of 36.0% (Table 4-2). The median was nearly identical between American (34.7%), British (37.2%), and Canadian (36.1%) studies.
DISCUSSION

Key Findings

The body of research on mental health care use reviewed herein suggests that less than half of depressed military personnel receive mental health treatment (47.6% median period prevalence of mental health service use, across 12 studies). Studies combining depression with other psychiatric conditions to identify soldiers in need of mental health care led us to very similar conclusions (36.0% median period prevalence of mental health service use, across 16 studies). However, treatment gap estimates varied substantially between studies included in our review; this variation seemed to depend, at least partly, on the tools used to measure depression, and the psychiatric conditions used to define need for mental health care.

Comparison with the Literature

The general trends uncovered by our systematic review are consistent with the findings of a recent meta-analysis of 11 studies, where only 29.3% of soldiers with past-year mental health problems were found to have used mental health services over the previous 12 months [50]. Our findings are also consistent with the results of a systematic review of 32 studies that reported a 43.7% median prevalence of mental health service use in depressed civilians [5].

Implications

Our results highlight a large depression treatment gap in military populations. There are likely multiple reasons for this treatment gap. A substantial number of depressed soldiers may lack the mental health literacy skills required to self-recognize the need for care;
indeed, over 80% of Canadian Armed Forces members who met diagnostic criteria for a past-year mental health disorder but had not received mental counseling or medication in the previous 12 months reported no perceived need for mental health care [38]. Among depressed soldiers who recognize the need for mental health care, structural barriers (e.g., difficulty scheduling an appointment or getting time off work) are often cited as reasons for not receiving treatment [50]. Fear of negative career repercussions (e.g., inability to deploy overseas while completing mental health treatment), perceived stigma, and personal stigma are additional treatment barriers [50]. Finally, negative attitudes towards mental health treatment (i.e., belief that treatment is ineffective) have been identified as important treatment barriers in depressed soldiers [17]. By highlighting the large existing treatment gap, our results should encourage military organizations to further pursue research, mental health literacy efforts, and health system reforms to address the treatment barriers listed above and ensure that all depressed soldiers receive needed mental health care.

It should be noted that some studies included in our review found that mental health service use in depressed soldiers was alarmingly low [31, 33, 51], while others reported that service use was encouragingly high [17, 28]. Such large variance in reported mental health service use observed between studies may be a methodological artefact, attributable to important differences in measurement tools and outcome definitions. Structured diagnostic interviews are very reliable major depression measurement tools [52], and are often used as the reference standard to assess the validity of other measurement tools in community settings [22, 23]. While structured diagnostic tools may not be in perfect agreement with the clinical diagnoses of mental health specialists [52], they are expected to have minimal classification error in community settings. In other words, most individuals identified as
depressed using a diagnostic interview in studies included in our review were likely true positives and were truly in need of mental health services. On the other hand, screening tools are less accurate and invariably lead to false positives. For example, the 9-item Patient Health Questionnaire (PHQ-9; the depression screening tool most commonly used in studies included in our review) has a sensitivity ranging from 28-95% and a specificity ranging from 61-98% across various patient populations [53]. If the past-year prevalence of major depression is 8% (as has been reported by Rusu et al [10] in the Canadian Armed Forces), at least 20% of individuals identified as depressed by the PHQ-9 would therefore be false positives, and unlikely to have the same need for mental health care as those who truly meet criteria for major depression. Including these false positive cases in the denominator could lead to overestimation of the major depression treatment gap. Furthermore, very brief screening tools used in other included studies were originally designed for use in a two-tier screening process for major depression; these tools were intended to rapidly identify any patient who may be suffering from major depression and refer them for more extensive psychiatric assessment [54]. These brief screening tools are designed to minimize false negative rates and may generate more false positive cases than the PHQ-9 [53].

For the reasons noted above, it is not surprising that the median period prevalence of mental health service use for major depression was two times higher in studies using diagnostic interviews to identify depressed cases, compared to studies relying on shorter screening tools. Methodological differences could also explain the large variation in apparent mental health service use in Canadian vs. American military personnel with depression; Canadian
studies tended to use diagnostic interviews to measure depression, whereas American studies tended to use screening tools.

The issue of false positive cases is compounded in studies using screening tools for multiple psychiatric conditions to identify an apparent need for mental health services. Indeed, the false positive risk increases with each additional screening tool used to identify patients in need. This may explain why the two studies with the smallest reported treatment gap only used two screening tools to identify patients in need of mental health care [35, 36], whereas the study with the largest reported treatment gap defined need for mental health care by combining four different screening tools [47]. Studies operationalizing mental health care need as a positive screen on at least one of several different screening tools may overestimate the mental health treatment gap in military populations.

Limitations

Studies included in our systematic review completed primary data collection from 1996 [26] to 2013 [17, 30]. For all Five-Eyes nations, this 17-year span included the beginning of combat operations related to the Global War on Terror, and important changes to military mental health systems. Results pooled from studies conducted over these two decades may therefore no longer represent today’s military realities.

Conclusions

In conclusion, our results have highlighted a seemingly large treatment gap in depression military personnel. We have also brought attention to the pitfalls of using imperfect measurement tools to identify a population in need of mental health care. Our results should
encourage future researchers to carefully consider the implications of using short screening tools when studying mental health treatment gaps.
Chapter 5: Systematic review of service use in depressed military samples

**Figure 5-1:** Flow chart of systematic search and review

- 3,950 records found in EMBASE
- 2,674 records found in MEDLINE
- 2,444 records found in PsycINFO

3,699 duplicates

5,369 unique records

4,622 irrelevant abstracts

747 full texts reviewed

440 Health service use not measured
107 Civilian or retired military sample
67 Depression not measured
45 Clinical sample
25 Not from a FVEY country
24 Not research study
15 Too few details

4 other records found through reference search

28 studies included

12 studies measured health service use in depressed military personnel

16 studies measured health service use in military personnel with depression and/or other psychiatric disorders
<table>
<thead>
<tr>
<th>Ref</th>
<th>Country</th>
<th>Data Collected</th>
<th>Sample</th>
<th>Depression Measure</th>
<th>Definition of Health Service Utilization</th>
<th>Health Service Utilization (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[17]</td>
<td>Canada</td>
<td>2013</td>
<td>Personnel with past-year depression, among a weighted sample of 20 National Guard personnel with a positive screen for depression on a 16-month deployment anonymous survey</td>
<td>Diagnostic Interview</td>
<td>74.7</td>
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<td>[28]</td>
<td>USA</td>
<td>2002</td>
<td>50 National Guard personnel with a positive screen for depression on an anonymous survey 2 months after return from deployment</td>
<td>Screening Tool (Self-reported use of psychotherapy or mental health services 2 months after return)</td>
<td>56.4</td>
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<tr>
<td>[29]</td>
<td>USA</td>
<td>2007</td>
<td>50 National Guard personnel with a positive screen for depression on an anonymous survey 2 months after return from deployment</td>
<td>Screening Tool (Self-reported use of psychotherapy or mental health services 2 months after return)</td>
<td>50.0</td>
<td></td>
</tr>
<tr>
<td>[32]</td>
<td>USA</td>
<td>2011 to 2013</td>
<td>20 National Guard personnel with a positive screen for depression on a 16-month deployment anonymous survey</td>
<td>Diagnostic Interview</td>
<td>85.1</td>
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<tr>
<td>[35]</td>
<td>USA</td>
<td>2009 to 2010</td>
<td>20 National Guard personnel with a positive screen for depression on a 16-month deployment anonymous survey</td>
<td>Screening Tool (Self-reported use of psychotherapy or mental health services 2 months after return)</td>
<td>52.9</td>
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<tr>
<td>[36]</td>
<td>USA</td>
<td>2006 to 2010</td>
<td>30 National Guard personnel with a positive screen for depression on a 16-month deployment anonymous survey</td>
<td>Diagnostic Interview</td>
<td>64.1</td>
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<tr>
<td>[37]</td>
<td>USA</td>
<td>2009 to 2011</td>
<td>20 National Guard personnel with a positive screen for depression on a 16-month deployment anonymous survey</td>
<td>Screening Tool (Self-reported use of psychotherapy or mental health services 2 months after return)</td>
<td>56.0</td>
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</tr>
</tbody>
</table>

Table 5.1: Summary of studies measuring mental health service utilization in military personnel with depression.
| Study | Sample Description | Tool | Self-reported receiving therapy or care | Self-reported receiving professional mental health service | Survey or Screening Tool | Screening for depression | Number | Year |
|-------|-------------------|------|------------------|------------------|----------------------|-------------------|-----------------|-------|------|
| USA 2011 to 2013 | National Guard with a positive screen for depression during anonymous survey, 2-4 months after return from combat deployment | 16-item Patient Health Questionnaire | Self-reported receiving therapy or care | | | | 51 | 2005 |
| USA 2008 | 5,435 active-duty personnel with a positive screen for depression on anonymous survey | Beck Depression Inventory – Second Edition | Self-reported receiving professional mental health service | | | | 4,526 | 2003 |
| USA 1996 | 71 Navy and Marine personnel with past-year depression | Diagnostic Interview Schedule | Self-reported receiving therapy or care | | | | | 71 | 1996 |
| USA 2014 | 233 infantry personnel with a positive screen for depression on anonymous survey | Center for Epidemiological Studies – Depression Scale | Self-reported receiving professional mental health service | | | | | 233 | 2014 |
| USA 2005 | Active-duty personnel who deployed to Iraq or Afghanistan in past 3 years, among 6,116 survey participants who deployed to Afghanistan, among 6,161 | Burnam screening criteria – Version A | Self-reported receiving therapy or care | | | | | 1,122 | 2005 |
| USA 2003 to 2004 | 112 soldiers with a positive screen for depression on anonymous survey, 3 months post-deployment | | | | | | | 112 | 2004 |
| USA 2003 to 2004 | 22.3% of soldiers, 3 months post-deployment | | | | | | | | |

**Notes:**
- a: Patient Health Questionnaire – 9 item
- b: Beck Depression Inventory – Second Edition
- c: Burnam screening criteria – Version A
- d: Center for Epidemiological Studies – Depression Scale
Table 5-2: Summary of studies measuring mental health service utilization in military personnel with any mental health disorder

<table>
<thead>
<tr>
<th>Ref</th>
<th>Country</th>
<th>Data Collected</th>
<th>Sample</th>
<th>Mental Health Disorders Included</th>
<th>Definition of Health Service Utilization</th>
<th>Health Service Utilization (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[35]</td>
<td>USA</td>
<td>2006 to 2007</td>
<td>40 National Guard personnel who met diagnostic criteria for mental health disorder 3 months after return from a combat deployment</td>
<td>Depression, PTSD</td>
<td>Self-reported receiving mental health services, 3 months after return</td>
<td>65.0</td>
</tr>
<tr>
<td>[36]</td>
<td>USA</td>
<td>2009 to 2010</td>
<td>1,579 personnel who screened positive for a mental health disorder, 3-6 months after returning from deployment</td>
<td>Depression, PTSD, Anxiety, Suicidal Ideation, Panic Disorder</td>
<td>Self-reported currently seeing a health professional for emotional or mental health issues, or currently using psychiatric medications for anxiety, depression or stress</td>
<td>45.1</td>
</tr>
<tr>
<td>[37]</td>
<td>USA</td>
<td>2007 to 2008</td>
<td>133 National Guard personnel who screened positive for a mental health disorder on anonymous survey, 45-90 days after returning from a 12-month deployment</td>
<td>Depression, PTSD, Suicidal Ideation, Hazardous Drinking</td>
<td>Self-reported receiving mental health services from a mental health professional 6 months after return</td>
<td>49.6</td>
</tr>
<tr>
<td>[38]</td>
<td>Canada</td>
<td>2009 to 2012</td>
<td>1,220 anonymous survey participants</td>
<td>Depression, PTSD, Anxiety</td>
<td>Self-reported receiving mental health services since last month for emotional or mental health issues, or currently using psychiatric medications for anxiety, depression or stress</td>
<td>42.6</td>
</tr>
<tr>
<td>[39]</td>
<td>USA</td>
<td>2002</td>
<td>Reference sample of 1,220 anonymous survey participants</td>
<td>Depression</td>
<td>Self-reported currently seeing a health professional for a mental health disorder</td>
<td>75.0</td>
</tr>
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</table>

Note: Table summarizes studies measuring mental health service utilization in military personnel with any mental health disorder.
Chapter 5: Systematic review of service use in depressed military samples

