

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

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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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## TABLE OF CONTENTS

Chapter 1: Introduction .....	1
Chapter 2: Major Depression – A Brief Review of the Literature .....	9
Classification .....	9
Etiology .....	10
Prevalence .....	16
Burden .....	16
Access to Treatment .....	18
Routinely Collected Data .....	22
Major Depression in the Military .....	24
Physical Pain and Major Depression .....	28
References .....	31
Chapter 3: Research Setting .....	47
Canadian Armed Forces .....	47
CAF Mental Healthcare System .....	47
CAF Electronic Medical Record System .....	50
Canadian Forces Mental Health Survey .....	52
References .....	54
Chapter 4: Mental health service utilization in depressed Canadian Armed Forces personnel .....	55
Preface .....	55
Abstract .....	57
Introduction .....	59

Methods .....	62
Results .....	67
Discussion .....	69
Conclusion .....	74
Tables .....	75
References .....	80
Appendices .....	85
 Chapter 5: Mental health service use in depressed military personnel: a systematic review .....	 87
Preface .....	87
Abstract .....	89
Introduction .....	91
Methods .....	93
Results .....	96
Discussion .....	98
Tables and Figures .....	103
References .....	109
Appendices .....	117
 Chapter 6: Incidence of major depression diagnoses in the Canadian Armed Forces: Longitudinal analysis of clinical and health administrative data .....	 123
Preface .....	123
Abstract .....	125
Introduction .....	127
Methods .....	129

Results .....	134
Discussion .....	135
Tables and Figures .....	140
References .....	144
Appendices .....	148
Chapter 7: Spinal pain and major depression in the Canadian Armed Forces: Longitudinal analysis of electronic medical record data .....	151
Preface .....	151
Abstract .....	152
Introduction .....	153
Methods .....	155
Results .....	162
Discussion .....	164
Tables and Figures .....	169
References .....	173
Appendices .....	179
Chapter 8: General Discussion .....	181
Summary of research findings .....	181
Policy Implications .....	187
Future Research Direction .....	190
Conclusion .....	195
Bibliography .....	202

## LIST OF FIGURES

Figure 2-1: Diathesis-stress model of major depression in adults . . . . .	11
Figure 3-1: Flow of depressed patients through the CAF mental health system, and electronic data elements recorded at various stages of treatment . . . . .	49
Figure 5-1: Flow chart of systematic search and review . . . . .	103
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 . . . . .	140
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) . . . . .	169
Figure 8-1: Model of military career progression and exposure to occupational factors . . . . .	192

## LIST OF TABLES

Table 1-1: Research questions corresponding to four distinct thesis studies . . . . .	4
Table 2-1: Disability weights associated with the lived experiences of select disorders, as calculated for the Global Burden of Disease (GBD) study . . . . .	19
Table 4-1: Characteristics of Regular Force personnel with past-year major depression . . . . .	75
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 . . . . .	76
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 . . . . .	78
Table 4-4: 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 . . . . .	79
Table 5-1: Summary of studies measuring mental health service utilization in military personnel with depression . . . . .	104
Table 5-2: Summary of studies measuring mental health service utilization in military personnel with any mental health disorder . . . . .	106
Table 6-1: Person-years at risk of an incident major depression diagnosis, CAF Regular Force personnel, January to December 2017. . . . .	141
Table 6-2: Incidence of new major depression diagnoses in CAF Regular Force personnel, January to December 2017. . . . .	142
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. . . . .	143
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. . . . .	170

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 . . . 171

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. . . . . 172

Table 8-1: Summary of research findings from Chapters 4 to 7 . . . . . 186

## **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

<b>Study</b>	<b>Research Question</b>
1 (Chapter 4)	<ul style="list-style-type: none"> <li>• 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?</li> <li>• Among depressed CAF personnel who used mental health services in the past 12 months, what proportion were treated by a mental health specialist?</li> <li>• 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?</li> </ul>
2 (Chapter 5)	<ul style="list-style-type: none"> <li>• 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?</li> <li>• What is the median period prevalence of mental health service use among depressed military personnel, across these studies?</li> </ul>
3 (Chapter 6)	<ul style="list-style-type: none"> <li>• What proportion of CAF personnel have a past-year clinician diagnosis of major depression in their electronic medical records?</li> <li>• Is the proportion of CAF personnel with past-year diagnosis of major depression consistent with the findings of Chapter 4?</li> <li>• What is the incidence rate of new major depression diagnoses in CAF personnel?</li> <li>• What socio-demographic and occupational factors are associated with the incidence rate of new major depression diagnoses in CAF personnel?</li> </ul>
4 (Chapter 7)	<ul style="list-style-type: none"> <li>• Are incident diagnoses of spinal pain associated with the likelihood of incident diagnoses of major depression over a 20-month period?</li> <li>• 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?</li> <li>• Is the risk of an incident diagnosis of major depression increased after an incident diagnosis of spinal pain?</li> <li>• Is the risk of an incident diagnosis of spinal pain increased after an incident diagnosis of major depression?</li> </ul>

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

1. Kessler RC, Bromet EJ, de Jonge P, et al (2017) The burden of depressive illness. In: Cohen NL (ed) *Public Health Perspectives on Depressive Disorders*. Johns Hopkins University Press, Baltimore
2. Ferrari AJ, Charlson FJ, Norman RE, et al (2013) Burden of Depressive Disorders by Country, Sex, Age, and Year: Findings from the Global Burden of Disease Study 2010. *PLoS Med* 10:e1001547. <https://doi.org/10.1371/journal.pmed.1001547>
3. Mcfarlane A, Sriapada R, Ganoczy D, et al (2011) Mental health in the Australian Defence Force: 2010 ADF mental health and wellbeing study: Full report. Canberra
4. Rusu C, Zamorski MA, Boulos D, Garber BG (2016) Prevalence Comparison of Past-year Mental Disorders and Suicidal Behaviours in the Canadian Armed Forces and the Canadian General Population. *Can J Psychiatry* 61:46S-55S.
5. Goodwin L, Wessely S, Hotopf M, et al (2015) Are common mental disorders more prevalent in the UK serving military compared to the general working population? *Psychol Med* 45:1881–91. <https://doi.org/10.1017/S0033291714002980>
6. Gadermann AM, Engel CC, Naifeh JA, et al (2012) Prevalence of DSM-IV major depression among U.S. military personnel: meta-analysis and simulation. *Mil Med* 177:47–59
7. Ursano RJ, Kessler RC, Stein MB, et al (2016) Risk Factors, Methods, and Timing of Suicide Attempts Among US Army Soldiers. *JAMA psychiatry* 73:741–9. <https://doi.org/10.1001/jamapsychiatry.2016.0600>
8. Pflanz SE, Ogle AD (2006) Job Stress, Depression, Work Performance, and Perceptions of Supervisors in Military Personnel. *Mil Med* 171:861–865. <https://doi.org/10.7205/MILMED.171.9.861>
9. Littman AJ, Jacobson IG, Boyko EJ, et al (2013) Weight change following US military service. *Int J Obes* 37:244–253. <https://doi.org/10.1038/ijo.2012.46>
10. NATO Science and Technology Organization (2014) *A NATO Guide for Assessing Deployability for Military Personnel with Medical Conditions*

11. Stetz MC, McDonald JJ, Lukey BJ, Gifford RK (2005) Psychiatric diagnoses as a cause of medical evacuation. *Aviat Space Environ Med* 76:C15-20
12. Parikh S V, Quilty LC, Ravitz P, et al (2016) Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder: Section 2. Psychological Treatments. *Can J Psychiatry* 61:524–39. <https://doi.org/10.1177/0706743716659418>
13. Kennedy SH, Lam RW, McIntyre RS, et al (2016) Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder. *Can J Psychiatry* 61:540–560. <https://doi.org/10.1177/0706743716659417>
14. Bockting CL, Hollon SD, Jarrett RB, et al (2015) A lifetime approach to major depressive disorder: The contributions of psychological interventions in preventing relapse and recurrence. *Clin Psychol Rev* 41:16–26. <https://doi.org/10.1016/j.cpr.2015.02.003>
15. Thornicroft G, Chatterji S, Evans-Lacko S, et al (2017) Undertreatment of people with major depressive disorder in 21 countries. *Br J Psychiatry* 210:119–124. <https://doi.org/10.1192/bjp.bp.116.188078>
16. Weeks M, Zamorski MA, Rusu C, Colman I (2017) Mental Illness-Related Stigma in Canadian Military and Civilian Populations: A Comparison Using Population Health Survey Data. *Psychiatr Serv* 68:710–716. <https://doi.org/10.1176/appi.ps.201600398>
17. Clark LL, Hu Z (2015) Diagnoses of low back pain, active component, U.S. Armed Forces, 2010-2014. *MSMR* 22:8–11
18. Bair MJ, Robinson RL, Katon W, Kroenke K (2003) Depression and Pain Comorbidity. *Arch Intern Med* 163:2433. <https://doi.org/10.1001/archinte.163.20.2433>
19. Zamorski MA, Bennett RE, Rusu C, et al (2016) Prevalence of Past-Year Mental Disorders in the Canadian Armed Forces, 2002-2013. *Can J Psychiatry* 61:26S-35S.
20. Lash TL, Fox MP, Fink AK (2009) *Applying Quantitative Bias Analysis to Epidemiological Data*. Springer

## 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

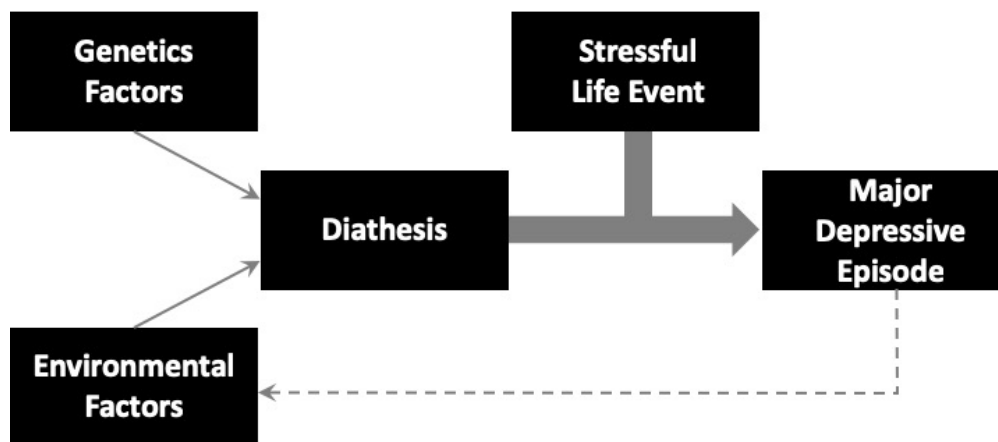
4. Change in sleep (either insomnia or hypersomnia)
5. Change in activity level (either psychomotor agitation or retardation)
6. Fatigue or loss of energy
7. Feelings of worthlessness, or excessive or inappropriate guilt
8. Diminished ability to think or concentrate
9. Thoughts of death, or suicidal 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, 10<sup>th</sup> 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).



**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-HTTLPT serotonin transporter gene may be associated with a higher risk of major depression onset following exposure to a stressful live 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-HTTLPR allele ( $p = 0.24$ ) [23]. These findings have been replicated in subsequent studies of 5-HTTLPR 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-HTTLPR 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 Kraepelin (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

[71]. 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].