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Year</th>
<th>Sample Size</th>
<th>Self-reported seeking treatment with a mental health professional</th>
<th>Depression</th>
<th>Anxiety</th>
<th>PTSD</th>
<th>Depressive disorder</th>
<th>Alcohol use disorder</th>
<th>Suicide attempt</th>
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<tr>
<td>[42]</td>
<td>Canada</td>
<td>2010</td>
<td>196</td>
<td>196 personnel who screened positive for a mental health disorder on anonymous survey</td>
<td>Depression</td>
<td>Anxiety</td>
<td>PTSD</td>
<td>7.0</td>
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<tr>
<td>[37]</td>
<td>USA</td>
<td>2003</td>
<td>4,377</td>
<td>4,377 soldiers from combat brigades who screened positive for a mental health disorder on anonymous survey</td>
<td>Depression</td>
<td>Anxiety</td>
<td>PTSD</td>
<td>2.0</td>
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<tr>
<td>[41]</td>
<td>Canada</td>
<td>2010</td>
<td>105</td>
<td>105 personnel who screened positive for a mental health disorder on anonymous survey</td>
<td>Depression</td>
<td>Anxiety</td>
<td>PTSD</td>
<td>2.5</td>
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<tr>
<td>[40]</td>
<td>USA</td>
<td>2013</td>
<td>3,494</td>
<td>3,494 infantrymen who self-reported a mental health disorder on anonymous survey</td>
<td>Depression</td>
<td>Anxiety</td>
<td>PTSD</td>
<td>2.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[39]</td>
<td>UK</td>
<td>2007</td>
<td>1,000</td>
<td>1,000 personnel who screened positive for a mental health disorder on anonymous survey</td>
<td>Depression</td>
<td>Anxiety</td>
<td>PTSD</td>
<td>2.2</td>
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<tr>
<td>[38]</td>
<td>USA</td>
<td>2003</td>
<td>150</td>
<td>150 National Guard personnel who screened positive for a mental health disorder on anonymous survey</td>
<td>Depression</td>
<td>Anxiety</td>
<td>PTSD</td>
<td>2.0</td>
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</table>

Note: The percentages in brackets indicate the prevalence of mental health disorders in the military population.
<table>
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<th>Year</th>
<th>Sample Size</th>
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<th>Mental Health Disorder Screened Positive for</th>
<th>Self-reported Receiving Professional Mental Health Services in the Past 12 Months</th>
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<td>2003-2007</td>
<td>2,334</td>
<td>3 months after returning from a combat deployment</td>
<td>14.1</td>
<td>26.8</td>
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<tr>
<td>2004</td>
<td>77</td>
<td>3 months after returning from a combat deployment</td>
<td>5.0</td>
<td>18.0</td>
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<tr>
<td>2003-2009</td>
<td>1,048</td>
<td>6 months after returning from deployment</td>
<td>21.5</td>
<td>21.5</td>
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<td>2003-2011</td>
<td>731</td>
<td>3 months after returning from a combat deployment</td>
<td>7.1</td>
<td>23.6</td>
</tr>
</tbody>
</table>

Authors reported annual mental health service use for every year in study period, from 2003 to 2011; we present the median and range of annual results.
References


177:47–59


**Chapter 5: Systematic review of service use in depressed military personnel**

https://doi.org/10.1001/jama.2013.65164

https://doi.org/10.1176/appi.ajp.161.9.1626

https://doi.org/10.1056/NEJMoa040603

https://doi.org/10.1177/0706743718787792


https://doi.org/10.1258/jrsm.2010.090426

https://doi.org/10.3163/1536-5050.104.3.014


Chapter 5: Systematic review of service use in depressed military personnel

https://doi.org/10.1177/0091217416652616


https://doi.org/10.1002/jts.20480


https://doi.org/10.1080/08854726.2016.1171598

https://doi.org/10.1177/070674370505001308


https://doi.org/10.1097/01.MLR.000093487.78664.3C

https://doi.org/10.1176/appi.ps.201300282
Appendix 5A: Screenshot of submission confirmation letter from the journal *Military Medicine*

Dear [Name],

Your submission entitled "Mental health service use in depressed military personnel: a systematic review" has been assigned the following manuscript number: MIUMED-0-19-00468.

You will be able to check on the progress of your paper by logging on to Editorial Manager as an author.

The URL is [BLOCKED]..

Thank you for submitting your work to this journal.

Regards,
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**Appendix 5B: PRISMA Checklist**

Chapter 5: Systematic review of service use in depressed military personnel
### Chapter 5: Systematic review of service use in depressed military personnel

#### 14. Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$) for each meta-analysis.

#### 24. Summary of evidence

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<td>Describe results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression)</td>
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| 25 | N/A | Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., between-study heterogeneity).
| 70 | N/A | Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., between-study heterogeneity).

#### Additional analyses

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<td>Present data on risk of bias of each study and, if available, any outcome level assessment (see Item 12).</td>
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#### Conclusions

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#### Additional analyses

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Appendix 5C: MEDLINE search strategy, 19 January 2017

1  Military Personnel/ (37644)
2  military.ti,ab. (40160)
3  militaries.ti,ab. (94)
4  active duty.ti,ab. (2614)
5  navy.ti,ab. (4080)
6  navies.ti,ab. (32)
7  army.ti,ab. (13993)
8  armies.ti,ab. (341)
9  armed force?.ti,ab. (4356)
10  air force?.ti,ab. (3670)
11  coast guard.ti,ab. (194)
12  soldier?.ti,ab. (9388)
13  airm*n.ti,ab. (309)
14  marines.ti,ab. (474)
15  sailor?.ti,ab. (949)
16  Department of Defen*e.ti,ab. (1940)
17  Ministry of Defen*e.ti,ab. (330)
18  service member?.ti,ab. (2037)
19  servicemember?.ti,ab. (201)
20  submariner?.ti,ab. (174)
21  troops.ti,ab. (2122)
22  paratrooper?.ti,ab. (61)
23  special force?.ti,ab. (204)
24  1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 (81051)
25  Depression/ (106907)
26  exp Depressive Disorder/ (105848)
27  MDD.ti,ab. (10512)
28  dysthymi*.ti,ab. (3187)
29  depress*.ti,ab. (414003)
30  25 or 26 or 27 or 28 or 29 (457764)
31  24 and 30 (2293)
Appendix 5D: EMBASE search strategy, 19 January 2017

1 soldier/ (28800)
2 army/ (22304)
3 sailor/ (1406)
4 navy/ (2022)
5 military.ti,ab. (42581)
6 militaries.ti,ab. (108)
7 active duty.ti,ab. (2738)
8 navy.ti,ab. (3717)
9 navies.ti,ab. (37)
10 army.ti,ab. (12357)
11 armies.ti,ab. (286)
12 armed force?.ti,ab. (4497)
13 air force?.ti,ab. (3462)
14 coast guard.ti,ab. (232)
15 soldier?.ti,ab. (9248)
16 airm*n.ti,ab. (353)
17 marines.ti,ab. (471)
18 sailor?.ti,ab. (985)
19 Department of Defen*e.ti,ab. (2050)
20 Ministry of Defen*e.ti,ab. (340)
21 service member?.ti,ab. (2040)
22 servicemember?.ti,ab. (211)
23 submariner?.ti,ab. (177)
24 troops.ti,ab. (2030)
25 paratrooper?.ti,ab. (59)
26 special force?.ti,ab. (207)
27 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 (81731)
28 exp depression/ (390806)
29 exp depression assessment/ (50766)
30 MDD.ti,ab. (13280)
31 dysthymi*.ti,ab. (3756)
32 depress*.ti,ab. (494053)
33 28 or 29 or 30 or 31 or 32 (637788)
34 27 and 33 (3472)
Appendix 5E: PsycINFO search strategy, 19 January 2017

1. exp Military Personnel/ (14605)
2. military.ti,ab. (20318)
3. militaries.ti,ab. (69)
4. active duty.ti,ab. (1548)
5. navy.ti,ab. (2165)
6. navies.ti,ab. (4)
7. army.ti,ab. (7046)
8. armies.ti,ab. (195)
9. armed force?.ti,ab. (1348)
10. air force?.ti,ab. (2343)
11. coast guard.ti,ab. (145)
12. soldier?.ti,ab. (5874)
13. airm*n.ti,ab. (305)
14. marines.ti,ab. (312)
15. sailor?.ti,ab. (367)
16. Department of Defen*e.ti,ab. (895)
17. Ministry of Defen*e.ti,ab. (46)
18. service member?.ti,ab. (1591)
19. servicemember?.ti,ab. (75)
20. submariner?.ti,ab. (46)
21. troops.ti,ab. (945)
22. paratrooper?.ti,ab. (35)
23. special force?.ti,ab. (94)
24. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 (35099)
25. exp Major Depression/ (110267)
26. Atypical Depression/ (186)
27. "Depression (Emotion)"/ (23266)
28. "Long-term depression (neuronal)"/ (793)
29. Beck Depression Inventory/ (662)
30. MDD.ti,ab. (7513)
31. dysthymi*.ti,ab. (3514)
32. depress*.ti,ab. (250762)
33. 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 (257416)
34. 24 and 33 (2118)
CHAPTER 6

Incidence of major depression diagnoses in the Canadian Armed Forces: Longitudinal analysis of clinical and health administrative data

Preface

In Chapter 4, I reported that 75% of Canadian Armed Forces (CAF) personnel with past-year major depression reported using mental health services in the past year. In theory, these depressed patients should have generated depression-related data in their CAF electronic medical records. Because 8% of all CAF personnel suffer from major depression in a given year, and 75% of them use mental health services, 6% of all CAF personnel are therefore expected to have depression-related data in their electronic medical records in a given year.

The objectives of the study presented in this chapter were two-fold. The first objective was to develop a valid case-finding algorithm to identify diagnosed cases of major depression in CAF personnel, using data extracted from their electronic medical records. The past-year prevalence estimate of treated major depression obtained using this algorithm was compared to the expected 6% prevalence; strong database agreement would suggest high algorithm quality. The second objective was to use the newly-developed algorithm to measure the rate at which new major depressive episodes are diagnosed in CAF personnel. This estimate – henceforth referred to as the incident rate of major depression diagnoses – represents the rate at which new episodes of major depression are made known to the CAF health care system, regardless of the date of symptom onset or the number of major depressive episodes from which the patient had previously recovered.

The study was published in the journal *Social Psychiatry and Psychiatric Epidemiology* in
September 2019, and is cited as Thériault FL, Hawes RA, Garber BG, Momoli F, Garder W, Zamorski MA, Colman I (2019) Incidence of major depression diagnoses in the Canadian Armed Forces: longitudinal analysis of clinical and health administrative data. *Soc Psychiatry Psychiatr Epidemiol*. https://doi.org/10.1007/s00127-019-01776-w. The journal acceptance letter is included in Appendix 6A, and proof of ethical approval is included in Appendix 6B and 6C. Tables and figures were re-numbered to avoid confusion with other thesis chapters (i.e., the table labeled “Table 1” in the *Social Psychiatry and Psychiatric Epidemiology* article is labeled “Table 6-1” here, to clearly distinguish it from tables in other chapters).

**Contribution Statement**

I was responsible for generating the study objectives and design, with guidance from my supervisor and co-authors. I conducted all statistical analyses presented herein. I drafted preliminary and final versions of the manuscript. I also responded to all comments arising from the peer-review process.
ABSTRACT

Purpose

Major depression is a leading cause of morbidity in military populations. However, due to a lack of longitudinal data, little is known about the rate at which military personnel experience the onset of new episodes of major depression. We used a new source of clinical and administrative data to estimate the incidence of major depression diagnoses in Canadian Armed Forces (CAF) personnel, and to compare incidence rates between demographic and occupational factors.

Methods

We extracted all data recorded in the electronic medical records of CAF Regular Force personnel, at every primary care and mental health clinical encounter since 2016. Using a 12-month lookback period, we linked data over time, and identified all patients with incident diagnoses of major depression. We then linked clinical data to CAF administrative records, and estimated incidence rates. We used multivariate Poisson regression to compare adjusted incidence rates between demographic and occupational factors.

Results

From January to December 2017, CAF Regular Force personnel were diagnosed with major depression at a rate of 29.2 new cases per 1,000 person-years at risk. Female sex, older age, and non-officer ranks were associated with significantly higher incidence rates.

Conclusions

We completed the largest study to date on diagnoses of major depression in the Canadian military, and have provided the first estimates of incidence rates in CAF personnel. Our results can inform
future mental health resource allocation, and ongoing major depression prevention efforts within the Canadian Armed Forces and other military organizations.
Chapter 6: Incidence of major depression diagnoses

INTRODUCTION

Major depression is a recurring disorder that disproportionately affects military personnel. In Australia, Canada, the United Kingdom, and the United States, the prevalence of major depression in military personnel is at least twice that in comparable civilian populations [1–4]. Depressed soldiers are at increased risk of suicidal behaviors [5] poor job performance and absenteeism [6], and early separation from the military [7]. Because of its high prevalence and deleterious impact, major depression is a public health concern for military organizations. Epidemiological data are therefore needed to inform depression prevention strategies, and optimize the allocation of military mental health resources.

Until now, cross-sectional surveys have been the main source of epidemiological data on major depression in military personnel. These surveys have provided valuable information on the prevalence of major depression across different military organizations [1, 3, 8]. They have also shed new light on the occupational factors associated with major depression in military personnel [9] and on stigma perceptions [10] and care-seeking behaviors [11] related to this condition. However, cross-sectional surveys cannot provide information on the rate of major depression incidence.

Incidence rates are an important mental health indicator [12], particularly in open occupational cohorts such as an active military force. Military organizations must ensure that sufficient clinical resources are available to meet the mental health needs of their personnel. But mental health needs at the population level may change over time. New personnel are enlisted, currently serving personnel are exposed to occupational stressors, and other personnel release from military service. These factors can alter the population-level risks of mental disorder onset. Incidence rate estimates are needed to better forecast the future mental healthcare needs of military populations. However,
due to a historical lack of longitudinal data, the incidence rate of major depression remains unknown for the military organizations of multiple nations.

Fortunately, recent developments in the Canadian Armed Forces (CAF) electronic medical record system have created new opportunities to fill this information gap. Since January 2016, all mental health assessments and treatments provided at CAF clinics have been documented using standardized electronic notes by the attending clinician. That clinician can be a psychiatrist, psychologist, social worker, counselor, nurse, or primary care physician. To estimate the rate of depression in the CAF, we had to develop and validate a customized algorithm to identify incident major depression diagnoses using the standardized electronic notes.

The primary objective of our study was to estimate the rate of major depression diagnoses in CAF personnel using data extracted from these electronic notes. However, current guidelines recommend assessing the quality of such data, when they are used for epidemiological research [13]. As a secondary objective, we therefore assessed the quality of our data by comparing our results to those of a recent cross-sectional study of self-reported mental health service utilization in a large representative sample CAF personnel with major depression [11]. This cross-sectional survey and our current study both measured similar outcomes in the same population; close agreement between their results would therefore support the validity of data used in the current study.
Chapter 6: Incidence of major depression diagnoses

METHODS

Study population

This study included all individuals who served in the CAF Regular Force between January and December 2017. Regular Force personnel are full-time soldiers who receive complete health coverage from the Canadian Forces Health Services. We excluded all CAF Reservists (who are mostly part-time soldiers) because they largely receive primary and specialty mental health care from the civilian sector. CAF electronic medical records would therefore have been at high risk of underestimating the mental health care utilization of Reservists.

CAF mental health care

The Canadian Forces Health Services provide a comprehensive system of outpatient mental health care. Depressed patients may be assessed and treated in CAF primary care or specialty mental health clinics. They may also be referred to a civilian specialist in the surrounding community, if timely specialty care is not available at their local CAF clinic (Figure 6-1).

Clinical data

Whenever patients visit a CAF primary care or specialty mental health clinic, their care provider must complete an electronic note. CAF physicians, psychologists, and psychiatrists must record at least one diagnosis to complete their assessment and treatment notes (Figure 6-1). Diagnoses are recorded using International Classification of Diseases (ICD-10) or Diagnostic and Statistical Manual of Mental Disorders (DSM-5) codes. CAF providers who do not have the professional authority to assign formal diagnoses (e.g., triage nurses, social workers, etc.) must record at least one symptom to complete their notes (Figure 6-1). These symptoms are selected from a drop-down list of standardized clinical impressions.
External specialists do not have access to CAF electronic medical records. But to be reimbursed for services provided to externally-referred patients, external specialists must send a paper copy of their clinical notes to the local CAF clinic. These notes are then scanned into the CAF electronic medical records of externally-referred patients. A CAF healthcare provider – usually a nurse or social worker by training – periodically reviews the clinical progress of externally-referred patients by completing an electronic note. External Provider Review notes are part of the CAF electronic medical record, and must contain at least one symptom code (Figure 6-1).

**Case definition**

We sought to identify all personnel with an incident diagnosis of major depression, from January to December 2017. To do so, we extracted all diagnostic and symptom codes entered in CAF electronic medical records between January 2016 and June 2018.

We considered that personnel with at least one diagnostic code for major depressive episode (F32.x) or major depressive disorder (F33.x) in their electronic medical records were patients with major depression, irrespective of co-morbid psychiatric conditions. For all patients with major depression, we identified all clinical encounters related to major depression care as either: (1) clinical visits during which a diagnostic code for major depression was recorded, or (2) clinical visits that occurred within six months of a major depression diagnosis, and during which a code for “depressive symptoms” was recorded. Consistent with other studies [14–16], incident diagnoses were defined as the first clinical encounter for major depression in a 12-month period. With data available from January 2016 to June 2018, and with the case definition presented above, we were able to report on incident diagnoses from January to December 2017.
Patients with major depression who are exclusively assessed and treated by external specialists may never generate a depression code in CAF electronic medical records (Figure 1). We therefore reviewed the scanned clinical notes of all externally-referred patients with a “depressive symptom” code recorded on an External Provider Review note between January 2016 and June 2018 (n = 444); we thus identified an additional 116 patients who had been diagnosed with major depression over this time period. For these 116 patients, the incidence date was defined as the first encounter with the external specialist.

Demographic data

CAF administrative databases were used to determine the sex, age, rank, military unit, military trade, and duration of enlistment, for all CAF Regular Force personnel, from January to December 2017. Age was categorized into four groups: (a) 18-29 years, (b) 30-39 years, (c) 40-49 years, and (d) 50-60 years. Ranks were dichotomized as Non-Commissioned Members (NCM) and Officers.

Occupational data

Military units were linked to one of six commands: (a) the Canadian Army, (b) the Royal Canadian Air Force, (c) the Royal Canadian Navy, (d) Military Personnel Command, (e) Joint and Special Forces, and (f) other central agencies. Military Personnel Command includes Joint Personnel Support Units (JPSU) that are administrative cells where ill or injured personnel from any command may be posted, if a medical condition precludes them from performing regular duties for a period of at least six months. JPSU personnel are expected to have much higher morbidity than other members of Military Personnel Command; we therefore reported on their incidence rates separately.
Military trades were linked to one of ten occupational groups, as outlined on the CAF recruitment website (www.forces.ca): (a) technicians, (b) combat specialists, (c) administration and support, (d) engineers, (e) telecommunications, (f) air and ship crew, (g) health care, (h) sensor and radar, (i) public protection, including military police and firefighters, and (g) other.

**Statistical analyses**

For the estimation of incidence rates, we excluded all Regular Force personnel with any clinical encounter for major depression from January to December 2016. We then computed population-level counts of person-years at risk of an incident major depression diagnosis in remaining Regular Force personnel, from January to December 2017. We calculated the incidence of new major depression diagnoses per person-years at risk. We treated demographic categories (i.e. age group, rank category, command, and occupational group) as time-varying covariates, and used multivariate Poisson regression models to compare incidence rates across patient characteristics, adjusting for sex, age, and rank. We entered the log of person-years at risk as an offset in all multivariate Poisson analyses.

All analyses were performed using Stata, version 14.0 [17].

**Secondary analysis: Assessment of data source agreement**

As recommended in current guidelines [13], we also sought to assess the validity of our case definition. Data source agreement is an accepted method for assessing the quality of case definitions in health administrative data research [18], and a large cross-sectional survey recently estimated that 6.0% of Regular Force personnel with major depression used mental health services in the previous year [11]. In an effort to assess the quality of data used in the current study, we identified all individuals who were serving in the Regular Force on the last day of our study period.
(i.e. December 31st 2017), and used our case definition to determine whether they had any clinical encounters for major depression at any point from January to December 2017. We qualitatively compared the sex and age distribution of patients with past-year clinical encounters for major depression to the results of the aforementioned survey [11].

*Ethical considerations*

The study was approved by the CAF Director of Force Health Protection, the CAF Director of Mental Health, and the University of Ottawa Office of Research Ethics and Integrity.
Chapter 6: Incidence of major depression diagnoses

RESULTS

A total of 72,054 individuals served in the CAF Regular Force at some point in 2017. We excluded 3,638 (5.1%) of these individuals from our study because they had at least one diagnosis of major depression recorded in the 12 months preceding the study start date. The remaining 68,416 individuals contributed 61,997 service-years at risk of an incident major depression diagnosis during the study period; most of this person-time was contributed by males (86.0%) under the age of 40 years (69.5%) (Table 6-1).

During the study period, 1,812 incident diagnoses of major depression were observed. Regular Force personnel were diagnosed at a rate of 29.2 new cases per 1,000 person-years at risk (95% CI: 27.9, 30.6). Female sex, age greater than 29 years, and non-officer ranks were associated with higher incidence rates. After adjusting for demographic differences, technicians, and air and ship crewmembers, had significantly lower incidence rates than combat specialists. Adjusted rates were also lower in the Air Force than in the Army. Individuals posted to Joint Personnel Support Units, who were already ill or injured, were nearly three times more likely to have an incident diagnosis of major depression, compared to Army personnel of the same sex, age, and rank (Table 6-2).

For our secondary analysis, we identified all 66,605 individuals who were serving in the Regular Force on the last day of the 12-month study period. Using the case definition developed for our study, we estimated that 5.6% (95% CI: 5.4%, 5.8%) of these individuals had a clinical encounter for major depression diagnosis at some point in the previous 12 months. Among these patients, 24.5% (95% CI: 23.1, 25.9) were female, and 18.5% (95% CI: 17.3%, 19.8%) were under the age of 30 years (Table 6-3). These results can be compared to those of a recent cross-sectional survey (see discussion below).
DISCUSSION

This paper presents the most comprehensive examination to date of major depression incidence in serving CAF Regular Force personnel. We found that major depression amongst CAF personnel was diagnosed at a rate of 29.2 new cases per 1,000 person-years of service, and that this rate varied considerably across demographic and organizational characteristics.

The overall incidence rate reported in this study is somewhat higher than that observed in the U.S. Armed Forces, where 24.2 new cases of depressive disorders are diagnosed per 1,000 person-years [19]. Several factors may account for this difference. First, CAF personnel suffering from major depression may be more likely to seek care than their American counterparts, and may therefore be more likely to receive a formal diagnosis; previous studies have found that 75% of depressed Canadian soldiers access mental health care in a 12-month period [11], compared to less than 50% in the U.S. military [20–22]. This apparent difference in care-seeking propensity may be partly explained by the substantial difference in age composition between the two militaries; on average, CAF personnel are older than their American counterparts [23, 24], and older age is associated with higher mental health service use in depressed patients [25]. Second, our case-finding algorithm was likely more inclusive than that used for the U.S. military study. In fact, U.S. Armed Forces researchers only considered major depression diagnoses if they were recorded in the first or second diagnostic position during medical encounters [19]. In contrast, we used any major depression diagnosis to identify incident cases in our study, even if these diagnoses were recorded along with several co-morbid conditions.

We found that female sex, older age, and non-officer ranks were associated with higher incidence of major depression diagnoses. These findings largely mirror those of previous studies. Indeed, a large body of research has already shown that, compared to males, females are more likely to suffer
from major depression [26], and are more likely to seek care when experiencing depressive symptoms [25]. It is therefore not surprising to find that females were more likely to be diagnosed with major depression, compared to their male counterparts. Similarly, non-officer rank [27] and older age [25] have also been associated with greater likelihood of seeking mental healthcare, when needed.

Until now, researchers have depended on data from either population surveys (e.g., [28]) or manual reviews of medical charts (e.g., [29]) to investigate mental health care utilization in CAF personnel, and have lacked the statistical power required to compare occupational groups with the level of granularity reported in our study. With our large sample size, we found that combat specialists had a greater incidence of major depression than technicians, and air and ship crewmembers. However, incidence rates in combat specialists were not significantly different than in numerous other non-combat trades. This finding has important implications. Although combat experiences are associated with a substantial increase in depression risk [30], they only account for a small proportion of the major depression burden observed in Canada’s military [31]. Similarly, most American soldiers who attempt suicide have never deployed [5]. Since the early 2000s, the CAF have improved access to mental health care, implemented mental health training programs across the organization, and provided post-deployment mental health screening to all personnel returning from an overseas deployment, irrespective of their specific occupations [32]. Our findings support this holistic strategy, in the context of major depression prevention.