<b>Disorder</b>	<b>Lived experience</b>	<b>Disability Weight</b>
<i>Major depression, severe</i>	<ul style="list-style-type: none"> <li>• <i>Overwhelming and constant sadness.</i></li> <li>• <i>Cannot function in daily life.</i></li> </ul>	0.658
Ischemic stroke, severe	<ul style="list-style-type: none"> <li>• Confined to bed or wheelchair.</li> <li>• Depends on others for feeding, toileting, and dressing.</li> <li>• Difficulty speaking, thinking clearly, and remembering things.</li> </ul>	0.588
Parkinson disease, severe	<ul style="list-style-type: none"> <li>• Severe tremors and moves very slowly</li> <li>• Difficulty walking, talking, swallowing, sleeping, and remembering things</li> </ul>	0.575
Idiopathic epilepsy, severe	<ul style="list-style-type: none"> <li>• Sudden seizures <math>\geq</math> once each month, with violent muscle contraction and loss of bowel control</li> <li>• Between seizures, memory loss and difficulty concentrating</li> </ul>	0.552
Cancer, terminal phase	<ul style="list-style-type: none"> <li>• Confined to bed with nausea and no appetite</li> <li>• Regular use of strong medications to avoid constant pain</li> </ul>	0.540
<i>Major depression, moderate</i>	<ul style="list-style-type: none"> <li>• <i>Constant sadness and loss of interest</i></li> <li>• <i>Difficulty sleeping and concentrating</i></li> </ul>	0.396
Alzheimer disease, moderate	<ul style="list-style-type: none"> <li>• Memory problems and confusion</li> <li>• Feels disoriented, and sometimes hear voices</li> <li>• Needs help with some daily activities</li> </ul>	0.377
Low back pain, severe	<ul style="list-style-type: none"> <li>• Constant back pain</li> <li>• Difficulty dressing, sitting, standing, walking, lifting things, and sleeping</li> </ul>	0.372
<i>Major depression, mild</i>	<ul style="list-style-type: none"> <li>• <i>Persistent sadness and loss of interest</i></li> <li>• <i>Sometimes sleeps badly, feels tired, or has trouble concentrating</i></li> </ul>	0.145
Ebola	<ul style="list-style-type: none"> <li>• High fever and pain</li> <li>• Feels very weak, which causes great difficulty with daily activities</li> </ul>	0.133

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 comorbid 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 **RE**porting of studies **C**onducted using **O**bservational **R**outinely-collected health **D**ata 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 19<sup>th</sup> and early 20<sup>th</sup> 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

1. Davison K (2009) Historical aspects of mood disorders. *Psychiatry* 8:47–51. <https://doi.org/10.1016/j.mppsy.2008.10.019>
2. Gruenberg AM, Goldstein RD, Pincus HA Classification of Depression: Research and Diagnostic Criteria: DSM-IV and ICD-10. In: *Biology of Depression*. Wiley-VCH Verlag GmbH, Weinheim, Germany, pp 1–12
3. Lewis AJ (1934) Melancholia: A Historical Review. *J Ment Sci* 80:1–42. <https://doi.org/10.1192/bjp.80.328.1>
4. American Psychiatric Association (2013) *Diagnostic and Statistical Manual of Mental 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
6. Biesheuvel-Leliefeld KEM, Kok GD, Bockting CLH, et al (2014) Effectiveness of psychological interventions in preventing recurrence of depressive disorder: Meta-analysis and meta-regression. *J Affect Disord* 174:400–410. <https://doi.org/10.1016/j.jad.2014.12.016>
7. Spijker J, de Graaf R, Bijl R V, et al (2002) Duration of major depressive episodes in the general population: results from The Netherlands Mental Health Survey and Incidence Study (NEMESIS). *Br J Psychiatry* 181:208–13
8. Kessler RC, Berglund P, Demler O, et al (2003) The Epidemiology of Major Depressive Disorder. *JAMA* 289:3095. <https://doi.org/10.1001/jama.289.23.3095>
9. Bebbington P (1987) Misery and the of Disease Theories of Depression. *Int J Soc Psychiatry* 33:13–20. <https://doi.org/10.1177/002076408703300102>
10. Robins CJ, Block P (1989) Cognitive theories of depression viewed from a diathesis-stress perspective: Evaluations of the models of Beck and of Abramson, Seligman, and Teasdale. *Cognit Ther Res* 13:297–313. <https://doi.org/10.1007/BF01173475>
11. Patten SB (2013) Major depression epidemiology from a diathesis-stress

- conceptualization. *BMC Psychiatry* 13:19. <https://doi.org/10.1186/1471-244X-13-19>
12. Cramer AOJ, Van Borkulo CD, Giltay EJ, et al (2016) Major Depression as a Complex Dynamic System. <https://doi.org/10.1371/journal.pone.0167490>
  13. Colman I, Ataullahjan A (2010) Life Course Perspectives on the Epidemiology of Depression. *Can J Psychiatry* 55:622–632. <https://doi.org/10.1177/070674371005501002>
  14. Kendler KS, Karkowski LM, Prescott CA (1999) Causal Relationship Between Stressful Life Events and the Onset of Major Depression. *Am J Psychiatry* 156:837–841. <https://doi.org/10.1176/ajp.156.6.837>
  15. Mitchell PB, Parker GB, Gladstone GL, et al (2003) Severity of stressful life events in first and subsequent episodes of depression: the relevance of depressive subtype
  16. Park S, Hatim A, Si T-M, et al (2015) Stressful life events preceding the onset of depression in Asian patients with major depressive disorder. *Int J Soc Psychiatry* 61:735–42. <https://doi.org/10.1177/0020764015577842>
  17. Hammen C (2005) Stress and Depression. *Annu Rev Clin Psychol* 1:293–319. <https://doi.org/10.1146/annurev.clinpsy.1.102803.143938>
  18. Kendler KS, Thornton LM, Gardner CO (2000) Stressful Life Events and Previous Episodes in the Etiology of Major Depression in Women: An Evaluation of the “Kindling” Hypothesis. *Am J Psychiatry* 157:1243–1251. <https://doi.org/10.1176/appi.ajp.157.8.1243>
  19. Sullivan PF, Neale MC, Kendler KS (2000) Genetic Epidemiology of Major Depression: Review and Meta-Analysis. *Am J Psychiatry* 157:1552–1562. <https://doi.org/10.1176/appi.ajp.157.10.1552>
  20. Kendler KS, Gatz M, Gardner CO, Pedersen NL (2006) A Swedish National Twin Study of Lifetime Major Depression. *Am J Psychiatry* 163:109–114. <https://doi.org/10.1176/appi.ajp.163.1.109>
  21. Flint J, Kendler KS (2014) The Genetics of Major Depression. *Neuron* 81:1214. <https://doi.org/10.1016/j.neuron.2014.02.033>
  22. Malhi GS, Mann JJ (2018) Depression. *Lancet* (London, England) 392:2299–2312.

- [https://doi.org/10.1016/S0140-6736\(18\)31948-2](https://doi.org/10.1016/S0140-6736(18)31948-2)
23. Caspi A, Sugden K, Moffitt TE, et al (2003) Influence of Life Stress on Depression: Moderation by a Polymorphism in the 5-HTT Gene. *Science* (80- ) 301:386–389. <https://doi.org/10.1126/science.1083968>
  24. Karg K, Burmeister M, Shedden K, Sen S (2011) The serotonin transporter promoter variant (5-HTTLPR), stress, and depression meta-analysis revisited: evidence of genetic moderation. *Arch Gen Psychiatry* 68:444–54. <https://doi.org/10.1001/archgenpsychiatry.2010.189>
  25. Eaton WW, Shao H, Nestadt G, et al (2008) Population-Based Study of First Onset and Chronicity in Major Depressive Disorder. *Arch Gen Psychiatry* 65:513. <https://doi.org/10.1001/archpsyc.65.5.513>
  26. Risch N, Herrell R, Lehner T, et al (2009) Interaction between the serotonin transporter gene (5-HTTLPR), stressful life events, and risk of depression: a meta-analysis. *JAMA* 301:2462–71. <https://doi.org/10.1001/jama.2009.878>
  27. Otte C, Gold SM, Penninx BW, et al (2016) Major depressive disorder. *Nat Rev Dis Prim* 2:16065. <https://doi.org/10.1038/nrdp.2016.65>
  28. Colman I, Jones PB, Kuh D, et al (2014) Early development, stress and depression across the life course: pathways to depression in a national British birth cohort. *Psychol Med* 44:2845–2854. <https://doi.org/10.1017/S0033291714000385>
  29. Kramer MS (1987) Determinants of low birth weight: methodological assessment and meta-analysis. *Bull World Health Organ* 65:663–737
  30. Wadhwa PD, Sandman CA, Porto M, et al (1993) The association between prenatal stress and infant birth weight and gestational age at birth: a prospective investigation. *Am J Obstet Gynecol* 169:858–65. [https://doi.org/10.1016/0002-9378\(93\)90016-c](https://doi.org/10.1016/0002-9378(93)90016-c)
  31. Lima SAM, El Dib RP, Rodrigues MRK, et al (2018) Is the risk of low birth weight or preterm labor greater when maternal stress is experienced during pregnancy? A systematic review and meta-analysis of cohort studies. *PLoS One* 13:e0200594. <https://doi.org/10.1371/journal.pone.0200594>

32. De Mola CL, De França GVA, de Avila Quevedo L, Horta BL (2014) Low birth weight, preterm birth and small for gestational age association with adult depression: systematic review and meta-analysis. *Br J Psychiatry* 205:340–347.  
<https://doi.org/10.1192/bjp.bp.113.139014>
33. Faa G, Manchia M, Pintus R, et al (2016) Fetal programming of neuropsychiatric disorders. *Birth Defects Res Part C Embryo Today Rev* 108:207–223.  
<https://doi.org/10.1002/bdrc.21139>
34. Hellemans KGC, Sliwowska JH, Verma P, Weinberg J (2010) Prenatal alcohol exposure: fetal programming and later life vulnerability to stress, depression and anxiety disorders. *Neurosci Biobehav Rev* 34:791–807. <https://doi.org/10.1016/j.neubiorev.2009.06.004>
35. Kapoor A, Dunn E, Kostaki A, et al (2006) Fetal programming of hypothalamo-pituitary-adrenal function: prenatal stress and glucocorticoids. *J Physiol* 572:31–44.  
<https://doi.org/10.1113/jphysiol.2006.105254>
36. Xiong F, Zhang L (2013) Role of the hypothalamic–pituitary–adrenal axis in developmental programming of health and disease. *Front Neuroendocrinol* 34:27–46.  
<https://doi.org/10.1016/j.yfrne.2012.11.002>
37. de Kloet ER, Joëls M, Holsboer F (2005) Stress and the brain: from adaptation to disease. *Nat Rev Neurosci* 6:463–475. <https://doi.org/10.1038/nrn1683>
38. Heim C, Newport DJ, Mletzko T, et al (2008) The link between childhood trauma and depression: insights from HPA axis studies in humans. *Psychoneuroendocrinology* 33:693–710. <https://doi.org/10.1016/j.psyneuen.2008.03.008>
39. van Bodegom M, Homberg JR, Henckens MJAG (2017) Modulation of the Hypothalamic-Pituitary-Adrenal Axis by Early Life Stress Exposure. *Front Cell Neurosci* 11:87. <https://doi.org/10.3389/fncel.2017.00087>
40. Heim C, Newport DJ, Wagner D, et al (2002) The role of early adverse experience and adulthood stress in the prediction of neuroendocrine stress reactivity in women: a multiple regression analysis. *Depress Anxiety* 15:117–25. <https://doi.org/10.1002/da.10015>
41. Jaworska-Andryszewska P, Rybakowski JK (2019) Childhood trauma in mood disorders: Neurobiological mechanisms and implications for treatment. *Pharmacol Rep* 71:112–120.

- <https://doi.org/10.1016/j.pharep.2018.10.004>
42. Kendler KS, Gardner CO, Prescott CA (2006) Toward a comprehensive developmental model for major depression in men. *Am J Psychiatry* 163:115–24.  
<https://doi.org/10.1176/appi.ajp.163.1.115>
  43. Patten SB, Wilkes TCR, Williams JVA, et al (2015) Retrospective and prospectively assessed childhood adversity in association with major depression, alcohol consumption and painful conditions. *Epidemiol Psychiatr Sci* 24:158–165.  
<https://doi.org/10.1017/S2045796014000018>
  44. Chapman DP, Whitfield CL, Felitti VJ, et al (2004) Adverse childhood experiences and the risk of depressive disorders in adulthood. *J Affect Disord* 82:217–225.  
<https://doi.org/10.1016/j.jad.2003.12.013>
  45. Nelson EC, Heath AC, Madden PAF, et al (2002) Association between self-reported childhood sexual abuse and adverse psychosocial outcomes: results from a twin study. *Arch Gen Psychiatry* 59:139–45
  46. Meng X, Brunet A, Turecki G, et al (2017) Risk factor modifications and depression incidence: a 4-year longitudinal Canadian cohort of the Montreal Catchment Area Study. *BMJ Open* 7:e015156. <https://doi.org/10.1136/bmjopen-2016-015156>
  47. Arias-de la Torre J, Vilagut G, Martín V, et al (2018) Prevalence of major depressive disorder and association with personal and socio-economic factors. Results for Spain of the European Health Interview Survey 2014–2015. *J Affect Disord* 239:203–207.  
<https://doi.org/10.1016/j.jad.2018.06.051>
  48. Scarinci IC, Beech BM, Naumann W, et al (2002) Depression, socioeconomic status, age, and marital status in black women: a national study. *Ethn Dis* 12:421–8
  49. Zimmerman FJ, Katon W (2005) Socioeconomic status, depression disparities, and financial strain: what lies behind the income-depression relationship? *Health Econ* 14:1197–1215. <https://doi.org/10.1002/hec.1011>
  50. REHMAN U, GOLLAN J, MORTIMER A (2008) The marital context of depression: Research, limitations, and new directions☆. *Clin Psychol Rev* 28:179–198.