After excluding Joint Personnel Support Units (JPSU, i.e. service centers where seriously ill or injured personnel are posted if a medical condition precludes them from performing regular military duties for a period of at least six months) from Military Personnel Command, we found no large difference in the incidence rate of major depression diagnoses between the six CAF
commands. Of note, JPSU personnel were nearly three times more likely to be diagnosed with major depression compared to any other personnel, even after using a 12-month lookback period to exclude prevalent cases. This elevated incidence rate is therefore not a consequence of personnel with prevalent major depression diagnoses being transferred to a JPSU. Rather, our finding suggests that individuals are at particularly high risk of being newly diagnosed with major depression after being transferred to a JPSU. This could be explained by several factors. First, individuals who are posted to a JPSU without a prevalent major depression diagnosis must have another physical or mental health condition. These pre-existing conditions could be strong risk factors for major depression onset [33]. Second, individuals who are separating from the military on medical grounds are often posted to a JPSU, and may be more willing to disclose their depressive symptoms. Fear of negative career repercussions is commonly reported as a barrier to mental health care among military personnel [34], but that barrier is unlikely to impact individuals already in the process of releasing from military service. Third, the process of transitioning out of an operational unit and into a JPSU may represent a stressful life event for some individuals which may therefore increase their risk of major depression onset [35]. In any case, our findings suggest that military personnel posted to administrative units such as JPSUs may benefit from counselling and other enhanced mental health prevention efforts.

When used to assess past-year prevalence of clinical encounters related to major depression, our case definition produced results that were highly consistent with previous research on CAF personnel. Indeed, a large population-based survey conducted in 2013 found that 6.0% of all CAF Regular Force personnel had sought care for major depression in the previous 12 months [11]; this estimate is remarkably close to the 5.6% past-year prevalence of diagnosed major depression reported herein. The estimated age and sex distribution of diagnosed patients was also similar.
between studies. Such a high level of data source agreement supports the quality of our data, and the validity of the case definitions used in our study.

Our study had noteworthy limitations. First, not all depressed individuals seek care. In fact, a recent study found that only 75% of CAF Regular Force personnel who met diagnostic criteria for major depression at any point in the previous year had sought professional mental health care over the same time period [11]. While this treatment gap is much smaller than in other populations [36, 37], 25% of depressed personnel remain undiagnosed. Clinical data can only be used to identify major depression in care-seeking individuals. Our study therefore misclassified a substantial number of depressed patients, and underestimated the true incidence of major depression in the CAF Regular Force. While our results cannot be used to measure major depression morbidity in the Canadian military, they nonetheless reflect current mental health service utilization rates for this condition.

Second, we relied on diagnostic codes extracted from electronic medical records to identify depressed patients. Previous authors have argued that diagnostic codes can be inaccurate; psychiatrists may incorrectly code their patients’ diagnoses, and may also code only one of several co-morbid conditions [38]. Depressed patients may therefore not generate a diagnostic code for major depression every time they encounter a health professional. We mitigated this risk of misclassification bias by creating a case-finding algorithm, and linking data elements over time. Although we did not validate our case-finding algorithm against a gold-standard measure of major depression, our estimates of past-year treatment prevalence were highly consistent with those obtained from a 2013 population-based survey [11], as discussed above. As already noted, data source agreement is an accepted method for assessing the quality of case-finding algorithms using routinely collected data sources [18].
Despite the limitations listed above, we completed the largest study to date on major depression diagnoses in the Canadian military, and provided the first estimates of incident rates in CAF personnel. Our results have highlighted that the rates of major depression diagnoses vary substantially across sex, age, and rank categories, but are very similar between combat and non-combat trades. Our findings make an important contribution to military population health surveillance, and may be used by military organizations to better prepare for their future mental healthcare needs. For example, our estimated incidence rates could be used in predictive models to forecast the expected number of new major depression cases in a military population, given the age, sex, and occupational profile of its personnel. Furthermore, our study clearly demonstrated the feasibility of using electronic medical records as a powerful tool to study the incidence of mental disorder diagnoses in military populations.
Figure 6-1: Data elements generated in the electronic medical records of patients as they flow through the CAF system of outpatient mental health care.
Table 6-1: Person-years at risk of an incident major depression diagnosis, CAF Regular Force personnel, January to December 2017.

<table>
<thead>
<tr>
<th></th>
<th>Person-years</th>
<th>(%)</th>
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<tr>
<td>Female</td>
<td>8,698</td>
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</tr>
<tr>
<td>Male</td>
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<td><strong>Age (years)</strong></td>
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<td>30-39</td>
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<td>40-49</td>
<td>12,877</td>
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<tr>
<td>50-60</td>
<td>6,012</td>
<td>(9.7 )</td>
</tr>
<tr>
<td><strong>Rank</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Commissioned Members</td>
<td>46,337</td>
<td>(74.7)</td>
</tr>
<tr>
<td>Officers</td>
<td>15,660</td>
<td>(25.3)</td>
</tr>
<tr>
<td><strong>Command</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canadian Army</td>
<td>21,952</td>
<td>(35.4)</td>
</tr>
<tr>
<td>Royal Canadian Air Force</td>
<td>12,779</td>
<td>(20.6)</td>
</tr>
<tr>
<td>Military Personnel Command</td>
<td>8,288</td>
<td>(13.4)</td>
</tr>
<tr>
<td>Royal Canadian Navy</td>
<td>8,036</td>
<td>(13.0)</td>
</tr>
<tr>
<td>Joint &amp; Special Forces</td>
<td>3,270</td>
<td>(5.3 )</td>
</tr>
<tr>
<td>Joint Personnel Support Units</td>
<td>907</td>
<td>(1.5 )</td>
</tr>
<tr>
<td>Other a</td>
<td>6,766</td>
<td>(10.9)</td>
</tr>
<tr>
<td><strong>Military Trade</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technicians</td>
<td>13,907</td>
<td>(22.4)</td>
</tr>
<tr>
<td>Combat Specialists</td>
<td>11,835</td>
<td>(19.1)</td>
</tr>
<tr>
<td>Administration &amp; Support</td>
<td>10,731</td>
<td>(17.3)</td>
</tr>
<tr>
<td>Engineers</td>
<td>6,146</td>
<td>(9.9 )</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>4,742</td>
<td>(7.6 )</td>
</tr>
<tr>
<td>Air &amp; Ship Crew</td>
<td>4,711</td>
<td>(7.6 )</td>
</tr>
<tr>
<td>Health Care</td>
<td>2,812</td>
<td>(4.5 )</td>
</tr>
<tr>
<td>Sensor &amp; Radar</td>
<td>2,463</td>
<td>(4.0 )</td>
</tr>
<tr>
<td>Public Protection</td>
<td>1,876</td>
<td>(3.0 )</td>
</tr>
<tr>
<td>Other</td>
<td>2,774</td>
<td>(4.5 )</td>
</tr>
</tbody>
</table>

*a Includes personnel posted to central agencies, including the offices of the Minister and Associate Minister of National Defence, and of the Chief and Vice-Chief of the Defence Staff.*
Table 6-2: Incidence of new major depression diagnoses in CAF Regular Force personnel, January to December 2017.

<table>
<thead>
<tr>
<th>Rate per 1,000 p-y (95% CI)</th>
<th>aIRR$^b$ (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>44.2 (39.7, 48.6)</td>
<td>ref</td>
</tr>
<tr>
<td>Males</td>
<td>26.8 (25.4, 28.2)</td>
<td>0.61 (0.54, 0.68)</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>20.7 (18.8, 22.6)</td>
<td>ref</td>
</tr>
<tr>
<td>30-39</td>
<td>31.5 (29.1, 33.9)</td>
<td>1.51 (1.34, 1.70)</td>
</tr>
<tr>
<td>40-49</td>
<td>39.2 (35.8, 42.6)</td>
<td>1.92 (1.69, 2.18)</td>
</tr>
<tr>
<td>50-60</td>
<td>30.4 (26.0, 34.8)</td>
<td>1.56 (1.32, 1.86)</td>
</tr>
<tr>
<td>Rank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Commissioned Members</td>
<td>32.5 (30.8, 34.1)</td>
<td>ref</td>
</tr>
<tr>
<td>Officers</td>
<td>19.6 (17.4, 21.8)</td>
<td>0.57 (0.50, 0.64)</td>
</tr>
<tr>
<td>Command</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canadian Army</td>
<td>27.5 (25.3, 29.7)</td>
<td>ref</td>
</tr>
<tr>
<td>Royal Canadian Air Force</td>
<td>24.4 (21.7, 27.1)</td>
<td>0.85 (0.74, 0.98)</td>
</tr>
<tr>
<td>Military Personnel Command</td>
<td>30.8 (27.0, 34.5)</td>
<td>1.14 (0.98, 1.33)</td>
</tr>
<tr>
<td>Royal Canadian Navy</td>
<td>28.7 (25.0, 32.5)</td>
<td>0.99 (0.85, 1.15)</td>
</tr>
<tr>
<td>Joint &amp; Special Forces</td>
<td>31.5 (25.4, 37.6)</td>
<td>1.07 (0.87, 1.32)</td>
</tr>
<tr>
<td>Joint Personnel Support Units</td>
<td>97.0 (76.7, 117.3)</td>
<td>2.90 (2.31, 3.64)</td>
</tr>
<tr>
<td>Other $^a$</td>
<td>32.4 (28.1, 36.7)</td>
<td>1.12 (0.96, 1.32)</td>
</tr>
<tr>
<td>Military Trade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combat Specialists</td>
<td>27.4 (24.4, 30.4)</td>
<td>ref</td>
</tr>
<tr>
<td>Technicians</td>
<td>26.1 (23.4, 28.8)</td>
<td>0.80 (0.69, 0.93)</td>
</tr>
<tr>
<td>Administration &amp; Support</td>
<td>41.1 (37.3, 44.9)</td>
<td>1.12 (0.96, 1.31)</td>
</tr>
<tr>
<td>Engineers</td>
<td>22.1 (18.4, 25.8)</td>
<td>0.89 (0.73, 1.10)</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>33.7 (28.5, 39.0)</td>
<td>1.06 (0.88, 1.28)</td>
</tr>
<tr>
<td>Air &amp; Ship Crew</td>
<td>14.9 (11.4, 18.3)</td>
<td>0.66 (0.51, 0.87)</td>
</tr>
<tr>
<td>Health Care</td>
<td>35.2 (28.3, 42.1)</td>
<td>1.06 (0.84, 1.35)</td>
</tr>
<tr>
<td>Sensor &amp; Radar</td>
<td>30.4 (23.6, 37.3)</td>
<td>0.97 (0.76, 1.25)</td>
</tr>
<tr>
<td>Public Protection</td>
<td>33.0 (24.8, 41.3)</td>
<td>1.00 (0.76, 1.31)</td>
</tr>
<tr>
<td>Other</td>
<td>29.6 (23.2, 36.0)</td>
<td>0.95 (0.74, 1.21)</td>
</tr>
</tbody>
</table>

$^a$ Includes personnel posted to central agencies, including the offices of the Minister and Associate Minister of National Defence, and of the Chief and Vice-Chief of the Defence Staff.

$^b$ Incidence rate ratio, adjusted for sex, age group, and rank category.
Table 6-3: Characteristics of CAF Regular Force personnel with incident or prevalent major depression diagnoses in the previous 12 months, as of December 2017.

<table>
<thead>
<tr>
<th></th>
<th>Percent (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>24.5 (23.1, 25.9)</td>
</tr>
<tr>
<td>Male</td>
<td>75.5 (74.1, 76.9)</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>18.5 (17.3, 19.8)</td>
</tr>
<tr>
<td>30-39</td>
<td>38.6 (37.0, 40.2)</td>
</tr>
<tr>
<td>40-49</td>
<td>31.1 (29.7, 32.6)</td>
</tr>
<tr>
<td>50-60</td>
<td>11.8 (10.8, 12.9)</td>
</tr>
</tbody>
</table>
References


Chapter 6: Incidence of major depression diagnoses


Chapter 6: Incidence of major depression diagnoses

https://doi.org/10.1056/NEJMoa040603


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Chapter 6: Incidence of major depression diagnoses


Appendix 6A: Screenshot of manuscript acceptance letter from the journal *Social Psychiatry and Psychiatric Epidemiology*

![Letter Image]
Chapter 6: Incidence of major depression diagnoses

Appendix 6B: Ethics approval from the University of Ottawa’s Research Ethics Board

Ethics Approval Notice
Health Sciences and Science REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name</th>
<th>Affiliation</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ian</td>
<td>Colman</td>
<td>Medicine / Medicine</td>
<td>Supervisor</td>
</tr>
<tr>
<td>François</td>
<td>Thériault</td>
<td>Medicine / Medicine</td>
<td>Student Researcher</td>
</tr>
<tr>
<td>Robert</td>
<td>Hawes</td>
<td>Others / Others</td>
<td>Other Collaborator</td>
</tr>
</tbody>
</table>

File Number: H04-17-04B

Type of Project: PhD Thesis

Title: Major depressive disorders in the Canadian Armed Forces: A longitudinal study of risk factors, care seeking, and treatment outcomes

Approval Date (mm/dd/yyyy): 11/30/2017
Expiry Date (mm/dd/yyyy): 11/29/2018

Approval Type: Approval

Special Conditions / Comments:
N/A

550, rue Cumberland, pièce 154      550 Cumberland Street, room 154
Ottawa (Ontario) K1N 6N5 Canada    Ottawa, Ontario K1N 6N5 Canada
(613) 562-5387 • Téléc./Fax (613) 562-5338
www.recherche.uottawa.ca/deontologie/ www.research.uottawa.ca/ethics/
Chapter 6: Incidence of major depression diagnoses

Appendix 6C: Screenshot of online portal for the Surgeon General’s Health Research Program, showing this project was approved on November 14th, 2017
CHAPTER 7

Spinal pain and major depression in the Canadian Armed Forces: Longitudinal analysis of electronic medical record data

Preface

In Chapter 6, I used data extracted from CAF electronic medical records and reported that CAF personnel are diagnosed with major depression at a rate of 29.2 new cases per 1,000 person-years. But, as shown in Chapter 4, not all CAF personnel suffering from major depression are diagnosed by health professionals. And as discussed in Chapter 2, electronic medical records have several other limitations precluding their use for inference on disease aetiology. Therefore, the rate of major depression diagnoses reported in Chapter 6 does not reflect the rate of major depression onset in CAF personnel with perfect accuracy.

The objective of the study presented in this chapter was to measure the association between major depression and spinal pain in CAF personnel. To achieve this objective, I used data extracted from CAF electronic medical records to identify new cases of major depression and spinal pain. Because of the inherent limitations of electronic medical record data, I used probabilistic bias analysis methods to adjust findings for the differential misclassification of clinical outcomes. Proof of ethical approval is included in Appendices 7A and 7B.

Contribution Statement

I was responsible for generating the study objectives and design, with guidance from my supervisor and co-authors. I conducted all statistical analyses presented herein. I drafted preliminary and final versions of the manuscript.
ABSTRACT

Spinal pain and major depression are public health concerns in military populations. Using data extracted from electronic medical records, we assessed the association between incident diagnoses of spinal pain and major depression in a cohort of 48,007 Canadian Armed Forces personnel followed over 20 months. Subjects newly diagnosed with spinal pain during the study period were 80% more likely to also be diagnosed with incident major depression, and personnel newly diagnosed with major depression were 58% more likely to also be diagnosed with spinal pain, compared to undiagnosed counterparts of the same age and sex. After correcting for misclassification in probabilistic bias modelling, these associations decreased to 41% and 28%, respectively. Survival models found a 67% higher risk of incident major depression diagnosis following an incident spinal pain diagnosis, and a 71% higher risk of incident spinal pain diagnosis following an incident major depression diagnosis. Our results highlight a moderate and bidirectional association between two of the most prevalent disorders in military populations. Our results also highlight the importance of correcting for misclassification in electronic medical record data research.
INTRODUCTION

Major depression is a leading cause of worldwide morbidity [1], and is at least twice as prevalent in military personnel compared to civilians [2–5]. In military populations, major depression is associated with increased risk of suicidal behaviors [6], poor job performance [7], and premature career termination [8].

Spinal pain is another prevalent problem in military organizations. In the US Armed Forces, back problems are the most common reason for clinical encounters [9], and are a leading cause for medical evacuations out of theatres of operations [10]. In the Canadian Armed Forces, 23% of personnel report currently suffering from medically diagnosed back problems [11]. Moreover, spinal pain during military service is associated with pain episodes later in life [12].

Major depression and spinal pain are comorbid illnesses among civilians [13]. The strong association between depression and pain can be explained by different mechanisms [14]. Depressed mood and the emotional experience of pain are modulated by nociceptive pathways that involve many of the same brain regions and neurotransmitters [14]. Depressed patients experience disruptions in pain perception [15], which could increase their risk of spinal pain onset. Twin [16, 17] and family [18] studies have suggested that depression and pain may also share common genetic risk factors. Other authors have proposed psychosocial mechanisms, whereby debilitating pain leads to social isolation, diminished enjoyment of life, and a loss of social roles, ultimately causing the onset of major depression [14].
Longitudinal data are needed to better understand the temporal relationships between major depression and spinal pain in active military personnel. Such data can help inform screening policies, health resource allocation, and multidisciplinary collaborations in an effort to reduce the morbidity burden of these two important public health issues.

In this study, we investigated the association between incident major depression and incident spinal pain over a 20-month period in Canadian Armed Forces personnel, using electronic medical record data. We addressed three research questions. First, we investigated whether incident diagnoses of major depression and spinal pain are clustered in time. Second, we investigated whether the inherent limitations of electronic medical record data could have biased the observed association between spinal pain and major depression. Third, we investigated whether the temporal association between the two disorders is bidirectional.
Chapter 7: Major depression and spinal pain

METHODS

Study design

We conducted a 20-month retrospective study of Canadian Armed Forces (CAF) personnel who were free of major depression and spinal pain at baseline. We used electronic medical record data to identify incident diagnoses of major depression and spinal pain.

Sample population

Using CAF administrative databases, we identified all individuals who were in the CAF Regular Force on January 1, 2017 (n = 65,981). To study the incidence of major depression and spinal pain diagnoses, we required all study subjects to have neither condition at baseline. We therefore excluded all individuals who had diagnoses of major depression or spinal pain in the 12 months preceding the study start date (n = 13,273). We also excluded individuals who had not served in the CAF Regular Force for at least 12 consecutive months prior to the study start date (n = 4,701) because the absence of past-year diagnoses could not have been reliably ascertained using CAF electronic medical records. Our final sample consisted of 48,007 subjects.

Measures

We used data extracted from CAF electronic medical records to identify all incident diagnoses of major depression and spinal pain in study subjects, from January 1, 2017 to August 31, 2018. Methods used to define incident cases of major depression [19] and spinal pain [20] have been described in additional detail elsewhere.
**Major Depression**

Two types of data signals were used to identify incident cases of major depression: a) International Classification of Disease (ICD-10) or Diagnostic Statistical Manual of Mental Disorders (DSM-5) diagnostic codes for major depression recorded by healthcare providers in CAF primary care or specialty mental health clinics, and b) depressive symptoms selected from a standardized list of clinical impressions, and recorded in CAF clinics within six months of a major depression diagnostic code. The first data signal related to depression recorded during the study period was interpreted as an incident diagnosis. We also manually reviewed the medical charts of patients receiving most of their care from civilian mental health specialists, and thus identified additional incident diagnoses in patients who were treated in non-CAF mental health clinics and therefore had incomplete data in their CAF electronic medical records.

**Spinal Pain**

Consistent with previous studies [21], we defined spinal pain as pain originating from the cervical, thoracic, or lumbar spine. We identified incident cases of spinal pain using over 150 related ICD-10 codes [22] recorded in CAF primary care clinics (see Annex 1 for a full list). For the purposes of our study, the first diagnostic code related to spinal pain recorded in a patient’s medical chart during the study period was interpreted as an incident spinal pain diagnosis.

**Demographic characteristics**

We extracted the age and sex of all study subjects from CAF administrative databases. We also censored subjects from analyses on their date of release from the CAF Regular Force.
Data Analyses

Research Question 1

We investigated whether new diagnoses of major depression and onset of spinal pain co-occur in CAF personnel, in a 20-month period. To do so, we used multivariate Poisson regression models with robust error variance to compare the period prevalence of new major depression diagnoses in subjects with vs without incident diagnoses of spinal pain during the study period, and vice-versa. All diagnoses and person-years of military service accrued between January 1, 2017 and August 31, 2018 were included. All models were adjusted for sex and age group, and included the log of person-years of observation contributed by each subject as an offset.

Research Question 2

The models used to address our first research question were at risk of bias, in part because electronic medical record data have several limitations [23]. For example, diagnostic codes can only be recorded during medical encounters, but not all individuals seek care for their symptoms of major depression [24] or spinal pain [25]. Diagnostic codes are also not recorded in the electronic medical record of every care-seeking patient. For example, diagnostic codes are rarely generated in CAF physiotherapy clinics, because CAF physiotherapists tend to scan hand-written notes into the electronic medical record of spinal pain patients [20]. Finally, military personnel are more likely to seek care for their depressive symptoms if they are experiencing co-morbid physical pain [26]. These limitations could create a spurious association between spinal pain and major depression through misclassification. As a second objective, we estimated the impact that misclassification bias may have had on the results obtained in our first models.
We used probabilistic bias analysis methods [27] to simulate 50,000 datasets hypothetically free of misclassification. Because the precise extent of misclassification in our sample was unknown, we relied on available evidence to derive probability distributions for each bias parameter. These reflected a range of plausible values and quantified the uncertainty of each bias parameter.

*Misclassification of spinal pain*

Based on previous evidence, we assumed that the risk of major depression misclassification depended on the unbiased values of spinal pain [26]. As recommended under such conditions [28], we corrected spinal pain misclassification first, and then used bias-corrected spinal pain status to inform the correction of major depression misclassification.

Based on the results of an internal validation study [20], we sampled a positive predictive value (PPV) from a normal distribution with mean 0.905 and standard error 0.025. Similarly, we sampled a negative predictive value (NPV) from a normal distribution with mean 0.881 and standard error 0.014. We imposed a correlation coefficient \( r = 0.5 \) between these randomly sampled values. On the rare occasions where one of the sampled values was greater than 1.0, the value was replaced with 0.999. For each patient with a diagnostic code for spinal pain during the study period, we assigned a bias-corrected care-seeking status using a single Bernouilli trial with \( p = \text{PPV} \). For each subject with no diagnostic code for spinal pain during the study period, we assigned a bias-corrected care-seeking status using a single Bernouilli trial with \( p = 1 - \text{NPV} \).

We assumed that all patients with bias-corrected positive care-seeking status had truly experienced spinal pain during the study period. We then sampled a probability of unreported spinal pain, \( \psi \),
from a normal distribution with mean 0.015 and standard error 0.010. For each subject who had not sought care for spinal pain in the past year, we assigned a bias-corrected spinal pain status using a single Bernoulli trial with $p = \psi$.

**Misclassification of major depression**

Based on the results of an internal survey [24], we assumed that the probability of care-seeking and subsequent diagnosis among all CAF Regular Force personnel with major depression followed a normal distribution with mean 0.747 and standard error 0.042. We randomly selected a diagnosis probability, $p$, from this normal distribution. We then divided the observed number of diagnoses cases, $nd$, by the sampled diagnosis probability, $p$, to estimate the total number of incident cases, $nt$, and the number of undiagnosed cases, $nu$, as follows:

$$nt = \frac{nd}{p} \quad [1]$$

$$nu = nt - nd \quad [2]$$

The number of undiagnosed cases of incident major depression, $nu$, was considered to be the sum of undiagnosed cases among patients with ($nu_{\text{pain}}$) and without ($nu_{\text{no}}$) spinal pain.

$$nu_{\text{pain}} = nu - nu_{\text{no}} \quad [3]$$

We also assumed that misclassification of outcome was differential across categories of exposure. More specifically, we assumed that patients with major depression had higher odds of diagnosis if
they had co-morbid spinal pain. Based on published data from a survey of US military personnel [26] and unpublished results from a survey of CAF personnel [25] we assumed that the odds of diagnosis were 10-50% higher in depressed subjects with vs without spinal pain. We randomly sampled an odds ratio, \( OR \), from a uniform distribution bounded by 1.1 and 1.5. We then entered the observed number of diagnosed cases in subjects with (\( nd_{pain} \)) and without (\( nd_{no} \)) spinal pain in equation [4], and algebraically solved for the number of undiagnosed cases among patients with (\( nu_{pain} \)) and without (\( nu_{no} \)) spinal pain.

\[
\frac{nd_{pain}}{nu_{pain}} = OR \times \frac{nd_{no}}{nu_{no}} \quad [4]
\]

We then reclassified depression status in \( nu_{pain} \) subjects randomly selected among those with bias-corrected spinal pain but no incident diagnosis of depression, and \( nu_{no} \) subjects among those without bias-corrected spinal pain and no incident diagnosis of depression.