- <https://doi.org/10.1016/j.cpr.2007.04.007>
51. Bulloch AGM, Williams JVA, Lavorato DH, Patten SB (2017) The depression and marital status relationship is modified by both age and gender. *J Affect Disord* 223:65–68.  
<https://doi.org/10.1016/j.jad.2017.06.007>
  52. 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 IN THE ETIOLOGY OF DEPRESSION. *Depress Anxiety* 31:326–334.  
<https://doi.org/10.1002/da.22221>
  53. Brown GW, Ban M, Craig TKJ, et al (2013) SEROTONIN TRANSPORTER LENGTH POLYMORPHISM, CHILDHOOD MALTREATMENT, AND CHRONIC DEPRESSION: A SPECIFIC GENE-ENVIRONMENT INTERACTION. *Depress Anxiety* 30:5–13. <https://doi.org/10.1002/da.21982>
  54. Cohen S, Murphy MLM, Prather AA (2019) Ten Surprising Facts About Stressful Life Events and Disease Risk. *Annu Rev Psychol* 70:577–597.  
<https://doi.org/10.1146/annurev-psych-010418-102857>
  55. Buckman JEJ, Underwood A, Clarke K, et al (2018) Risk factors for relapse and recurrence of depression in adults and how they operate: A four-phase systematic review and meta-synthesis. *Clin Psychol Rev* 64:13–38. <https://doi.org/10.1016/j.cpr.2018.07.005>
  56. Solomon DA, Keller MB, Leon AC, et al (2000) Multiple Recurrences of Major Depressive Disorder. *Am J Psychiatry* 157:229–233.  
<https://doi.org/10.1176/appi.ajp.157.2.229>
  57. Bulloch A, Williams J, Lavorato D, Patten S (2014) Recurrence of major depressive episodes is strongly dependent on the number of previous episodes. *Depress Anxiety* 31:72–6. <https://doi.org/10.1002/da.22173>
  58. Kessing LV, Andersen PK (1999) The effect of episodes on recurrence in affective disorder: a case register study. *J Affect Disord* 53:225–231.  
[https://doi.org/10.1016/S0165-0327\(98\)00125-6](https://doi.org/10.1016/S0165-0327(98)00125-6)
  59. Post RM (2016) Epigenetic basis of sensitization to stress, affective episodes, and

- stimulants: implications for illness progression and prevention. *Bipolar Disord* 18:315–24. <https://doi.org/10.1111/bdi.12401>
60. Monroe SM, Harkness KL (2005) Life Stress, the “Kindling” Hypothesis, and the Recurrence of Depression: Considerations From a Life Stress Perspective. *Psychol Rev* 112:417–445. <https://doi.org/10.1037/0033-295X.112.2.417>
  61. Kraepelin E (1921) *Manic-depressive insanity and paranoia*. Edinburgh, Scotland
  62. Wichers M, Geschwind N, van Os J, Peeters F (2010) Scars in depression: is a conceptual shift necessary to solve the puzzle? *Psychol Med* 40:359–65
  63. Kendler KS, Neale MC, Kessler RC, et al (1993) A Longitudinal Twin Study of Personality and Major Depression in Women. *Arch Gen Psychiatry* 50:853. <https://doi.org/10.1001/archpsyc.1993.01820230023002>
  64. Thornicroft G, Chatterji S, Evans-Lacko S, et al (2017) Undertreatment of people with major depressive disorder in 21 countries. *Br J Psychiatry* 210:119–124. <https://doi.org/10.1192/bjp.bp.116.188078>
  65. Ferrari AJ, Somerville AJ, Baxter AJ, et al (2013) Global variation in the prevalence and incidence of major depressive disorder: a systematic review of the epidemiological literature. *Psychol Med* 43:471–481. <https://doi.org/10.1017/S0033291712001511>
  66. Patten SB, Williams JVA, Lavorato DH, et al (2015) Descriptive Epidemiology of Major Depressive Disorder in Canada in 2012. *Can J Psychiatry* 60:23–30. <https://doi.org/10.1177/070674371506000106>
  67. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators SL, Abate D, Abate KH, et al (2018) Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* (London, England) 392:1789–1858. [https://doi.org/10.1016/S0140-6736\(18\)32279-7](https://doi.org/10.1016/S0140-6736(18)32279-7)
  68. Kessler RC, Bromet EJ (2013) The Epidemiology of Depression Across Cultures. *Annu Rev Public Health* 34:119–138. <https://doi.org/10.1146/annurev-publhealth-031912-114409>

69. Riihimäki K, Sintonen H, Vuorilehto M, et al (2016) Health-related quality of life of primary care patients with depressive disorders. *Eur Psychiatry* 37:28–34. <https://doi.org/10.1016/j.eurpsy.2016.04.008>
70. Salomon JA, Haagsma JA, Davis A, et al (2015) Disability weights for the Global Burden of Disease 2013 study. *Lancet Glob Heal* 3:e712–e723. [https://doi.org/10.1016/S2214-109X\(15\)00069-8](https://doi.org/10.1016/S2214-109X(15)00069-8)
71. Salomon JA, Vos T, Hogan DR, et al (2012) Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010. *Lancet (London, England)* 380:2129–43. [https://doi.org/10.1016/S0140-6736\(12\)61680-8](https://doi.org/10.1016/S0140-6736(12)61680-8)
72. Global Burden of Disease Collaborative Network (2018) Global Burden of Disease Study 2017 (GBD 2017) Disability Weights. Seattle, United States
73. Kessler RC, Bromet EJ, de Jonge P, et al (2017) The burden of depressive illness. In: Cohen NL (ed) *Public Health Perspectives on Depressive Disorders*. Johns Hopkins University Press, Baltimore
74. Ferrari AJ, Charlson FJ, Norman RE, et al (2013) Burden of Depressive Disorders by Country, Sex, Age, and Year: Findings from the Global Burden of Disease Study 2010. *PLoS Med* 10:e1001547. <https://doi.org/10.1371/journal.pmed.1001547>
75. Alonso J, Petukhova M, Vilagut G, et al (2011) Days out of role due to common physical and mental conditions: results from the WHO World Mental Health surveys. *Mol Psychiatry* 16:1234–1246. <https://doi.org/10.1038/mp.2010.101>
76. Kessler RC (2012) The Costs of Depression. *Psychiatr Clin North Am* 35:1–14. <https://doi.org/10.1016/j.psc.2011.11.005>
77. Greenberg PE, Fournier A-A, Sisitsky T, et al (2015) The Economic Burden of Adults With Major Depressive Disorder in the United States (2005 and 2010). *J Clin Psychiatry* 76:155–162. <https://doi.org/10.4088/JCP.14m09298>
78. Aguilar-Gaxiola S, Loera G, Vigo D, et al (2017) The burden of comorbidity: depressive and physical disorders. In: Cohen NL (ed) *Public Health Perspectives on Depressive Disorders*. Johns Hopkins University Press, Baltimore

79. Frasure-Smith N, Lespérance F (2008) Depression and Anxiety as Predictors of 2-Year Cardiac Events in Patients With Stable Coronary Artery Disease. *Arch Gen Psychiatry* 65:62. <https://doi.org/10.1001/archgenpsychiatry.2007.4>
80. Dersh J, Polatin PB, Gatchel RJ Chronic pain and psychopathology: research findings and theoretical considerations. *Psychosom Med* 64:773–86
81. Bruce DG, Davis WA, Dragovic M, et al (2016) Comorbid Anxiety and Depression and Their Impact on Cardiovascular Disease in Type 2 Diabetes: The Fremantle Diabetes Study Phase II. *Depress Anxiety* 33:960–966. <https://doi.org/10.1002/da.22523>
82. Freedland KE, Hessler MJ, Carney RM, et al (2016) Major Depression and Long-Term Survival of Patients With Heart Failure. *Psychosom Med* 78:896–903. <https://doi.org/10.1097/PSY.0000000000000346>
83. DeWaters AL, Chansard M, Anzueto A, et al (2018) The Association Between Major Depressive Disorder and Outcomes in Older Veterans Hospitalized With Pneumonia. *Am J Med Sci* 355:21–26. <https://doi.org/10.1016/j.amjms.2017.08.015>
84. Balogun RA, Omotoso BA, Xin W, et al (2017) Major Depression and Long-Term Outcomes of Acute Kidney Injury. *Nephron* 135:23–30. <https://doi.org/10.1159/000449474>
85. Pilipenko N, Karekla M, Georgiou A, Feldman J (2016) Impact of psychiatric illness upon asthma patients' health care utilization and illness control. Are all psychiatric comorbidities created equal? *Psychol Health Med* 21:787–799. <https://doi.org/10.1080/13548506.2015.1131995>
86. Chan CMH, Wan Ahmad WA, MD Yusof M, et al (2015) Effects of depression and anxiety on mortality in a mixed cancer group: a longitudinal approach using standardised diagnostic interviews. *Psychooncology* 24:718–725. <https://doi.org/10.1002/pon.3714>
87. Parikh S V, Quilty LC, Ravitz P, et al (2016) Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder: Section 2. Psychological Treatments. *Can J Psychiatry* 61:524–39. <https://doi.org/10.1177/0706743716659418>
88. Kennedy SH, Lam RW, McIntyre RS, et al (2016) Canadian Network for Mood and

- Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder. *Can J Psychiatry* 61:540–560.  
<https://doi.org/10.1177/0706743716659417>
89. Qaseem A, Barry MJ, Kansagara D, Clinical Guidelines Committee of the American College of Physicians (2016) Nonpharmacologic Versus Pharmacologic Treatment of Adult Patients With Major Depressive Disorder: A Clinical Practice Guideline From the American College of Physicians. *Ann Intern Med* 164:350–9.  
<https://doi.org/10.7326/M15-2570>
  90. Tylee A (2006) Identifying and managing depression in primary care in the United kingdom. *J Clin Psychiatry* 67 Suppl 6:41–5
  91. Bockting CL, Hollon SD, Jarrett RB, et al (2015) A lifetime approach to major depressive disorder: The contributions of psychological interventions in preventing relapse and recurrence. *Clin Psychol Rev* 41:16–26. <https://doi.org/10.1016/j.cpr.2015.02.003>
  92. Cuijpers P, Noma H, Karyotaki E, et al (2019) Effectiveness and Acceptability of Cognitive Behavior Therapy Delivery Formats in Adults With Depression. *JAMA Psychiatry* 76:700. <https://doi.org/10.1001/jamapsychiatry.2019.0268>
  93. Mojtabai R, Olfson M, Mechanic D (2002) Perceived need and help-seeking in adults with mood, anxiety, or substance use disorders. *Arch Gen Psychiatry* 59:77–84
  94. Kohn R, Saxena S, Levav I, Saraceno B (2004) The treatment gap in mental health care. *Bull World Health Organ* 82:858–66. <https://doi.org/S0042-96862004001100011>
  95. Mojtabai R, Olfson M (2006) Treatment Seeking for Depression in Canada and the United States. *Psychiatr Serv* 57:631–639. <https://doi.org/10.1176/ps.2006.57.5.631>
  96. Simon GE, Fleck M, Lucas R, et al (2004) Prevalence and predictors of depression treatment in an international primary care study. *Am J Psychiatry* 161:1626–34.  
<https://doi.org/10.1176/appi.ajp.161.9.1626>
  97. Chen J, Hou F (2002) Unmet needs for health care. *Heal reports* 13:23–34
  98. Fikretoglu D, Guay S, Pedlar D, Brunet A (2008) Twelve month use of mental health services in a nationally representative, active military sample. *Med Care* 46:217–23.

<https://doi.org/10.1097/MLR.0b013e31815b979a>

99. Andrews G, Sanderson K, Corry J, Lapsley HM (2000) Using epidemiological data to model efficiency in reducing the burden of depression\*. *J Ment Health Policy Econ* 3:175–186
100. Iglesias-González M, Aznar-Lou I, Peñarrubia-María MT, et al (2018) Effectiveness of watchful waiting versus antidepressants for patients diagnosed of mild to moderate depression in primary care: A 12-month pragmatic clinical trial (INFAP study). *Eur Psychiatry* 53:66–73. <https://doi.org/10.1016/j.eurpsy.2018.06.005>
101. Davidson JRT (2010) Major Depressive Disorder Treatment Guidelines in America and Europe. *J Clin Psychiatry* 71:4–4. <https://doi.org/10.4088/JCP.9058se1c.04gry>
102. Hom MA, Stanley IH, Schneider ME, Joiner TE (2017) A systematic review of help-seeking and mental health service utilization among military service members. *Clin Psychol Rev* 53:59–78. <https://doi.org/10.1016/j.cpr.2017.01.008>
103. Langston V, Gould M, Greenberg N (2007) Culture: What Is Its Effect on Stress in the Military? *Mil Med* 172:931–935. <https://doi.org/10.7205/MILMED.172.9.931>
104. Weeks M, Zamorski MA, Rusu C, Colman I (2017) Mental Illness-Related Stigma in Canadian Military and Civilian Populations: A Comparison Using Population Health Survey Data. *Psychiatr Serv* 68:710–716. <https://doi.org/10.1176/appi.ps.201600398>
105. Mitchell AJ, Vaze A, Rao S (2009) Clinical diagnosis of depression in primary care: a meta-analysis. *Lancet* 374:609–619. [https://doi.org/10.1016/S0140-6736\(09\)60879-5](https://doi.org/10.1016/S0140-6736(09)60879-5)
106. Rost K, Nutting P, Smith J, et al (2000) The role of competing demands in the treatment provided primary care patients with major depression. *Arch Fam Med* 9:150–4
107. Gaynes BN, Rush AJ, Trivedi MH, et al (2008) Primary versus specialty care outcomes for depressed outpatients managed with measurement-based care: results from STAR\*D. *J Gen Intern Med* 23:551–60. <https://doi.org/10.1007/s11606-008-0522-3>
108. Young AS, Klap R, Sherbourne CD, Wells KB (2001) The quality of care for depressive and anxiety disorders in the United States. *Arch Gen Psychiatry* 58:55–61
109. Nicholls SG, Langan SM, Benchimol EI (2017) Routinely collected data: the importance

- of high-quality diagnostic coding to research. *CMAJ* 189:E1054–E1055.  
<https://doi.org/10.1503/cmaj.170807>
110. Kaplan RM, Chambers DA, Glasgow RE (2014) Big data and large sample size: a cautionary note on the potential for bias. *Clin Transl Sci* 7:342–6.  
<https://doi.org/10.1111/cts.12178>
  111. Spiranovic C, Matthews A, Scanlan J, Kirkby KC (2016) Increasing knowledge of mental illness through secondary research of electronic health records: opportunities and challenges. *Adv Ment Heal* 14:14–25. <https://doi.org/10.1080/18387357.2015.1063635>
  112. Raghupathi W, Raghupathi V (2014) Big data analytics in healthcare: promise and potential. *Heal Inf Sci Syst* 2:3. <https://doi.org/10.1186/2047-2501-2-3>
  113. Deeny SR, Steventon A (2015) Making sense of the shadows: priorities for creating a learning healthcare system based on routinely collected data. *BMJ Qual Saf* 24:505–515.  
<https://doi.org/10.1136/bmjqs-2015-004278>
  114. Crumlish N, Kelly BD (2009) How psychiatrists think. *Adv Psychiatr Treat* 15:72–79.  
<https://doi.org/10.1192/apt.bp.107.005298>
  115. Manuel DG, Rosella LC, Stukel TA (2010) Importance of accurately identifying disease in studies using electronic health records. *BMJ* 341:c4226–c4226.  
<https://doi.org/10.1136/bmj.c4226>
  116. Davis KAS, Sudlow CLM, Hotopf M (2016) Can mental health diagnoses in administrative data be used for research? A systematic review of the accuracy of routinely collected diagnoses. *BMC Psychiatry* 16:263. <https://doi.org/10.1186/s12888-016-0963-x>
  117. Lucyk K, Tang K, Quan H (2017) Barriers to data quality resulting from the process of coding health information to administrative data: a qualitative study. *BMC Health Serv Res* 17:766. <https://doi.org/10.1186/s12913-017-2697-y>
  118. Tang KL, Lucyk K, Quan H (2017) Coder perspectives on physician-related barriers to producing high-quality administrative data: a qualitative study. *C open* 5:E617–E622.  
<https://doi.org/10.9778/cmajo.20170036>
  119. Fiest KM, Jette N, Quan H, et al (2014) Systematic review and assessment of validated

- case definitions for depression in administrative data. *BMC Psychiatry* 14:289.  
<https://doi.org/10.1186/s12888-014-0289-5>
120. Townsend L, Walkup JT, Crystal S, Olfson M (2012) A systematic review of validated methods for identifying depression using administrative data. *Pharmacoepidemiol Drug Saf* 21:163–173. <https://doi.org/10.1002/pds.2310>
  121. Benchimol EI, Smeeth L, Guttman A, et al (2015) The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Med* 12:. <https://doi.org/10.1371/JOURNAL.PMED.1001885>
  122. Mcfarlane A, Sriapada R, Ganoczy D, et al (2011) Mental health in the Australian Defence Force: 2010 ADF mental health and wellbeing study: Full report. Canberra
  123. Rusu C, Zamorski MA, Boulos D, Garber BG (2016) Prevalence Comparison of Past-year Mental Disorders and Suicidal Behaviours in the Canadian Armed Forces and the Canadian General Population. *Can J Psychiatry* 61:46S-55S.  
<https://doi.org/10.1177/0706743716628856>
  124. Goodwin L, Wessely S, Hotopf M, et al (2015) Are common mental disorders more prevalent in the UK serving military compared to the general working population? *Psychol Med* 45:1881–91. <https://doi.org/10.1017/S0033291714002980>
  125. Gadermann AM, Engel CC, Naifeh JA, et al (2012) Prevalence of DSM-IV major depression among U.S. military personnel: meta-analysis and simulation. *Mil Med* 177:47–59
  126. Hoge CW, Castro CA, Messer SC, et al (2004) Combat Duty in Iraq and Afghanistan, Mental Health Problems, and Barriers to Care. *N Engl J Med* 351:13–22.  
<https://doi.org/10.1056/NEJMoa040603>
  127. Vanderploeg RD, Nazem S, Brenner LA, et al (2015) Suicidal Ideation among Florida National Guard Members: Combat Deployment and Non-Deployment Risk and Protective Factors. *Arch Suicide Res* 19:453–471. <https://doi.org/10.1080/13811118.2014.957454>
  128. Wells TS, LeardMann CA, Fortuna SO, et al (2010) A prospective study of depression following combat deployment in support of the wars in Iraq and Afghanistan. *Am J Public Health* 100:90–9. <https://doi.org/10.2105/AJPH.2008.155432>

129. Shen Y-C, Arkes J, Williams T V (2012) Effects of Iraq/Afghanistan deployments on major depression and substance use disorder: analysis of active duty personnel in the US military. *Am J Public Health* 102 Suppl 1:S80-7.  
<https://doi.org/10.2105/AJPH.2011.300425>
130. Bonde JP, Utzon-Frank N, Bertelsen M, et al (2016) Risk of depressive disorder following disasters and military deployment: systematic review with meta-analysis. *Br J Psychiatry* 208:330–336. <https://doi.org/10.1192/bjp.bp.114.157859>
131. Boulos D, Zamorski MA (2016) Contribution of the Mission in Afghanistan to the Burden of Past-Year Mental Disorders in Canadian Armed Forces Personnel, 2013. *Can J Psychiatry* 61:64S-76S. <https://doi.org/10.1177/0706743716628857>
132. Ursano RJ, Kessler RC, Stein MB, et al (2016) Risk Factors, Methods, and Timing of Suicide Attempts Among US Army Soldiers. *JAMA psychiatry* 73:741–9.  
<https://doi.org/10.1001/jamapsychiatry.2016.0600>
133. Kennedy CH, Zillmer E (2012) *Military psychology : clinical and operational applications*. Guilford Press
134. Clever M, Segal DR (2012) After Conscription: The United States and the All-Volunteer Force. *Sicherheit und Frieden / Secur. Peace* 30:9–18
135. Thériault FL, Gabler K, Naicker K (2016) Health and Lifestyle Information Survey of Canadian Armed Forces Personnel 2013/2014 – Regular Forces Report. Department of National Defence., Ottawa, Canada
136. Nock MK, Stein MB, Heeringa SG, et al (2014) Prevalence and Correlates of Suicidal Behavior Among Soldiers. *JAMA Psychiatry* 71:514.  
<https://doi.org/10.1001/jamapsychiatry.2014.30>
137. Kessler RC, Davis CG, Kendler KS (1997) Childhood adversity and adult psychiatric disorder in the US National Comorbidity Survey. *Psychol Med* 27:1101–19
138. Afifi TO, Taillieu T, Zamorski MA, et al (2016) Association of Child Abuse Exposure With Suicidal Ideation, Suicide Plans, and Suicide Attempts in Military Personnel and the General Population in Canada. *JAMA Psychiatry* 73:229.  
<https://doi.org/10.1001/jamapsychiatry.2015.2732>

139. Blosnich JR, Dichter ME, Cerulli C, et al (2014) Disparities in adverse childhood experiences among individuals with a history of military service. *JAMA psychiatry* 71:1041–8. <https://doi.org/10.1001/jamapsychiatry.2014.724>
140. Adler AB, Castro CA (2013) An Occupational Mental Health Model for the Military. *Mil Behav Heal* 1:41–45. <https://doi.org/10.1080/21635781.2012.721063>
141. Drummet AR, Coleman M, Cable S (2003) Military Families Under Stress: Implications for Family Life Education\*. *Fam Relat* 52:279–287. <https://doi.org/10.1111/j.1741-3729.2003.00279.x>
142. Liu X, Evatt DP, Belsher BE (2019) Development of Longitudinal Data Analysis in Mental Health Research For Military Service Members. *Mil Med* 184:e227–e232. <https://doi.org/10.1093/milmed/usy370>
143. Clark LL, Hu Z (2015) Diagnoses of low back pain, active component, U.S. Armed Forces, 2010–2014. *MSMR* 22:8–11
144. Vun E, Turner S, Sareen J, et al (2018) Prevalence of comorbid chronic pain and mental health conditions in Canadian Armed Forces active personnel: analysis of a cross-sectional survey. *C open* 6:E528–E536. <https://doi.org/10.9778/cmajo.20180093>
145. Murray JB (1982) Psychological Aspects of Low Back Pain: Summary. *Psychol Rep* 50:343–351. <https://doi.org/10.2466/pr0.1982.50.2.343>
146. Lépine J-P, Briley M (2004) The epidemiology of pain in depression. *Hum Psychopharmacol Clin Exp* 19:S3–S7. <https://doi.org/10.1002/hup.618>
147. Currie SR, Wang J (2004) Chronic back pain and major depression in the general Canadian population. *Pain* 107:54–60
148. Cherkin DC, Sherman KJ, Balderson BH, et al (2016) Effect of Mindfulness-Based Stress Reduction vs Cognitive Behavioral Therapy or Usual Care on Back Pain and Functional Limitations in Adults With Chronic Low Back Pain. *JAMA* 315:1240. <https://doi.org/10.1001/jama.2016.2323>
149. Richmond H, Hall AM, Copsey B, et al (2015) The Effectiveness of Cognitive Behavioural Treatment for Non-Specific Low Back Pain: A Systematic Review and Meta-

- Analysis. PLoS One 10:e0134192. <https://doi.org/10.1371/journal.pone.0134192>
150. Goesling J, Clauw DJ, Hassett AL (2013) Pain and Depression: An Integrative Review of Neurobiological and Psychological Factors. *Curr Psychiatry Rep* 15:421. <https://doi.org/10.1007/s11920-013-0421-0>
  151. Fernandez M, Colodro-Conde L, Hartvigsen J, et al (2017) Chronic low back pain and the risk of depression or anxiety symptoms: insights from a longitudinal twin study. *Spine J* 17:905–912. <https://doi.org/10.1016/j.spinee.2017.02.009>
  152. Pinheiro MB, Ferreira ML, Refshauge K, et al (2017) Symptoms of Depression and Risk of Low Back Pain. *Clin J Pain* 33:777–785. <https://doi.org/10.1097/AJP.0000000000000466>
  153. Sanders G, Stevinson C (2017) Associations between retirement reasons, chronic pain, athletic identity, and depressive symptoms among former professional footballers. *Eur J Sport Sci* 17:1311–1318. <https://doi.org/10.1080/17461391.2017.1371795>
  154. Blakey SM, Wagner HR, Naylor J, et al (2018) Chronic Pain, TBI, and PTSD in Military Veterans: A Link to Suicidal Ideation and Violent Impulses? *J Pain* 19:797–806. <https://doi.org/10.1016/j.jpain.2018.02.012>

## **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.

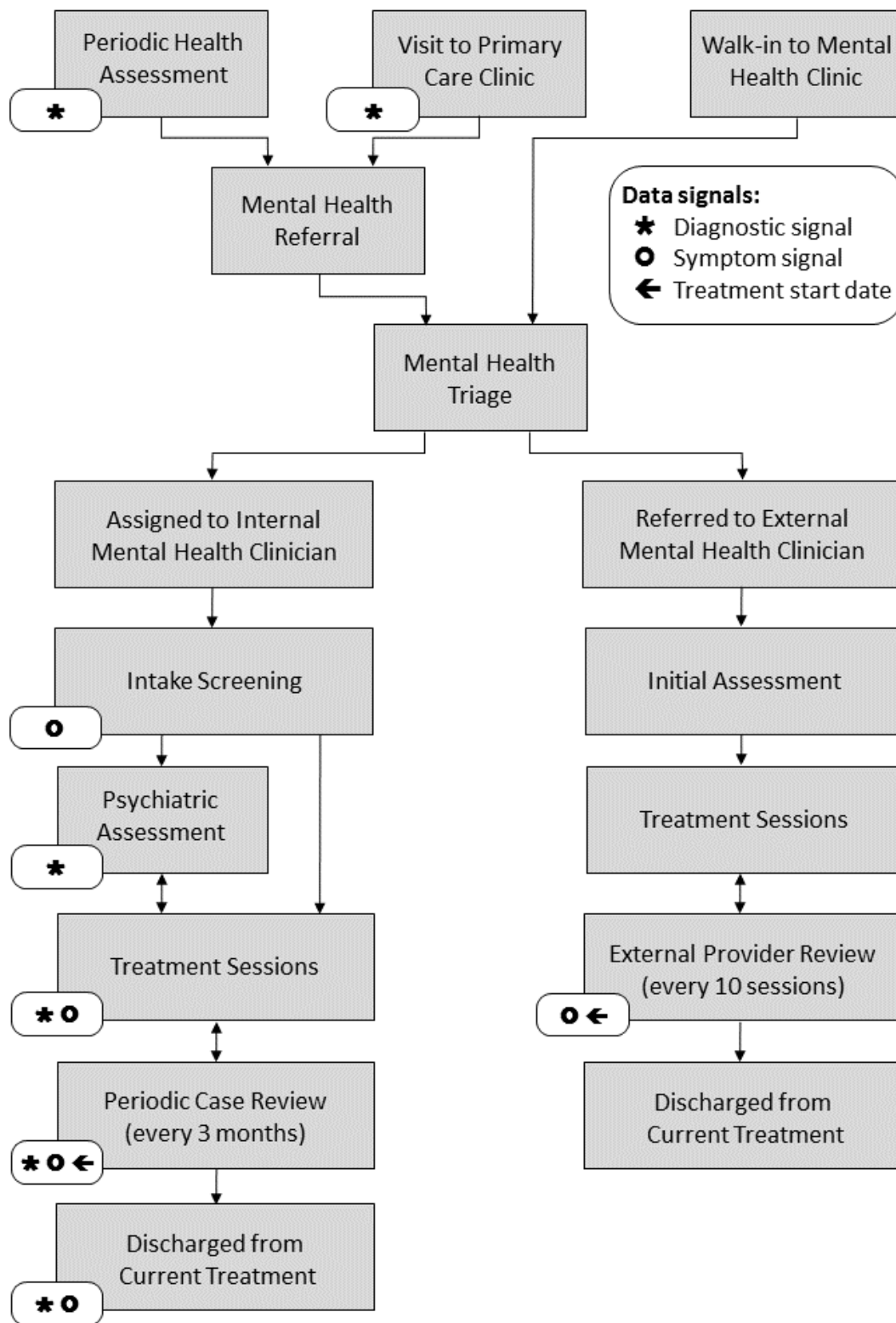
Unlike most Canadians, CAF personnel are excluded from the universal single-payer health insurance systems administered by Canada's 13 provincial and territorial governments. Instead, the *Canada Health Act* designates the Canadian Armed Forces as the country's 14<sup>th</sup> health jurisdiction. The 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, 10<sup>th</sup> 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, 5<sup>th</sup> 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 speciality 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