**Bias analysis**

We refitted our Poisson regression models on the bias-corrected data, to obtain bias-adjusted regression coefficients comparing the period prevalence of spinal pain in patients with vs without major depression, and the period prevalence of major depression in patients with vs without spinal pain. We reintroduced random error estimated from the original data. To obtain stable confidence limits, we repeated the bias-correction steps outlined above 50,000 times; the median of our 50,000 iterations was used as the bias-adjusted point estimate, and the 2.5\(^{th}\) and 97.5\(^{th}\) percentiles were used as the lower and upper bounds of its new 95% interval [26].
Research Question 3

Finally, we measured the association between an incident diagnosis of major depression and the subsequent increase in risk of incident spinal pain diagnosis, and vice-versa. We used Cox regression models to compare the hazards of incident major depression diagnoses in patients with vs without an incident diagnosis of spinal pain. Exposure to a spinal pain diagnosis was time-varying; all subjects were unexposed at baseline, but the variable was allowed to change as subjects experienced incident pain diagnoses. Subjects were removed from the at-risk group after an incident diagnosis of major depression. We used the cumulative failure function to estimate the risk of an incident diagnosis of major depression within 30 and 365 days of an incident diagnosis of spinal pain. We then used separate Cox regression models to assess the inverse association, and thus also compared the hazards of incident spinal pain diagnoses in patients exposed vs unexposed to an incident diagnosis of major depression.

We examined smoothed hazard plots, predicted survival plots, and Schoenfeld residuals to ascertain that all models satisfied the proportional hazards assumption. All analyses were performed using Stata, version 14.0 [29].

Ethical considerations

This study was approved by the CAF Deputy Surgeon General, and the University of Ottawa Office of Research Ethics and Integrity.
RESULTS

Our sample consisted of 48,007 CAF personnel observed over 76,163 person-years of military service. Most study subjects were male, and younger than 40 years (Table 7-1). By design, no subject had been diagnosed spinal pain or major depression in the 12 months preceding the study start date.

During the study period, 9,520 subjects were diagnosed with spinal pain, and 2,179 subjects were diagnosed with major depression (Table 7-2). After adjusting for age and sex, subjects with diagnoses related to spinal pain at any point during the study had a 1.80-fold (95% CI: 1.65, 1.97) higher likelihood of also being diagnosed with major depression. Conversely, subjects diagnosed with major depression at any point during the study had a 1.58-fold (95% CI: 1.48, 1.68) higher likelihood of also being diagnosed with spinal pain (Figure 7-1). After correcting for misclassification of both spinal pain and major depression with bias modelling, these adjusted prevalence ratios decreased to 1.41 (95% interval: 1.25, 1.59) and 1.28 (95% interval: 1.17, 1.39), respectively (Figure 7-1).

Among the 707 subjects diagnosed with both spinal pain and major depression during the study period, the incident spinal pain diagnosis preceded the incident major depression diagnosis in 49.9% of cases, and the incident major depression diagnosis preceded the incident spinal pain diagnosis in 45.3% of cases. The remaining 4.8% of co-morbid cases received both incident diagnoses on the same day.
After adjusting for age and sex, the hazard of an incident major depression diagnosis was 1.67-fold higher (95% CI: 1.48, 1.88) after an incident diagnosis spinal pain, compared to person-time with no recent diagnosis of spinal pain. The adjusted hazard of an incident spinal pain diagnosis was 1.71-fold higher (95% CI: 1.53, 1.92) after an incident diagnosis of major depression, compared to person-time with no recent diagnosis of major depression (Table 7-3).

Based on the cumulative failure function, 0.6% (95% CI: 0.2%, 2.5%) of at-risk patients experienced an incident diagnosis of major depression in the 30 days immediately following an incident diagnosis of spinal pain; in the 365 days following an incident diagnosis of spinal pain, 5.6% (95% CI: 4.5%, 7.0%) of at-risk patients experienced an incident major depression diagnosis. On the other hand, 0.8% (95% CI: 0.1%, 5.8%) of at-risk patients experienced an incident spinal pain diagnosis in the 30 days immediately following an incident diagnosis of major depression; in the 365 days following an incident diagnosis of major depression, 19.9% (95% CI: 16.6%, 23.7%) of at-risk patients experienced an incident diagnosis of spinal pain.
DISCUSSION

We found that incident diagnoses of major depression and spinal pain were comorbid in a large sample of military personnel. Over a 20-month period, personnel newly experiencing spinal pain were 80% more likely to also be diagnosed with major depression, and personnel newly diagnosed with major depression were 58% more likely to also have a diagnosis of spinal pain, compared to counterparts of the same age and sex. After correcting for misclassification in our bias modelling, these associations decreased in magnitude from 80% to 41%, and from 58% to 28%, respectively. Furthermore, we found evidence that these associations were bi-directional.

Our results are consistent with recent studies suggesting a bi-directional relationship between pain and depression [30–32]. Indeed, approximately half of patients who experienced both outcomes during the study period were diagnosed with spinal pain before major depression; a similar percentage were diagnosed with major depression first, and spinal pain second. Furthermore, survival models measuring the effect of spinal pain on risk of subsequent major depression diagnoses yielded adjusted hazard ratios that were similar to those of survival models measuring the inverse temporal association. This symmetry in the timing of incident diagnoses is consistent with models of shared vulnerability to major depression and spinal pain (14, 16). Some military personnel may already be at high risk for both outcomes; in these individuals, the onset of one outcome may precipitate onset of the other, but the disorders could conceivably manifest in any order.
**Implications**

The U.S. Preventive Task Force currently recommends depression screening in primary care settings for all adult patients [33]. The Canadian military conducts mental health screening for all personnel reporting to primary care clinics for mandatory health exams, but such exams only occur once every five years for individuals in certain occupational groups. Currently, patients reporting to primary care clinics for specific physical complaints are not systematically screened for mental health symptoms. The close relationship between spinal pain and major depression incidence reported herein suggests that, in theory, mental health screening in CAF primary care clinics could improve major depression case detection among spinal pain patients. But depression screening has associated costs [34], and its benefits are context-dependent [35]. Future research is warranted to measure the benefits of major depression screening in spinal pain patients, in a military context.

Our results should also encourage increased collaboration between primary care clinicians, mental health specialists, and pain specialists in the treatment of military personnel with major depression or spinal pain. The two conditions are prevalent, comorbid, and their respective onsets tend to cluster in time. Integrated healthcare systems offer an opportunity for the multidisciplinary management of these two disorders. Other authors have also recommended engaging mental health specialists in the treatment of spinal pain patients [36]. In fact, cognitive behavioral therapy – a first-line psychotherapy for major depression [37] – is an effective treatment for spinal pain [38]. Additionally, effective treatment of major depression can improve spinal pain outcomes, and vice-versa [39].
Finally, our results highlight the importance of correcting for misclassification bias in epidemiological studies relying on electronic medical record data to measure disease status. The adjusted prevalence ratios measuring the association between major depression and spinal pain decreased substantially after bias modelling. Insofar as our bias parameters were correctly specified, part of the association between major depression and spinal pain observed in electronic medical record data was due to misclassification. If we had failed to correct for misclassification, our biased results would have overestimated the need for clinical and preventive resources specifically targeted to major depression and spinal pain.

**Limitations**

Our study had noteworthy limitations. First, we operationalized major depression and spinal pain as two dichotomous outcomes. However, symptoms of major depression and spinal pain range in severity (40, 41), and previous studies have found that symptom severity is an important effect modifier in the association between chronic pain and depression (42, 43). We reported moderate associations between our dichotomous variables, but there may exist much stronger associations between severe depression and severe spinal pain in military personnel. We could not assess these associations because of difficulties in measuring symptom severity with our data. Second, we did not measure musculoskeletal pain originating from body regions other than the spine. Our results can therefore not provide a comprehensive overview of pain and depression comorbidity in the military. But chronic pain and major depression are complex disorders, with hundreds of contributing factors (44, 45). Developing comprehensive models of pain and depression in the military was beyond the scope of this study. Our objective was simply to measure the association between two of the most impactful health conditions in CAF personnel, which did not require
accounting for non-spinal pain. Third, we conceptualized incidence as the onset of new episodes of clinical care, regardless of past history of major depression or spinal pain. It is therefore possible that a substantial number of cases herein identified as incident diagnoses were, in fact, recurrences. For example, a patient who recovered from a major depressive episode years before the study start date, and who experienced a major depression recurrence during the study period, would have been identified as an incident case. While this accurately reflects the incidence of new episodes of care from a healthcare provider’s perspective, it may have limited our inferences on the association between spinal pain and risk of major depression. Indeed, risk factors for the onset of new major depressive episodes have been shown to differ depending on the number of previous lifetime episodes [46–48]. Fourth, we did not account for care-seeking delays. We implicitly assumed that care-seeking patients sought care for major depression or spinal pain immediately after symptom onset. However, CAF personnel who seek care for depression sometimes only do so years after the onset of their depressive symptoms [49]. It is therefore possible that patients met clinical criteria for major depression before the onset of new pain episodes, but sought mental healthcare for their depressive symptoms only once their spinal pain had been diagnosed. This limits the temporal interpretation of our findings but does not limit their relevance for screening efforts and clinical programs. Our results show that diagnosis of one of these conditions is often followed by diagnosis of the other. Ensuring that mental health resources are available to patients first presenting with spinal pain, and that pain management resources are available to patients first presenting with major depression, could be beneficial regardless of the actual timing of symptom onset. Fifth, our bias modelling did not guarantee the complete elimination of bias. In fact, we could have inadvertently increased – rather than reduced – misclassification bias if our bias parameters were incorrectly specified [50]. As recommended [51], we mitigated this risk by
specifying our bias parameters using results from internal CAF studies, and by specifying wide probability distributions for each bias parameter.

**Conclusion**

In conclusion, we have completed one of the largest studies to date on the incidence of major depression and spinal pain in a military population. Our results could inform future screening efforts, prevention programs, and multidisciplinary collaborations in the military. Our results also highlight the importance of correcting for misclassification bias in electronic medical record data research.
Figure 7-1: Ratios comparing the prevalence of new major depression diagnoses in subjects with vs without incident diagnoses of spinal pain during study period, and the prevalence of new spinal pain diagnoses in subjects with vs without incident major depression diagnoses. Multivariate Poisson regression models adjusting for sex and age group were fitted on observed data (white bars), and on data corrected for misclassification of spinal pain and major depression through 50,000 bias analysis iterations (grey bars).
Table 7-1: Demographic characteristics of study subjects, and number of incident diagnoses of major depression and spinal pain during the study period, January 2017 to August 2018.

<table>
<thead>
<tr>
<th></th>
<th>Total count at baseline</th>
<th>Incident major depression diagnosis</th>
<th>Incident spinal pain diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (col %)</td>
<td>n (row %)</td>
<td>n (row %)</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>6,165 (12.8)</td>
<td>455 (7.4)</td>
<td>1,579 (25.6)</td>
</tr>
<tr>
<td>Male</td>
<td>41,842 (87.2)</td>
<td>1,724 (4.1)</td>
<td>7,941 (19.0)</td>
</tr>
<tr>
<td><strong>Age at baseline</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-29 years</td>
<td>17,536 (36.5)</td>
<td>601 (3.4)</td>
<td>2,717 (15.5)</td>
</tr>
<tr>
<td>30-39 years</td>
<td>16,753 (34.9)</td>
<td>870 (5.2)</td>
<td>3,453 (20.6)</td>
</tr>
<tr>
<td>40-49 years</td>
<td>9,750 (20.3)</td>
<td>539 (5.5)</td>
<td>2,393 (24.5)</td>
</tr>
<tr>
<td>50-60 years</td>
<td>3,968 (8.3)</td>
<td>169 (4.3)</td>
<td>957 (24.1)</td>
</tr>
</tbody>
</table>
**Table 7-2:** Number of study subjects with an incident diagnosis of major depression and spinal pain at any point during the study period, January 2017 to August 2018.

<table>
<thead>
<tr>
<th>Incident spinal pain diagnosis</th>
<th>Incident major depression diagnosis</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>707</td>
<td>8,813</td>
<td>9,520</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>1,472</td>
<td>37,015</td>
<td>38,487</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>2,179</td>
<td>45,828</td>
<td>48,007</td>
</tr>
</tbody>
</table>
Table 7-3: Adjusted hazard ratios of incident major depression diagnoses (Model #1) and incident spinal pain diagnoses (Model #2) in at-risk study subjects, January 2017 to August 2018.

<table>
<thead>
<tr>
<th></th>
<th>Model #1 (Major depression)</th>
<th>Model #2 (Spinal pain)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>aHR  (95% CI)</td>
<td>aHR  (95% CI)</td>
</tr>
<tr>
<td>Spinal pain diagnosis *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>ref</td>
<td>-</td>
</tr>
<tr>
<td>Yes</td>
<td>1.67 (1.48, 1.88)</td>
<td>-</td>
</tr>
<tr>
<td>Major depression diagnosis *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>-</td>
<td>ref</td>
</tr>
<tr>
<td>Yes</td>
<td>-</td>
<td>1.71 (1.53, 1.92)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>ref</td>
<td>ref</td>
</tr>
<tr>
<td>Male</td>
<td>0.58 (0.52, 0.64)</td>
<td>0.73 (0.69, 0.77)</td>
</tr>
<tr>
<td>Age at baseline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-29 years</td>
<td>ref</td>
<td>ref</td>
</tr>
<tr>
<td>30-39 years</td>
<td>1.47 (1.32, 1.63)</td>
<td>1.34 (1.28, 1.41)</td>
</tr>
<tr>
<td>40-49 years</td>
<td>1.58 (1.41, 1.77)</td>
<td>1.67 (1.58, 1.77)</td>
</tr>
<tr>
<td>50-60 years</td>
<td>1.36 (1.15, 1.62)</td>
<td>1.86 (1.73, 2.00)</td>
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</table>

* Time-varying exposure
References


10. Armed Forces Health Surveillance Center (AFHSC) (2012) Medical evacuations from


30. Schmaling KB, Nounou ZA (2019) Incident Chronic Spinal Pain and Depressive
Chapter 7: Major depression and spinal pain


Chapter 7: Major depression and spinal pain


## Appendix 7A: Ethics approval from the University of Ottawa’s Research Ethics Board

**File Number:** H04-17-04B  
**Date (mm/dd/yyyy):** 11/30/2017

![Université d’Ottawa University of Ottawa](image)

**Office of Research Ethics and Integrity**

**Ethics Approval Notice**

**Health Sciences and Science REB**

<table>
<thead>
<tr>
<th>Principal Investigator / Supervisor / Co-investigator(s) / Student(s)</th>
<th>Role</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ian Colman</td>
<td>Supervisor</td>
<td>Medicine / Medicine</td>
</tr>
<tr>
<td>François Thériault</td>
<td>Student Researcher</td>
<td>Medicine / Medicine</td>
</tr>
<tr>
<td>Robert Hawes</td>
<td>Other Collaborator</td>
<td>Others / Others</td>
</tr>
</tbody>
</table>

**File Number:** H04-17-04B  
**Type of Project:** PhD Thesis

**Title:** Major depressive disorders in the Canadian Armed Forces: A longitudinal study of risk factors, care seeking, and treatment outcomes

**Approval Date (mm/dd/yyyy):** 11/30/2017  
**Expiry Date (mm/dd/yyyy):** 11/29/2018  
**Approval Type:** Approval

**Special Conditions / Comments:** N/A
Appendix 7B: Screenshot of online portal for the Surgeon General’s Health Research Program, showing this project was approved on November 14th, 2017
CHAPTER 8

General Discussion

The first chapter of this thesis introduced 13 research questions (see Table 1-1), which were answered in four distinct studies, presented in detail in Chapters 4 through 7. In this final chapter, I briefly summarize the findings of my four research studies. I also discuss their implications for the wider epidemiological literature, and for the future of major depression research and prevention efforts in military populations.

8.1 Summary of research findings

8.1.1 Major depression treatment gap in military populations

In 2013, Statistics Canada conducted a large population-based survey of Canadian Armed Forces (CAF) personnel [1]. Previous analysis of this survey data revealed that 8.0% of all CAF Regular Force personnel had met the diagnostic criteria for major depression in the previous 12 months [2]. In Chapter 4, I performed additional analyses of the survey data, and found that 74.7% of CAF Regular Force personnel with past-year major depression – representing 6.0% of the entire CAF Regular Force population – had used mental health services in the previous 12 months. Among care-seekers, 70.3% had consulted a psychologist or a psychiatrist, and only 4.7% had been treated exclusively by primary care physicians. In other words, 52.5% of all CAF personnel with past-year major depression were seen by a psychologist or a psychiatrist in the previous 12 months, and an additional 3.5% were seen exclusively by primary care physicians. These findings are in stark contrast to care-seeking patterns observed in general civilian populations, where a majority of
depressed patients do not seek care [3], and care-seekers are often treated exclusively in primary care settings [4]. Among depressed CAF personnel, belief in the effectiveness of mental health care was the factor most strongly associated with past-year mental health service use. Other factors associated with mental health service use included sex, age group, past-year psychiatric co-morbidities, and level of depression-related functional impairment. However, none of these associations were particularly strong, with prevalence ratios only ranging from 1.04 to 1.52.

In Chapter 5, I conducted a systematic review, and found that 11 previous studies had also attempted to quantify the major depression treatment gap in the military populations of Australia, Canada, New Zealand, the United Kingdom, or the United States. Across these 11 other studies, the period prevalence of mental health service use in depressed military personnel ranged from 19.6% to 64.1%. Even with the addition of the 74.7% estimate from the Chapter 4 study (i.e., a 12th study on major depression treatment gap in military populations), the median period prevalence of mental health service use among depressed military personnel was only 47.6%. Interestingly, the 12 studies differed substantially on the measurement tools used to identify personnel with major depression. Indeed, four studies measured major depression using lengthy diagnostic interviews, while the other eight relied on shorter screening tools. Screening tools tend to be less specific than diagnostic interviews [5, 6], and are therefore generally at higher risk of falsely identifying depression in non-depressed subjects. The median period prevalence of mental health service use among depressed military personnel was much higher in the four studies that measured depression using diagnostic interviews (60.3%) than in the eight studies that used screening tools (44.4%).

Together, the findings of Chapters 4 and 5 suggest that a substantial proportion of military personnel struggling with major depression do not access mental health services, and the major
depression treatment gap reported in studies of CAF personnel is narrower than the gap reported in studies of military personnel from other allied nations. However, the measurement tools used to identify depressed individuals can have an important impact on estimates of the major depression treatment gap, and careful methodological considerations are needed before inferring that military personnel who need help for major depression have better access to mental health services in the CAF than in other military organizations.

8.1.2 Incidence of major depression diagnoses in CAF personnel

When CAF personnel with major depression use mental health services, they generate data signals in their electronic medical records. In Chapter 6, I used data extracted from CAF electronic medical records to identify diagnosed cases of major depression. I found that 5.6% of all CAF personnel had been diagnosed with major depression over a given 12-month period; the close database agreement between this estimate of mental health service use prevalence and the 6.0% estimate I obtained from the Chapter 4 study was a quality indicator suggesting that CAF electronic medical records are a valid source of major depression data. Using this data source, I also found that CAF personnel are diagnosed with major depression at a rate of 29.2 new cases per 1,000 person-years at risk. Female sex, older age, and non-officer ranks were moderately associated with higher incidence rates; adjusted incidence rate ratios for socio-demographic factors ranged from 0.57 to 1.92. Interesting, the adjusted incidence rate of new major depression diagnoses was not significantly different among combat specialists than in numerous non-combat trades including administrative staff, engineers, telecommunication specialists, health care providers, sensor and radar operators, and public protection officers. However, the adjusted incidence rate of new major depression diagnoses was nearly three times higher in severely sick or injured patients already posted to a Joint Personnel Support Unit (i.e., administrative cells where ill or injured personnel
from any command may be posted, if a medical condition precludes them from performing regular duties for a period of at least six months), compared to other CAF personnel of the same age group, sex, and rank category.

Finally, in Chapter 7, I expanded the analyses of CAF electronic medical record data to measure the temporal associations between incident major depression and spinal pain. The major depression treatment gap presented in Chapter 4 was incorporated in quantitative bias analysis methods to mitigate one of the biggest limitations of electronic medical record data. Before correcting for misclassification bias, CAF personnel who were diagnosed with spinal pain at any point during a 20-month follow-up period had a 1.80-fold higher likelihood of also being newly diagnosed with major depression compared to personnel of the same age and sex who remained free of spinal pain. After correcting for misclassification bias, this increase in risk decreased by half, to an adjusted prevalence ratio of 1.41. Interestingly, the moderate association observed between spinal pain and major depression was bi-directional. Among the 707 subjects diagnosed with both conditions during the 20-month study period, almost exactly half experienced the incident spinal pain diagnosis before the incident major depression diagnosis, and the other half experienced the incident diagnoses in reverse order. Following an incident diagnosis of spinal pain, the adjusted hazards of an incident major depression diagnosis increased 1.67-fold; following an incident diagnosis of major depression, the adjusted hazards of an incident spinal pain diagnosis increased 1.71-fold.

The findings outlined above all represent original contributions to the psychiatric and military epidemiology literature. The evidence on the major depression treatment gap in military populations had never been systematically reviewed, and its implications on studies of electronic medical record data had never been quantified. Moreover, the incidence of new major depression
diagnoses in the Canadian military had never been measured, and the association between major depression and spinal pain – two of the most common disorders among soldiers – had never been assessed in a military population. These findings could help shape the future direction of major depression surveillance and prevention efforts in military populations, and inform the methodological designs of future psychiatric epidemiology studies.
Table 8-1: Summary of research findings from Chapters 4 to 7

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Research Findings</th>
</tr>
</thead>
</table>
| 4       | • 74.7% of CAF personnel who met diagnostic criteria for major depression in the past 12 months also used mental health services over the same time period  
          • Among depressed CAF personnel who used mental health services in the past 12 months, 70.3% consulted a mental health specialist  
          • Belief in the effectiveness of mental health care, depression-related functional impairment, past-year psychiatric co-morbidities, age 30 years and over, and sex were associated with mental health service use in CAF personnel who met diagnostic criteria for major depression in the past 12 months. |
| 5       | • 12 studies have measured mental health service use in military personnel with past-year major depression in Five Eye nations  
          • Across these 12 studies, the median period prevalence of mental health service use among depressed military personnel was 47.6% |
| 6       | • 5.6% of CAF personnel have a past-year clinician diagnosis of major depression in their electronic medical records  
          • The proportion of CAF personnel with past-year diagnosis of major depression is highly consistent with the findings of Chapter 4  
          • Major depression is diagnosed at a rate of 29.2 new cases per 1,000 person-years in CAF personnel  
          • Female sex, older age, and non-officer rank are modestly associated with the incidence rate of new major depression diagnoses in CAF personnel |
| 7       | • Incident major depression diagnoses are more common in incident spinal pain patients than in other CAF personnel, after adjusting for age and sex (adjusted prevalence ratio = 1.80 over a 20-month period).  
          • The observed association between incident diagnoses of spinal pain and major depression are partly due to the inherent limitations of electronic medical record data. After correcting for misclassification, the adjusted prevalence ratio decreased to 1.41  
          • The risk of an incident diagnosis of major depression increases 1.67-fold after an incident diagnosis of spinal pain  
          • The risk of an incident diagnosis of spinal pain increases 1.71-fold after an incident diagnosis of major depression |
8.2 Policy Implications

The results presented in this thesis have shed new light on the risk factors associated with the onset of major depression in military populations, and could be used to inform policy on major depression screening in military populations. In particular, personnel diagnosed with spinal pain, and personnel assigned to administrative cells because of serious and chronic illnesses or injuries, were identified as sub-groups with elevated prevalence of past-year major depression. Expanding targeted screening programs to include these at-risk sub-groups may help lower the burden of major depression in the military. However, additional research is needed before the results of this thesis can be used to justify the implementation of expanded screening programs.

8.2.1 Expanding targeted screening programs

Military organizations currently conduct targeted screening programs to detect prevalent but undiagnosed cases of major depression in at-risk personnel, to improve timely access to mental healthcare [7, 8]. In light of the major depression treatment gaps uncovered in Chapters 4 and 5 of this thesis, the objectives of such screening efforts are laudable. Currently, targeted screening programs in the American and Canadian military focus almost exclusively on personnel returning from overseas deployments [8]. Exposure to traumatic experiences during overseas deployments is indeed associated with an increased risk of various psychiatric disorders [9], but combat veterans are not the only military sub-group with an elevated prevalence of major depression.

For example, CAF policy requires that all personnel who deployed overseas for at least 60 consecutive days be screened for major depression and other psychiatric disorders through the Enhanced Post-Deployment Screening (EPDS) process, 90 to 180 days after their return. From January 2009 to July 2012, 16,193 CAF personnel completed the EPDS after returning from Afghanistan, and 517 (3.2%) screened positive for major depression [10]; these individuals were
referred to mental healthcare providers, as appropriate. But a large portion of CAF personnel did not deploy to Afghanistan, and the past-year prevalence of major depression among those who did not deploy was 6.8% [11]. As a result, combat deployments to Afghanistan only accounted for a small proportion of the major depression burden observed in CAF personnel [11]. Similarly, the U.S. Armed Forces require that all personnel returning from overseas deployments be screened for major depression and other psychiatric disorders immediately after their return home through the Post Deployment Health Assessment (PDHA) process, and again 3-6 months later through the Post Deployment Health Re-Assessment (PDHRA) process [8]. Benefits to screened individuals notwithstanding, it is important to note that 5.7% of U.S. Armed Forces personnel who have never deployed suffer from major depression [12], and that most American soldiers who attempt suicide have never deployed [13]. The PDHA and PDHRA processes may therefore identify undiagnosed cases major depression in one particular sub-group of at-risk U.S. Armed Forces members, but cannot help prevent the major depression burden in other at-risk sub-groups.