1. Department of National Defence (2017) Strong, Secure, Engaged: Canada's Defence Policy. Ottawa (Canada)
2. Patten SB, Williams JVA, Lavorato DH, et al (2015) Descriptive Epidemiology of Major Depressive Disorder in Canada in 2012. *Can J Psychiatry* 60:23–30.
3. Currie SR, Wang J (2004) Chronic back pain and major depression in the general Canadian population. *Pain* 107:54–60
4. Wang JL, Schmitz N, Dewa CS (2010) Socioeconomic status and the risk of major depression: the Canadian National Population Health Survey. *J Epidemiol Community Heal* 64:447–452.
5. Zamorski MA, Bennett RE, Boulos D, et al (2016) The 2013 Canadian Forces Mental Health Survey. *Can J Psychiatry* 61:10S-25S.

## 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.

## **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.

### *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.

## **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.

### *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.

### *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.

## 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

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

**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

<b>Variable</b>	<b>Category</b>	<b>Percent (95% CI)</b>	<b>P value for <math>\chi^2</math> test</b>
Sex	Male	71.6 (67.1, 76.5)	0.005
	Female	87.5 (79.0, 93.9)	
Age (years)	18 to 29	63.0 (52.9, 72.1)	0.001
	30 to 39	81.1 (75.1, 86.5)	
	40 to 60	77.3 (72.3, 83.5)	
Marital status	Single	67.6 (58.7, 76.2)	0.021
	Married, Common-Law	75.7 (70.5, 80.6)	
	Widowed, Divorced, Separated	84.2 (76.8, 92.6)	
Element	Navy	76.9 (67.2, 86.1)	0.889
	Army	73.5 (68.4, 79.4)	
	Air Force	75.8 (66.4, 83.4)	
Past-year PTSD	No	70.5 (65.2, 75.8)	0.005
	Yes	83.6 (76.8, 89.1)	
Other past-year co-morbidities	No	67.7 (62.1, 74.2)	0.001
	Yes	81.6 (76.4, 87.0)	
Functional impairment	Moderate	63.4 (54.1, 71.8)	0.002
	Marked	77.4 (72.0, 82.4)	
	Extreme	82.7 (74.9, 92.6)	
Awareness of treatment history in family or friends	No	60.0 (46.1, 81.1)	0.134
	Yes	75.6 (71.5, 80.0)	

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	Lowest quartile		
Social provision	2nd quartile	74.1 (65.4, 83.2)	0.034
	3rd quartile	81.9 (75.9, 89.2)	
	Highest quartile	73.8 (65.9, 81.2)	
		66.1 (56.6, 74.9)	
Deployed to Afghanistan	No	72.4 (65.1, 79.1)	0.284
	Yes	77.0 (71.8, 81.5)	
Unit leaders encourage the use of mental health services	No	75.7 (69.1, 82.4)	0.625
	Yes	73.5 (68.3, 79.0)	
Would be seen as weak for seeking mental health care	No	71.3 (65.3, 77.2)	0.103
	Yes	78.4 (72.2, 83.6)	
Seeking mental health care would impact career	No	76.9 (71.3, 83.0)	0.275
	Yes	72.8 (66.9, 78.4)	
Could get time off work for mental health treatment	No	74.6 (66.8, 81.6)	0.903
	Yes	74.9 (69.7, 79.7)	
Mental health care is effective	No	48.6 (36.5, 63.5)	0.001
	Yes	78.9 (74.6, 82.8)	

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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

General practitioner	Health professional consulted		Percent	(95% CI)
	Psychologist and/or psychiatrist	Social worker, counsellor, and/or nurse		
No	No	No	25.3	(21.2, 29.6)
Yes	No	No	3.5	(1.9, 5.2)
No	Yes	No	7.0	(4.9, 9.0)
No	No	Yes	12.1	(8.9, 15.5)
Yes	Yes	No	7.0	(4.5, 9.4)
Yes	No	Yes	6.6	(4.2, 8.9)
No	Yes	Yes	10.1	(7.0, 13.0)
Yes	Yes	Yes	28.4	(24.4, 32.5)

**Table 4-4:** 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

<b>Variable</b>	<b>Category</b>	<b>Prevalence Ratio (95% CI)</b>	<b>P value</b>
Sex	Male	ref	
	Female	1.17 (1.06, 1.30)	0.003
Age (years)	18 to 29	ref	
	30 to 39	1.22 (1.04, 1.43)	0.013
	40 to 60	1.18 (1.01, 1.39)	0.035
Past-year PTSD	No	ref	
	Yes	1.04 (0.94, 1.15)	0.443
Other past-year co-morbidities	No	ref	
	Yes	1.16 (1.04, 1.30)	0.008
Functional impairment	Moderate	ref	
	Marked	1.18 (1.00, 1.39)	0.044
	Extreme	1.23 (1.02, 1.49)	0.032
Mental health care is effective	No	ref	
	Yes	1.52 (1.16, 2.00)	0.003

## References

1. Zamorski MA, Bennett RE, Rusu C, et al (2016) Prevalence of Past-Year Mental Disorders in the Canadian Armed Forces, 2002-2013. *Can J Psychiatry* 61:26S-35S. <https://doi.org/10.1177/0706743716628854>
2. Rusu C, Zamorski MA, Boulos D, Garber BG (2016) Prevalence Comparison of Past-year Mental Disorders and Suicidal Behaviours in the Canadian Armed Forces and the Canadian General Population. *Can J Psychiatry* 61:46S-55S. <https://doi.org/10.1177/0706743716628856>
3. Mcfarlane A, Sriapada R, Ganoczy D, et al (2011) Mental health in the Australian Defence Force: 2010 ADF mental health and wellbeing study: Full report. Canberra
4. Goodwin L, Wessely S, Hotopf M, et al (2015) Are common mental disorders more prevalent in the UK serving military compared to the general working population? *Psychol Med* 45:1881–91. <https://doi.org/10.1017/S0033291714002980>
5. Gadermann AM, Engel CC, Naifeh JA, et al (2012) Prevalence of DSM-IV major depression among U.S. military personnel: meta-analysis and simulation. *Mil Med* 177:47–59
6. Poisson R (2015) The imperative of military medical research and the duty to protect, preserve, and provide advanced evidence-informed care. *J Mil Veteran Fam Heal* 1:11–13. <https://doi.org/10.3138/jmvfh.2014-11>
7. Parikh S V., Quilty LC, Ravitz P, et al (2016) Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder. *Can J Psychiatry* 61:524–539. <https://doi.org/10.1177/0706743716659418>
8. Kennedy SH, Lam RW, McIntyre RS, et al (2016) Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder. *Can J Psychiatry* 61:540–560. <https://doi.org/10.1177/0706743716659417>
9. Mojtabai R, Olfson M (2006) Treatment Seeking for Depression in Canada and the United

- States. *Psychiatr Serv* 57:631–639. <https://doi.org/10.1176/ps.2006.57.5.631>
10. Fikretoglu D, Liu A, Pedlar D, Brunet A (2010) Patterns and predictors of treatment delay for mental disorders in a nationally representative, active Canadian military sample. *Med Care* 48:10–7. <https://doi.org/10.1097/MLR.0b013e3181bd4bf9>
  11. Quartana PJ, Wilk JE, Thomas JL, et al (2014) Trends in mental health services utilization and stigma in US soldiers from 2002 to 2011. *Am J Public Health* 104:1671–9. <https://doi.org/10.2105/AJPH.2014.301971>
  12. Fikretoglu D, Guay S, Pedlar D, Brunet A (2008) Twelve month use of mental health services in a nationally representative, active military sample. *Med Care* 46:217–23. <https://doi.org/10.1097/MLR.0b013e31815b979a>
  13. Chen J, Hou F (2002) Unmet needs for health care. *Heal reports* 13:23–34
  14. Zamorski MA, Bennett RE, Boulos D, et al (2016) The 2013 Canadian Forces Mental Health Survey. *Can J Psychiatry* 61:10S-25S. <https://doi.org/10.1177/0706743716632731>
  15. Sudom K, Zamorski MA, Garber BG (2012) Stigma and barriers to mental health care in deployed Canadian Forces personnel. *Mil Psychol* 24:414–431
  16. Weeks M, Zamorski MA, Rusu C, Colman I (2017) Mental Illness-Related Stigma in Canadian Military and Civilian Populations: A Comparison Using Population Health Survey Data. *Psychiatr Serv* 68:710–716. <https://doi.org/10.1176/appi.ps.201600398>
  17. Twomey CD, Baldwin DS, Hopfe M, Cieza A (2015) A systematic review of the predictors of health service utilisation by adults with mental disorders in the UK. *BMJ Open* 5:e007575. <https://doi.org/10.1136/bmjopen-2015-007575>
  18. Alonzo DM, Harkavy-Friedman JM, Stanley B, et al (2011) Predictors of Treatment Utilization in Major Depression. *Arch Suicide Res* 15:160–171. <https://doi.org/10.1080/13811118.2011.566052>
  19. Thériault FL, Colman I (2017) Awareness of treatment history in family and friends, and mental health care seeking propensity. *Soc Psychiatry Psychiatr Epidemiol* 52:485–492. <https://doi.org/10.1007/s00127-017-1349-1>
  20. Murphy D, Hunt E, Luzon O, Greenberg N (2014) Exploring positive pathways to care for

- members of the UK Armed Forces receiving treatment for PTSD: a qualitative study. *Eur J Psychotraumatol* 5:21759. <https://doi.org/10.3402/ejpt.v5.21759>
21. Chapman PL, Elnitsky C, Pitts B, et al (2014) Mental health, help seeking, and stigma and barriers to care among 3- and 12-month postdeployed and never deployed U.S. Army Combat Medics. *Mil Med* 179:55–62. <https://doi.org/10.7205/MILMED-D-12-00367>
  22. Sharp M-L, Fear NT, Rona RJ, et al (2015) Stigma as a Barrier to Seeking Health Care Among Military Personnel With Mental Health Problems. *Epidemiol Rev* 37:144–162. <https://doi.org/10.1093/epirev/mxu012>
  23. Burns BJ, Wagner HR, Gaynes BN, et al (2000) General Medical and Specialty Mental Health Service Use for Major Depression. *Int J Psychiatry Med* 30:127–143. <https://doi.org/10.2190/TLXJ-YXLX-F4YA-6PHA>
  24. Young AS, Klap R, Sherbourne CD, Wells KB (2001) The quality of care for depressive and anxiety disorders in the United States. *Arch Gen Psychiatry* 58:55–61
  25. Kessler RC, Berglund P, Demler O, et al (2003) The Epidemiology of Major Depressive Disorder. *JAMA* 289:3095. <https://doi.org/10.1001/jama.289.23.3095>
  26. Gaynes BN, Rush AJ, Trivedi MH, et al (2008) Primary versus specialty care outcomes for depressed outpatients managed with measurement-based care: results from STAR\*D. *J Gen Intern Med* 23:551–60. <https://doi.org/10.1007/s11606-008-0522-3>
  27. Rost K, Nutting P, Smith J, et al (2000) The role of competing demands in the treatment provided primary care patients with major depression. *Arch Fam Med* 9:150–4
  28. Mitchell AJ, Vaze A, Rao S (2009) Clinical diagnosis of depression in primary care: a meta-analysis. *Lancet* 374:609–619. [https://doi.org/10.1016/S0140-6736\(09\)60879-5](https://doi.org/10.1016/S0140-6736(09)60879-5)
  29. Robinson WD, Geske JA, Prest LA, Barnacle R Depression treatment in primary care. *J Am Board Fam Pract* 18:79–86
  30. Kessler RC, Üstün TB (2004) The World Mental Health (WMH) Survey Initiative Version of the World Health Organization (WHO) Composite International Diagnostic Interview (CIDI). *Int J Methods Psychiatr Res* 13:93–121
  31. Haro JM, Arbabzadeh-Bouchez S, Brugha TS, et al (2006) Concordance of the Composite

- International Diagnostic Interview Version 3.0 (CIDI 3.0) with standardized clinical assessments in the WHO World Mental Health surveys. *Int J Methods Psychiatr Res* 15:167–80
32. Stein MB, McAllister TW (2009) Exploring the convergence of posttraumatic stress disorder and mild traumatic brain injury. *Am J Psychiatry* 166:768–76. <https://doi.org/10.1176/appi.ajp.2009.08101604>
  33. Sheehan D V, Harnett-Sheehan K, Raj BA (1996) The measurement of disability. *Int Clin Psychopharmacol* 11 Suppl 3:89–95
  34. Caron J (1996) [The scale of social provisions: their validation in Quebec]. *Sante Ment Que* 21:158–80
  35. Bursac Z, Gauss CH, Williams DK, Hosmer DW (2008) Purposeful selection of variables in logistic regression. *Source Code Biol Med* 3:17. <https://doi.org/10.1186/1751-0473-3-17>
  36. Greenland S (2004) Model-based estimation of relative risks and other epidemiologic measures in studies of common outcomes and in case-control studies. *Am J Epidemiol* 160:301–5. <https://doi.org/10.1093/aje/kwh221>
  37. StataCorp (2015) *Stata Statistical Software: Release 14*
  38. Kohn R, Saxena S, Levav I, Saraceno B (2004) The treatment gap in mental health care. *Bull World Health Organ* 82:858–66. <https://doi.org/S0042-96862004001100011>
  39. Brewin CR, Andrews B, Hejdenberg J (2012) Recognition and treatment of psychological disorders during military service in the UK armed forces: a study of war pensioners. *Soc Psychiatry Psychiatr Epidemiol* 47:1891–1897. <https://doi.org/10.1007/s00127-012-0505-x>
  40. Andrade LH, Alonso J, Mneimneh Z, et al (2014) Barriers to mental health treatment: results from the WHO World Mental Health surveys. *Psychol Med* 44:1303–1317. <https://doi.org/10.1017/S0033291713001943>
  41. Angermeyer MC, van der Auwera S, Carta MG, Schomerus G (2017) Public attitudes towards psychiatry and psychiatric treatment at the beginning of the 21st century: a

- systematic review and meta-analysis of population surveys. *World Psychiatry* 16:50–61. <https://doi.org/10.1002/wps.20383>
42. Colman I, Atallahjan A (2010) Life Course Perspectives on the Epidemiology of Depression. *Can J Psychiatry* 55:622–632. <https://doi.org/10.1177/070674371005501002>
  43. Vogt D (2011) Mental health-related beliefs as a barrier to service use for military personnel and veterans: a review. *Psychiatr Serv* 62:135–42. [https://doi.org/10.1176/ps.62.2.pss6202\\_0135](https://doi.org/10.1176/ps.62.2.pss6202_0135)
  44. Jorm AF, Medway J, Christensen H, et al (2000) Attitudes towards people with depression: effects on the public's help-seeking and outcome when experiencing common psychiatric symptoms. *Aust N Z J Psychiatry* 34:612–8. <https://doi.org/10.1080/j.1440-1614.2000.00743.x>

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

On 2018-06-09, 1:46 PM, "The Canadian Journal of Psychiatry/La Revue canadienne de psychiatrie" <[onbehalf@manuscriptcentral.com](mailto:onbehalf@manuscriptcentral.com)> wrote:

09-Jun-2018

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

Dear Dr. Colman,

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

<b>File Number:</b> H04-17-04		<b>Date (mm/dd/yyyy):</b> 05/30/2017	
<b>Université d'Ottawa</b> Bureau d'éthique et d'intégrité de la recherche	<b>University of Ottawa</b> Office of Research Ethics and Integrity		
<b>Ethics Approval Notice</b> <b>Health Sciences and Science REB</b>			
<b>Principal Investigator / Supervisor / Co-investigator(s) / Student(s)</b>			
<b><u>First Name</u></b>	<b><u>Last Name</u></b>	<b><u>Affiliation</u></b>	<b><u>Role</u></b>
Ian	Colman	Medicine / Medicine	Supervisor
François	Thériault	Medicine / Medicine	Student Researcher
<b>File Number:</b> H04-17-04			
<b>Type of Project:</b> PhD Thesis			
<b>Title:</b> Care-seeking for major depression in the Canadian Armed Forces			
<b>Approval Date (mm/dd/yyyy)</b>	<b>Expiry Date (mm/dd/yyyy)</b>	<b>Approval Type</b>	
05/30/2017	05/29/2018	Approval	
<b>Special Conditions / Comments:</b> N/A			
1			
550, rue Cumberland, pièce 154 Ottawa (Ontario) K1N 6N5 Canada (613) 562-5387 • Téléc./Fax (613) 562-5338		550 Cumberland Street, room 154 Ottawa, Ontario K1N 6N5 Canada (613) 562-5387 • Téléc./Fax (613) 562-5338	
<a href="http://www.recherche.uottawa.ca/deontologie/">www.recherche.uottawa.ca/deontologie/</a> <a href="http://www.research.uottawa.ca/ethics/">www.research.uottawa.ca/ethics/</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 Defen\*e, Ministry of Defen\*e, service member, submariner, troops, paratrooper, special force*) and major depression (*depression, MDD, dysthymia, depressed*), from date of inception to July 24<sup>th</sup> 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-rater 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.

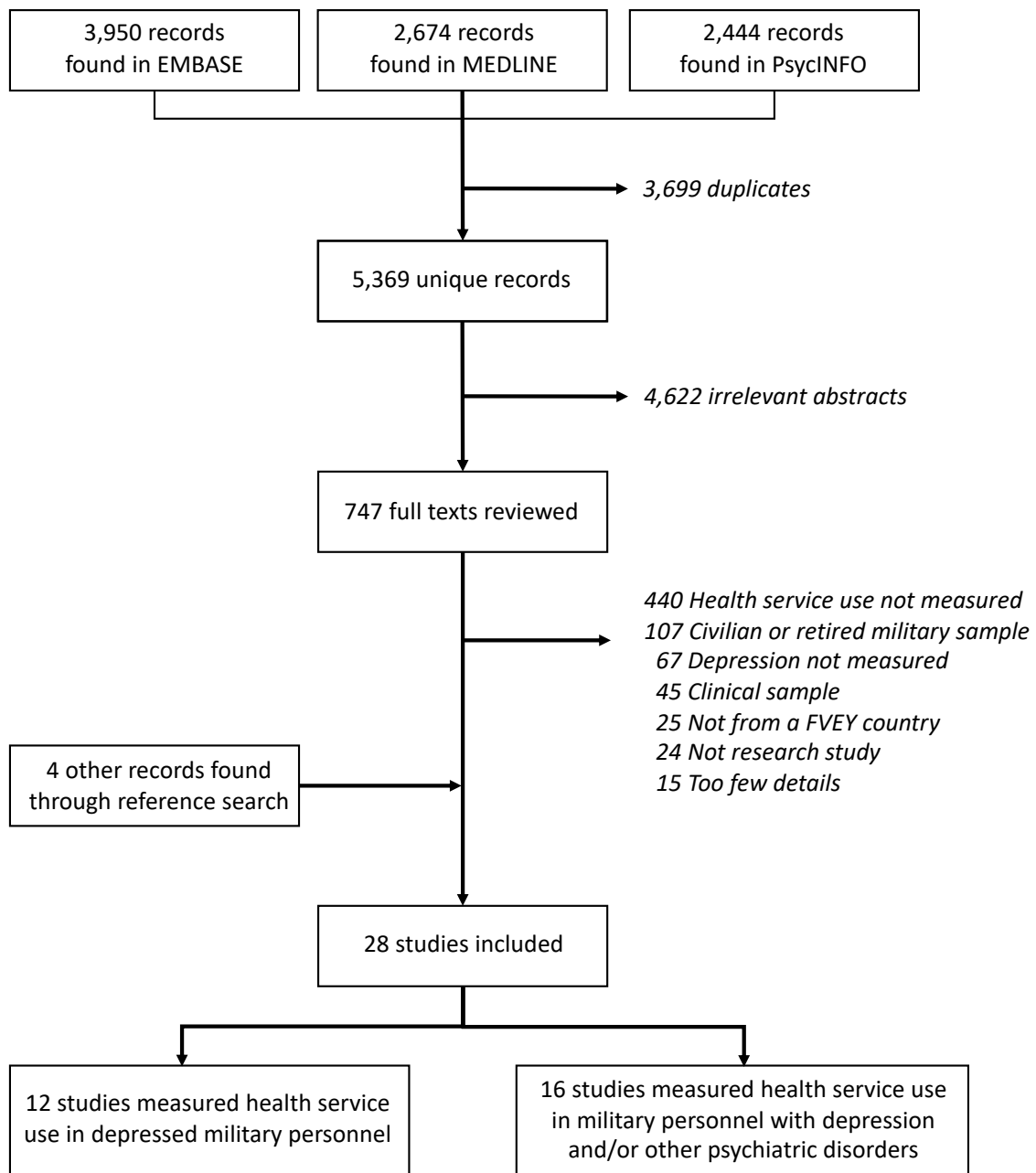
### *Limitations*

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.



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

**Table 5-1: Summary of studies measuring mental health service utilization in military personnel with depression**

Ref	Country	Data Collected	Sample	Depression Measure	Definition of Health Service Utilization	Health Service Utilization (%)
[17]	Canada	2013	Personnel with past-year depression, among a weighted sample of 6,996 survey participants	Diagnostic Interview	Self-reported talking to a professional about problems with emotions, mental health, or use of alcohol or drugs in the past 12 months	74.7
[28]	Canada	2002	Personnel with past-year depression, among a weighted sample of 8,441 survey participants	Diagnostic Interview	Self-reported receiving help for problems with emotions, mental health, or use of alcohol or drugs in the past 12 months	64.1
[32]	USA	2011 to 2013	299 National Guard personnel who deployed to combat zone in last 12 months, and with positive screen for depression on anonymous survey	Screening Tool <sup>a</sup>	Self-reported receiving mental health services for a stress, emotional, alcohol, or family problem in the past 12 months	61.3
[27]	USA	2006 to 2010	39 National Guards and Reservists with depression, recently returned from a combat deployment	Diagnostic Interview	Semi-structured interview to assess professional mental health service use in the past 12 months, administered 12 months after structured diagnostic interview	56.4
[55]	USA	2009 to 2011	134 National Guards with a positive screen for depression during 2 <sup>nd</sup> wave of a cohort study, and who also completed 3 <sup>rd</sup> wave	Screening Tool <sup>a</sup>	Self-reported seeing a health professional for problems with emotions, nerves, or use of alcohol or drugs in the year between 2 <sup>nd</sup> and 3 <sup>rd</sup> waves of cohort study	56.0
[29]	USA	2007	50 National Guard personnel with a positive screen for depression on anonymous survey, 2-3 months after return from a 16-month deployment	Screening Tool <sup>b</sup>	Self-reported use of psychotherapy or psychopharmacotherapy since return from deployment	50.0

[30]	USA	2011 to 2013	51 National Guards with a positive screen for depression during anonymous survey, 2-4 months after return from a combat deployment	Screening Tool <sup>a</sup>	Self-reported seeing a mental health professional for any psychological problem since return from most recent deployment	45.1
[34]	USA	2008	5,435 active-duty personnel with a positive screen for depression on anonymous survey	Screening Tool <sup>c</sup>	Self-reported receiving therapy or counselling for mental health or substance abuse in the past 12 months	43.7
[26]	USA	1996	71 Navy and Marine personnel with past-year depression	Diagnostic Interview	Self-reported use of any military medical facility or civilian doctor for mental health care in the past 12 months	32.3
[51]	USA	2014	233 infantry personnel with a positive screen for depression on anonymous survey	Screening Tool <sup>d</sup>	Self-reported receiving counselling or therapy for depression in the past 12 months	24.0
[33]	USA	2003 to 2004	112 soldiers with a positive screen for depression on anonymous survey, 3 months post-deployment	Screening Tool <sup>a</sup>	Self-reported receiving professional mental health services for a stress, emotional, alcohol, or family problem in the past 12 months	22.3
[31]	USA	2005	Active-duty personnel who screened positive for depression, among 6,116 survey participants who deployed to Iraq or Afghanistan in past 3 years	Screening Tool <sup>c</sup>	Self-reported receiving therapy or counselling for depression in the past 12 months	19.6