The findings presented in this thesis could encourage military organizations to evaluate the costs and benefits of expanding targeted screening programs for major depression to other high-risk groups than combat veterans returning from deployment, such as patients diagnosed with spinal pain, or individuals assigned to administrative cells because of serious and chronic illnesses or injuries.

8.2.2 Evaluating targeted screening programs

Simply identifying a military sub-population at elevated risk of major depression is not enough to recommend a new targeted screening program. For example, the PDHA and PDHRA processes target combat veterans, who have been shown to experience increased risk of psychiatric disorder onset [9]. But out of 9,611 U.S. Army soldiers and U.S. Marines who were referred for specialist
mental health care through the PDHA screening process, only 56% actually received mental health care over the following year [14]. Furthermore, 74% of U.S. soldiers who accessed mental health services within 30 days of PDHRA screened negative, and self-referred for issues that were not identified through the screening process [15]. Validation studies have confirmed that, while the PDHRA screening process can accurately rule out major depression, its sensitivity (60%) and positive predictive value (38%) are low [16]. Overall, evidence confirming the effectiveness of post-deployment screening programs to reduce major depression morbidity in military populations is still lacking [17].

Rona et al [7] proposed six criteria that should be met to justify the implementation of a mental health screening program in the military: 1) the target condition should be an important public health problem; 2) healthcare professionals and clinical facilities should be available to care for patients who screen positive; 3) screening tests should be ethically, clinically, and socially acceptable; 4) screening tests should be valid; 5) screening should effectively reduce morbidity, and 6) benefits should outweigh harms [7]. Chapters 6 and 7 have identified certain CAF sub-populations where major depression is a particularly important public health problem, and mental healthcare resources are available to all CAF personnel. Furthermore, the widespread acceptance of post-deployment screening tests suggests that targeted mental health screening programs are generally accepted among military personnel. The first three criteria for implementing a major depression screening program in military personnel diagnosed with spinal pain or suffering from chronic and severe illnesses or injuries are therefore met. However, due to a lack of evidence, it remains unclear if the final three criteria would also be satisfied.

Future studies should seek to measure the validity of major depression screening tests in military personnel with spinal pain, and chronic and severe illnesses or injuries. Future studies should also
seek to measure the costs and benefits of targeted screening programs on the burden of major depression in the at-risk sub-populations identified herein. The findings of these future studies would provide the additional evidence required to inform major depression screening policy.

8.3 Future Research Direction

8.3.1 Predicting major depression onset

Military applicants are screened for prevalent psychiatric disorders during the recruitment process, and are therefore not in the midst of a major depressive episode when they first join the military. Consequently, all military personnel who suffer from major depression must have experienced the onset of a new major depressive episode once they were already in uniform. Identifying military personnel at risk of future major depressive episodes could help further improve prevention strategies, but developing accurate prediction models has proved difficult.

Early in the 20th century, psychological tests were developed to screen out otherwise healthy applicants who were at high-risk of developing psychiatric disorders. In 1940, U.S. military psychologists believed that “setting up filters against the defective, the unstable, and the potentially neurotic” would allow the U.S. military to “dry up post-war neurotics at source” [18]. Unfortunately, screening tests developed to identify military candidates at risk of future psychiatric episodes had very low predictive power, and WWII-era preventive screening programs proved to be costly failures [19]. Over two million Americans were rejected from the U.S. military, the vast majority of whom would have been fit for service [20].

More recently, Kessler et al [21] used baseline data from 1,056 World Mental Health Survey respondents to predict depression status over the following 10 years. More specifically, they used Machine Learning applications to derive a predictive risk score for each subject, based on baseline
self-reported demographic characteristics, depressive symptom severity, and co-morbid conditions. Less than 40% of subjects who experienced major depression over the next 10 years were in the top 20% of risk scores at baseline (i.e. sensitivity < 40%) [21]. Furthermore, less than 1 in 5 subjects within the top 20% of baseline risk scores actually experienced major depression over the following 10 years (i.e. positive predictive value < 20%) [21]. A recent systematic review of 64 unique suicide prediction models published between 1990 and 2018 provided similarly sobering conclusions; most models had a positive predictive value of less than 1% for suicide mortality, and none achieved a positive predictive value greater than 20% [22]. And in their 2017 systematic review of 365 studies, Franklin et al [23] concluded that overall, models attempting to predict future suicidal thoughts and behaviours only perform slightly better than chance, and that the predictive accuracy of such models had not improved over the previous 50 years [23].

In this thesis, several factors associated with elevated risk of major depression in CAF personnel were identified, but none of the associations were particularly large in magnitude. The quest to discover the single factor explaining the higher risk of major depression in military vs civilian populations seems ill-fated. Previous authors have already commented on the dangers of “risk factorology” in mental health research, and have argued against the use of standard epidemiologic approaches to isolate single cross-sectional risk factors while controlling for confounding variables [24]. A life-course approach is likely needed to achieve the next breakthrough in understanding the unique etiology of major depression in military populations.

8.3.2 Life-course approach

Future research on major depression etiology in military personnel should embrace a life-course approach. A life-course approach would recognize that individuals who volunteer for military service are not a random sample of the general adult population, and that the sociodemographic
Figure 8-1: Model of military career progression and exposure to occupational factors
characteristics and accumulation of life experiences that lead someone to contemplate a military career may also be associated with the risk of major depression onset later in life. In other words, before ever donning a uniform, new recruits may already have a different risk profile for future major depressive episodes than members of the general civilian population (Figure 8-1).

A life-course approach would also recognize that a military population is extremely heterogeneous. For example, an 18-year-old who enrolled immediately after completing high school and subsequently trained as an infantryman and a 38-year-old family physician who enrolled as a medical officer after years of private practice, are both new recruits but will have very different occupational exposures during their military careers. It seems ill-advised to lump together the hundreds of occupational groups that make up a military organization when trying to understand the factors associated with major depression onset in military personnel (Figure 8-1). A life-course approach would also recognize that military personnel must maintain rigorous physical and psychological health standards throughout their careers, and that only those who remain healthy will eventually be exposed to risk factors such as combat deployments and isolated postings (Figure 8-1).

Embracing a life-course approach requires access to decades of longitudinal data, and assembling such databases can be prohibitively expensive and time-consuming. The Millennium Cohort Study is one of the most ambitious longitudinal studies ever conducted in a military population. Indeed, the Millennium Cohort Study has prospectively collected data from 201,649 U.S. Armed Forces personnel from four different panels through mail questionnaires administered once every three years [25, 26]. The first panel (n = 77,047) has been followed since 2001 and has now completed six survey waves; the fourth panel (n = 50,052) has been followed since 2011 and has now completed three survey waves [25]. Longitudinal data from the Millennium Cohort Study have
contributed to our knowledge on the temporal associations between major depression and a number of factors including obesity [27], irritable bowel syndrome [28], persistent PTSD [29], combat deployment [30], divorce [31], sleep [32], and diabetes [32]. Millennium Cohort Study participants will be followed for up to 21 years [25, 26] – an impressive follow-up period, but one that remains insufficient for studying major depression etiology across the entire life-course, from prenatal and early childhood experiences, to occupational and non-occupational exposures accrued before, during, and after military service. Differential loss to follow-up and recall bias further complicate the implementation of a life-course approach in traditional studies of military cohorts such as the Millennium Cohort Study.

8.3.3. Data linkage

Embracing a life-course approach in future research will likely require the deterministic linkage of several large datasets, including self-reported and interviewer-administered surveys, hospitalization and health encounter databases, pharmacy records, mandatory health screening and physical testing results, administrative and occupational information from military databases, and national-level vital statistics databases [33]. For example, Beliveau et al [34] recently linked pre-deployment screening data to survey data from 1,820 CAF personnel with a single lifetime overseas deployment, and found that the association between traumatic combat exposures and subsequent onset of post-traumatic stress disorder (PTSD) was much stronger in individuals with a past history of major depression [34]. Similarly, Abraham [35] recently completed a longitudinal study of 3,302 CAF personnel by linking self-reported questionnaires completed during basic training to post-deployment screening data collected after a combat deployment to Afghanistan; the association between traumatic combat exposures and major depression was much stronger in individuals with a history of adverse childhood experiences [35]. And in a large sample of 30,436
U.S. Army recruits, the association between past-year stressful life events and past-year major depressive episode was stronger in subjects with a history of adverse childhood experiences [36]. The results presented in this thesis have clearly shown that electronic medical records are a reliable source of information on health service use for major depression. And, with advanced statistical methods to overcome the inherent misclassification of depressed personnel who do not seek mental healthcare, electronic medical records can even be used to estimate the prevalence and incidence of major depression at the population level. Linking these databases to other data sources describing exposure to risk factors across the life-course is a promising avenue for future research. However, linkage of large datasets also pose a number of legal and ethical challenges [33]. Innovative policies are therefore needed to facilitate data linkage and enable major depression research across the life-course of military personnel, while also protecting the privacy and confidentiality of study subjects.

8.4 Conclusion

This thesis highlighted the existing major depression treatment gap in military populations. However, even if not all depressed military personnel access mental health services, the electronic medical record data generated by care-seeking patients can be used to conduct major depression research of high relevance to military public health. The current findings have highlighted differential incident diagnosis rates and potentially higher risk of major depression across certain demographic, occupational, and clinical sub-groups of military personnel. The current findings have also highlighted important methodological considerations in psychiatric epidemiology, including the need to assess the accuracy of major depression classification tools and the imperative to account for misclassification bias. Future research is needed to replicate our findings,
and to estimate the costs and benefits of major depression prevention interventions targeting the high-risk sub-groups identified herein. Furthermore, adopting a life-course perspective could help future studies gain a better understanding of causal pathways for major depression in the unique group of individuals who volunteer for military service and subsequently expose themselves to myriad occupational factors rarely encountered in civilian life.
References


18. Davidson HA (1940) Mental hygiene in our Armed Forces. Mil Surg 86:480


https://doi.org/10.1186/s12888-015-0517-7


35. Abraham N (2017) Childhood Adversity, Deployment-Related Stress, and Mental Health in the Canadian Armed Forces. University of Ottawa


Balogun, Rasheed A., Bolanle A. Omotoso, Wenjun Xin, Jennie Z. Ma, Kenneth W. Scully,


Brown GW, Craig TKJ, Harris TO, et al. 2014. Functional polymorphism in the brain-derived neurotrophic factor gene interacts with stressful life events but not childhood maltreatment
https://doi.org/10.1002/da.22221


https://doi.org/10.1016/j.jad.2017.06.007.


https://doi.org/10.2190/TLXJ-YXLX-F4YA-6PHA.

Bursac, Zoran, C Heath Gauss, David Keith Williams, and David W Hosmer. 2008. “Purposeful


210


Joffres, Michel, Alejandra Jaramillo, James Dickinson, Gabriela Lewin, Kevin Pottie, Elizabeth Shaw, Sarah Connor Gorber, Marcello Tonelli, and Canadian Task Force on Preventive Health Care. 2013. “Recommendations on Screening for Depression in Adults.” *CMAJ* :


Milliken, Charles S., Jennifer L. Auchterlonie, and Charles W. Hoge. 2007. “Longitudinal Assessment of Mental Health Problems Among Active and Reserve Component Soldiers
Returning From the Iraq War.” *JAMA* 298 (18): 2141.  
https://doi.org/10.1001/jama.298.18.2141.

https://doi.org/10.1016/S0140-6736(09)60879-5.


https://doi.org/10.1176/ps.2006.57.5.631.


Spijker, Jan, Ron de Graaf, Rob V Bijl, Aartjan T F Beekman, Johan Ormel, and Willem A Nolen. 2002. “Duration of Major Depressive Episodes in the General Population: Results from The Netherlands Mental Health Survey and Incidence Study (NEMESIS).” The British


StataCorp. 2015. “Stata Statistical Software: Release 14.” College Station, TX: StataCorp LP.


Depressive Disorder (MDD).”  
*Pain* 154 (12): 2759–68.  
https://doi.org/10.1016/j.pain.2013.08.009.


https://doi.org/10.1002/pds.2310.


Zamorski, Mark A., Rachel E. Bennett, David Boulos, Bryan G. Garber, Rakesh Jetly, and