<sup>a</sup> Patient Health Questionnaire – 9 item

<sup>b</sup> Beck Depression Inventory – Second Edition

<sup>c</sup> Burnam screening criteria Version A

<sup>d</sup> 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**

Ref	Country	Data Collected	Sample	Mental Health Disorders Included	Definition of Health Service Utilization	Health Service Utilization (%)
[36]	USA	2004 to 2005	16 care providers who recently deployed to a military hospital in a combat area, and who screened positive for a mental health disorder on an anonymous survey	Depression PTSD	Self-reported seeing a psychiatrist, psychologist, or social worker at least once since returning from deployment	75.0
[35]	USA	2006 to 2007	40 National Guard personnel who met diagnostic criteria for mental health disorder 3 months after return from a combat deployment, but had not used mental health services since their return	Depression PTSD	Self-reported receiving mental health services, 3 to 12 months after return from a combat deployment	65.0
[44]	USA	2011 to 2013	346 National Guard personnel who screened positive for a mental health disorder, 6 months after returning from overseas deployment	Depression PTSD Anxiety Hazardous Drinking	Self-reported receiving mental health services for a stress, emotional, alcohol, or family problem in the past 12 months.	54.4
[46]	USA	2007 to 2008	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	Depression PTSD Suicidal Ideation Hazardous Drinking	Self-reported receiving mental health services for a stress, emotional, alcohol, or family problem in the past 12 months.	49.6
[43]	Canada	2009 to 2012	1,579 personnel who screened positive for a mental health disorder, 3-6 months after returning from deployment	Depression PTSD Anxiety Suicidal Ideation Panic Disorder	Self-reported currently seeing a health professional for emotional or mental health issues, or currently using psychiatric medications for anxiety, depression or stress	45.1
[38]	Canada	2002	Weighted sample of 1,220 anonymous survey participants who	Depression PTSD Anxiety	Self-reported receiving information, medication or counseling for problems with emotions, mental	42.6

[40]	USA	2013	394 infantrymen who self-reported a mental health problem, or who screened positive for a mental health disorder on anonymous pre-deployment survey	Suicidal Ideation Social Phobia Alcohol Dependence Depression PTSD Hazardous Drinking	Self-reported receiving mental health services for a stress, emotional, alcohol, or family problem in the past 12 months.	39.8
[39]	UK	2006 to 2007	Weighted sample of 205 personnel with a positive screen for a mental health disorder on anonymous survey	Depression Anxiety	Self-reported contact with a medical professional for an emotional, stress-related, alcohol, or family problem in the past 12 months	37.2
[49]	USA	2005 to 2006	150 Nation Guard personnel who screened positive for a mental health disorder, 12 months after returning from combat deployment	Depression PTSD Anxiety Alcohol Use Disorder Panic Disorder	Self-reported seeking treatment from a physician or mental health specialist for mental health concerns since returning from combat deployment	34.7
[41]	Canada	2010	105 personnel who screened positive for a mental health disorder on anonymous survey halfway through rotation on overseas deployment	Depression Acute Traumatic Stress Anxiety	Self-reported receiving counselling or mental health services for a stress, emotional, alcohol or family problem since start of rotation	29.5
[37]	USA	2003 to 2011	4,327 soldiers from combat brigades who screened positive for a mental health disorder on anonymous survey, 3-6 months after returning from deployment from 2003 to 2011	Depression PTSD	Self-reported receiving counselling or treatment for a mental health or substance abuse problem in the past 1-6 months (recall period depends on deployment year)	28.0 (18.6, 42.1)*
[42]	Canada	2009 to 2010	196 personnel who screened positive for a mental health disorder on anonymous survey, while on deployment	Depression PTSD Anxiety	Self-reported receiving counselling or mental health services for a stress, emotional, alcohol, or family problem during current deployment	27.0

[16]	USA	2003	731 personnel who screened positive for a mental health disorder on anonymous survey administered either before or after a combat deployment	Depression PTSD Anxiety	Self-reported using professional mental health services in the past 12 months	26.8
[45]	USA	2003 to 2004	577 soldiers and Marines who screened positive for a mental health disorder on anonymous survey, 3 months after returning from a combat deployment	Depression PTSD Anxiety	Self-reported seeing a mental health specialist of general medical doctor for a mental health problem in the past 12 months	23.6
[48]	USA	2008 to 2009	1,048 personnel screened positive for a mental health disorder on anonymous survey, 6 months after returning from deployment	Depression PTSD Anxiety	Self-reported receiving mental health services for a stress, emotional, alcohol, or family problem in the past 3 months	21.5
[47]	USA	2003 to 2007	2,334 personnel who self-reported a stress, emotional, alcohol or family problem, or who screened positive for a mental health disorder on anonymous survey, 3 months after returning from a combat deployment	Depression PTSD Anxiety Aggressive Behaviors	Self-reported receipt of mental health services for a stress, emotional, alcohol, or family problem in the past 3 months	14.1

\* 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

1. Vos T, Abajobir AA, Abate KH, et al (2017) Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 390:1211–1259. [https://doi.org/10.1016/S0140-6736\(17\)32154-2](https://doi.org/10.1016/S0140-6736(17)32154-2)
2. Parikh S V, Quilty LC, Ravitz P, et al (2016) Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder: Section 2. Psychological Treatments. *Can J Psychiatry* 61:524–39. <https://doi.org/10.1177/0706743716659418>
3. Kennedy SH, Lam RW, McIntyre RS, et al (2016) Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder. *Can J Psychiatry* 61:540–560. <https://doi.org/10.1177/0706743716659417>
4. Mojtabai R, Olfson M (2006) Treatment Seeking for Depression in Canada and the United States. *Psychiatr Serv* 57:631–639. <https://doi.org/10.1176/ps.2006.57.5.631>
5. Kohn R, Saxena S, Levav I, Saraceno B (2004) The treatment gap in mental health care. *Bull World Health Organ* 82:858–66. <https://doi.org/S0042-96862004001100011>
6. Andrews G, Sanderson K, Corry J, Lapsley HM (2000) Using epidemiological data to model efficiency in reducing the burden of depression\*. *J Ment Health Policy Econ* 3:175–186
7. Gadermann AM, Engel CC, Naifeh JA, et al (2012) Prevalence of DSM-IV major depression among U.S. military personnel: meta-analysis and simulation. *Mil Med*

177:47–59

8. Goodwin L, Wessely S, Hotopf M, et al (2015) Are common mental disorders more prevalent in the UK serving military compared to the general working population? *Psychol Med* 45:1881–91. <https://doi.org/10.1017/S0033291714002980>
9. Mcfarlane A, Sriapada R, Ganoczy D, et al (2011) Mental health in the Australian Defence Force: 2010 ADF mental health and wellbeing study: Full report. Canberra
10. Rusu C, Zamorski MA, Boulos D, Garber BG (2016) Prevalence Comparison of Past-year Mental Disorders and Suicidal Behaviours in the Canadian Armed Forces and the Canadian General Population. *Can J Psychiatry* 61:46S-55S. <https://doi.org/10.1177/0706743716628856>
11. Eliasson A, Kashani M, Dela Cruz G, Vernalis M (2012) Readiness and associated health behaviors and symptoms in recently deployed Army National Guard soldiers. *Mil Med* 177:1254–60
12. Hoge CW, Lesikar SE, Guevara R, et al (2002) Mental disorders among U.S. military personnel in the 1990s: association with high levels of health care utilization and early military attrition. *Am J Psychiatry* 159:1576–83. <https://doi.org/10.1176/appi.ajp.159.9.1576>
13. Poisson R (2015) The imperative of military medical research and the duty to protect, preserve, and provide advanced evidence-informed care. *J Mil Veteran Fam Heal* 1:11–13. <https://doi.org/10.3138/jmvfh.2014-11>
14. LeardMann CA, Powell TM, Smith TC, et al (2013) Risk factors associated with suicide in current and former US military personnel. *JAMA* 310:496–506.

- <https://doi.org/10.1001/jama.2013.65164>
15. Simon GE, Fleck M, Lucas R, et al (2004) Prevalence and predictors of depression treatment in an international primary care study. *Am J Psychiatry* 161:1626–34.  
<https://doi.org/10.1176/appi.ajp.161.9.1626>
  16. Hoge CW, Castro CA, Messer SC, et al (2004) Combat Duty in Iraq and Afghanistan, Mental Health Problems, and Barriers to Care. *N Engl J Med* 351:13–22.  
<https://doi.org/10.1056/NEJMoa040603>
  17. Thériault FL, Garber BG, Momoli F, et al (2019) Mental Health Service Utilization in Depressed Canadian Armed Forces Personnel. *Can J Psychiatry* 64:59–67.  
<https://doi.org/10.1177/0706743718787792>
  18. Stahlman S, Oetting AA (2018) Mental health disorders and mental health problems, active component, U.S. Armed Forces, 2007-2016. *MSMR* 25:2–11
  19. Gould M, Adler A, Zamorski M, et al (2010) Do stigma and other perceived barriers to mental health care differ across Armed Forces? *J R Soc Med* 103:148–56.  
<https://doi.org/10.1258/jrsm.2010.090426>
  20. Bramer WM, Giustini D, de Jonge GB, et al (2016) De-duplication of database search results for systematic reviews in EndNote. *J Med Libr Assoc* 104:240–3.  
<https://doi.org/10.3163/1536-5050.104.3.014>
  21. Viera AJ, Garrett JM (2005) Understanding interobserver agreement: the kappa statistic. *Fam Med* 37:360–3
  22. Prisnie JC, Fiest KM, Coutts SB, et al (2016) Validating screening tools for depression in stroke and transient ischemic attack patients. *Int J Psychiatry Med* 51:262–77.

<https://doi.org/10.1177/0091217416652616>

23. Gelaye B, Tadesse MG, Williams MA, et al (2014) Assessing validity of a depression screening instrument in the absence of a gold standard. *Ann Epidemiol* 24:527–531.  
<https://doi.org/10.1016/j.annepidem.2014.04.009>
24. Cook DJ, Sackett DL, Spitzer WO (1995) Methodologic guidelines for systematic reviews of randomized control trials in health care from the Potsdam Consultation on Meta-Analysis. *J Clin Epidemiol* 48:167–71
25. Moher D, Liberati A, Tetzlaff J, et al (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ* 339:b2535–b2535.  
<https://doi.org/10.1136/bmj.b2535>
26. Hourani LL, Yuan H (1999) The mental health status of women in the Navy and Marine Corps: preliminary findings from the Perceptions of Wellness and Readiness Assessment. *Mil Med* 164:174–81
27. Primack JM, Borsari B, Benz MB, et al (2017) Mental health treatment utilization in OIF/OEF National Guard and Reserve troops with and without DSM diagnoses. *Am J Orthopsychiatry* 87:157–165. <https://doi.org/10.1037/ort0000226>
28. Sareen J, Cox BJ, Afifi TO, et al (2007) Combat and peacekeeping operations in relation to prevalence of mental disorders and perceived need for mental health care: findings from a large representative sample of military personnel. *Arch Gen Psychiatry* 64:843–52.  
<https://doi.org/10.1001/archpsyc.64.7.843>
29. Kehle SM, Polusny MA, Murdoch M, et al (2010) Early mental health treatment-seeking among U.S. National Guard soldiers deployed to Iraq. *J Trauma Stress* 23:33–40.

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

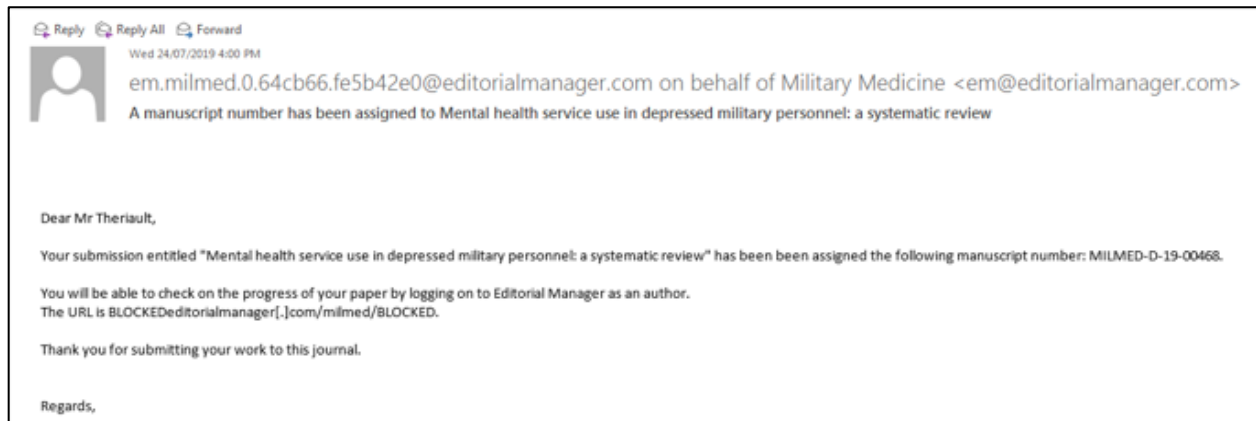
30. van den Berk-Clark C, Balan S, Shroff M V., et al (2016) The Impact of Hazardous Alcohol Use on Behavioral Healthcare Utilization Among National Guard Service Members. *Subst Use Misuse* 51:625–636.  
<https://doi.org/10.3109/10826084.2015.1133644>
31. Hickling EJ, Gibbons S, Barnett SD, Watts D (2011) The psychological impact of deployment on OEF/OIF healthcare providers. *J Trauma Stress* 24:726–734.  
<https://doi.org/10.1002/jts.20703>
32. Levine DS, Sripada RK, Ganoczy D, et al (2016) Poorer Physical Health is Associated With Greater Mental Health Service Utilization in a Sample of Depressed U.S. Army National Guard Soldiers. *Mil Med* 181:803–810. <https://doi.org/10.7205/MILMED-D-15-00287>
33. Varkis DL (2016) The impact of marital satisfaction on the utilization of mental health services among soldiers. Clemson University
34. Chu KM, Garcia SMS, Koka H, et al (2018) Mental health care utilization and stigma in the military: comparison of Asian Americans to other racial groups. *Ethn Health* 1–16.  
<https://doi.org/10.1080/13557858.2018.1494823>
35. Arbisi PA, Rusch L, Polusny MA, et al (2013) Does cynicism play a role in failure to obtain needed care? Mental health service utilization among returning U.S. National Guard soldiers. *Psychol Assess* 25:991–6. <https://doi.org/10.1037/a0032225>
36. Kolkow TT, Spira JL, Morse JS, Grieger TA (2007) Post-Traumatic Stress Disorder and Depression in Health Care Providers Returning from Deployment to Iraq and Afghanistan.

- Mil Med 172:451–455. <https://doi.org/10.7205/MILMED.172.5.451>
37. Quartana PJ, Wilk JE, Thomas JL, et al (2014) Trends in mental health services utilization and stigma in US soldiers from 2002 to 2011. *Am J Public Health* 104:1671–9. <https://doi.org/10.2105/AJPH.2014.301971>
  38. Fikretoglu D, Guay S, Pedlar D, Brunet A (2008) Twelve month use of mental health services in a nationally representative, active military sample. *Med Care* 46:217–23. <https://doi.org/10.1097/MLR.0b013e31815b979a>
  39. Iversen AC, van Staden L, Hughes JH, et al (2010) Help-seeking and receipt of treatment among UK service personnel. *Br J Psychiatry* 197:149–55. <https://doi.org/10.1192/bjp.bp.109.075762>
  40. Britt TW, Jennings KS, Cheung JH, et al (2015) The role of different stigma perceptions in treatment seeking and dropout among active duty military personnel. *Psychiatr Rehabil J* 38:142–149. <https://doi.org/10.1037/prj0000120>
  41. Garber BG, Zamorski MA, Jetly CR (2012) Mental Health of Canadian Forces Members While on Deployment to Afghanistan. *Can J Psychiatry* 57:736–744. <https://doi.org/10.1177/070674371205701205>
  42. Sudom K, Zamorski MA, Garber BG (2012) Stigma and barriers to mental health care in deployed Canadian Forces personnel. *Mil Psychol* 24:414–431
  43. Zamorski MA, Rusu C, Garber BG (2014) Prevalence and correlates of mental health problems in Canadian Forces personnel who deployed in support of the mission in Afghanistan: findings from postdeployment screenings, 2009-2012. *Can J Psychiatry* 59:319–26. <https://doi.org/10.1177/070674371405900605>

44. Bonar EE, Bohnert KM, Walters HM, et al (2015) Student and Nonstudent National Guard Service Members/Veterans and Their Use of Services for Mental Health Symptoms. *J Am Coll Health* 63:437–46. <https://doi.org/10.1080/07448481.2014.975718>
45. Brown MC, Creel AH, Engel CC, et al (2011) Factors associated with interest in receiving help for mental health problems in combat veterans returning from deployment to Iraq. *J Nerv Ment Dis* 199:797–801. <https://doi.org/10.1097/NMD.0b013e31822fc9bf>
46. Gorman LA, Blow AJ, Ames BD, Reed PL (2011) National Guard Families After Combat: Mental Health, Use of Mental Health Services, and Perceived Treatment Barriers. *Psychiatr Serv* 62:28–34. [https://doi.org/10.1176/ps.62.1.pss6201\\_0028](https://doi.org/10.1176/ps.62.1.pss6201_0028)
47. Kim PY, Thomas JL, Wilk JE, et al (2010) Stigma, barriers to care, and use of mental health services among active duty and National Guard soldiers after combat. *Psychiatr Serv* 61:582–8. <https://doi.org/10.1176/ps.2010.61.6.582>
48. Kim PY, Toblin RL, Riviere LA, et al (2016) Provider and Nonprovider Sources of Mental Health Help in the Military and the Effects of Stigma, Negative Attitudes, and Organizational Barriers to Care. *Psychiatr Serv* 67:221–6. <https://doi.org/10.1176/appi.ps.201400519>
49. Stecker T, Fortney J, Hamilton F, et al (2010) Engagement in mental health treatment among veterans returning from Iraq. *Patient Prefer Adherence* 4:45–9
50. Hom MA, Stanley IH, Schneider ME, Joiner TE (2017) A systematic review of help-seeking and mental health service utilization among military service members. *Clin Psychol Rev* 53:59–78. <https://doi.org/10.1016/j.cpr.2017.01.008>
51. Morgan JK, Hourani L, Lane ME, Tueller S (2016) Help-Seeking Behaviors Among

- Active-Duty Military Personnel: Utilization of Chaplains and Other Mental Health Service Providers. *J Health Care Chaplain* 22:102–17.  
<https://doi.org/10.1080/08854726.2016.1171598>
52. Kurdyak PA, Gnam WH (2005) Small signal, big noise: performance of the CIDI depression module. *Can J Psychiatry* 50:851–6.  
<https://doi.org/10.1177/070674370505001308>
53. El-Den S, Chen TF, Gan Y-L, et al (2018) The psychometric properties of depression screening tools in primary healthcare settings: A systematic review. *J Affect Disord* 225:503–522. <https://doi.org/10.1016/j.jad.2017.08.060>
54. Kroenke K, Spitzer RL, Williams JBW (2003) The Patient Health Questionnaire-2: validity of a two-item depression screener. *Med Care* 41:1284–92.  
<https://doi.org/10.1097/01.MLR.0000093487.78664.3C>
55. Goodwin RD, Cohen GH, Tamburrino M, et al (2014) Mental health service use in a representative sample of National Guard soldiers. *Psychiatr Serv* 65:1347–53.  
<https://doi.org/10.1176/appi.ps.201300282>

**Appendix 5A:** Screenshot of submission confirmation letter from the journal *Military Medicine*



**Appendix 5B: PRISMA Checklist**

Section/topic	#	Checklist item	Reported on page #
Title	1	Identify the report as a systematic review, meta-analysis, or both.	85
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria; participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	87, 88
Rationale	3	Describe the rationale for the review in the context of what is already known.	89
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	90
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	91
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	92
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	92, 118
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	92
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	92, 93
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	92, 93
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	92
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	93

Synthesis of results	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.	N/A
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	92
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	94, 101
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	94, 102
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	94, 102
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	102, 104
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	94, 102
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	96
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	99
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	96 - 99

## 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/s0012>. 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.

## 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.

## **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](http://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 31<sup>st</sup> 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.

## 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.

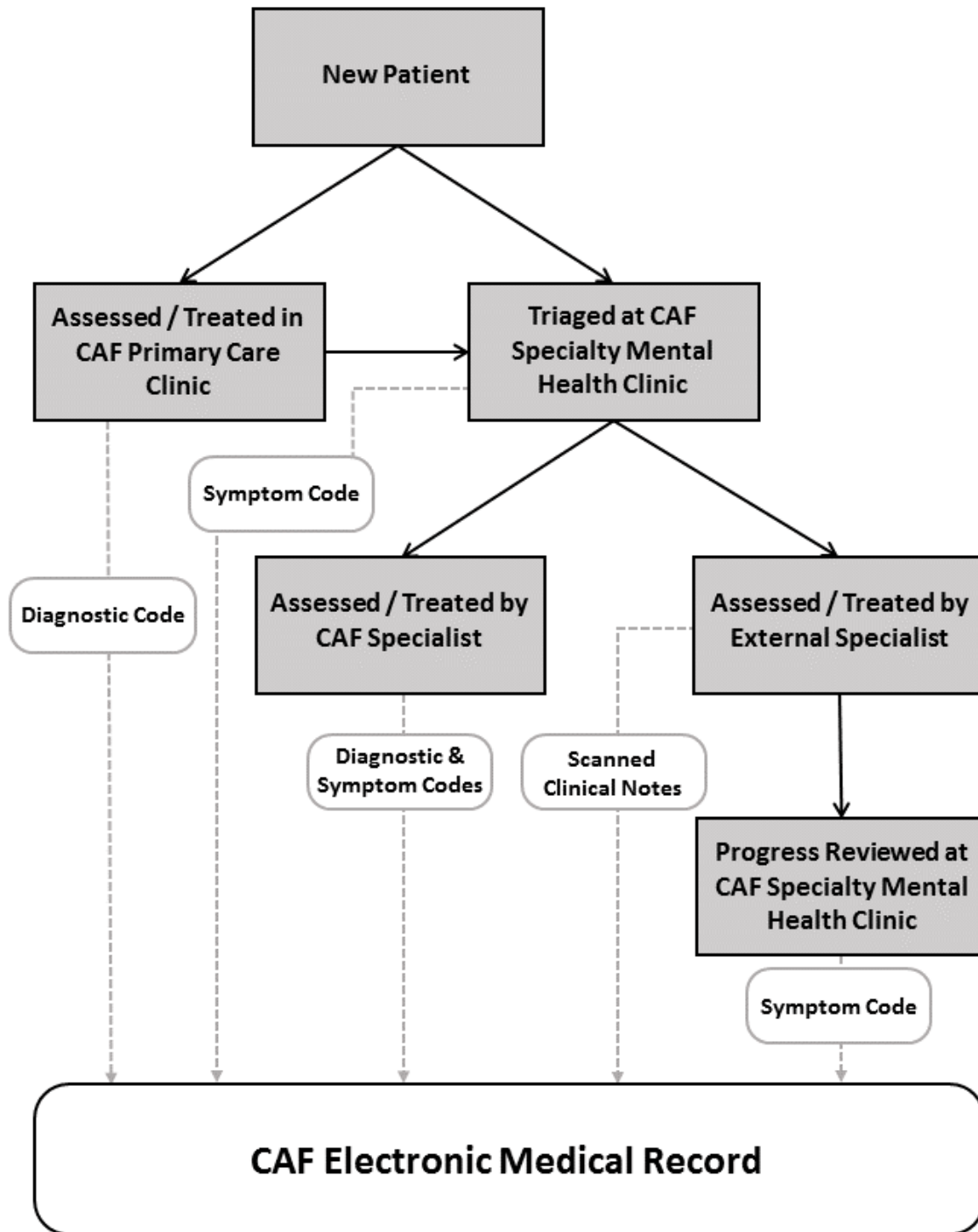
When used to assess past-year prevalence of clinical encounters related to major depression, our case definition produced results that were highly consistent with previous research on CAF personnel. Indeed, a large population-based survey conducted in 2013 found that 6.0% of all CAF Regular Force personnel 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.

	Person-years	(%)
<b>Sex</b>		
Female	8,698	(14.0)
Male	53,299	(86.0)
<b>Age (years)</b>		
18-29	21,708	(35.0)
30-39	21,400	(34.5)
40-49	12,877	(20.8)
50-60	6,012	(9.7)
<b>Rank</b>		
Non-Commissioned Members	46,337	(74.7)
Officers	15,660	(25.3)
<b>Command</b>		
Canadian Army	21,952	(35.4)
Royal Canadian Air Force	12,779	(20.6)
Military Personnel Command	8,288	(13.4)
Royal Canadian Navy	8,036	(13.0)
Joint & Special Forces	3,270	(5.3)
Joint Personnel Support Units	907	(1.5)
Other <sup>a</sup>	6,766	(10.9)
<b>Military Trade</b>		
Technicians	13,907	(22.4)
Combat Specialists	11,835	(19.1)
Administration & Support	10,731	(17.3)
Engineers	6,146	(9.9)
Telecommunications	4,742	(7.6)
Air & Ship Crew	4,711	(7.6)
Health Care	2,812	(4.5)
Sensor & Radar	2,463	(4.0)
Public Protection	1,876	(3.0)
Other	2,774	(4.5)

<sup>a</sup> 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.

	Rate per 1,000 p-y (95% CI)		aIRR <sup>b</sup>	(95% CI)	p-value
<b>Sex</b>					
Females	44.2	(39.7, 48.6)	ref		
Males	26.8	(25.4, 28.2)	0.61	(0.54, 0.68)	< 0.001
<b>Age (years)</b>					
18-29	20.7	(18.8, 22.6)	ref		
30-39	31.5	(29.1, 33.9)	1.51	(1.34, 1.70)	< 0.001
40-49	39.2	(35.8, 42.6)	1.92	(1.69, 2.18)	< 0.001
50-60	30.4	(26.0, 34.8)	1.56	(1.32, 1.86)	< 0.001
<b>Rank</b>					
Non-Commissioned Members	32.5	(30.8, 34.1)	ref		
Officers	19.6	(17.4, 21.8)	0.57	(0.50, 0.64)	< 0.001
<b>Command</b>					
Canadian Army	27.5	(25.3, 29.7)	ref		
Royal Canadian Air Force	24.4	(21.7, 27.1)	0.85	(0.74, 0.98)	0.025
Military Personnel Command	30.8	(27.0, 34.5)	1.14	(0.98, 1.33)	0.087
Royal Canadian Navy	28.7	(25.0, 32.5)	0.99	(0.85, 1.15)	0.899
Joint & Special Forces	31.5	(25.4, 37.6)	1.07	(0.87, 1.32)	0.522
Joint Personnel Support Units	97.0	(76.7, 117.3)	2.90	(2.31, 3.64)	< 0.001
Other <sup>a</sup>	32.4	(28.1, 36.7)	1.12	(0.96, 1.32)	0.157
<b>Military Trade</b>					
Combat Specialists	27.4	(24.4, 30.4)	ref		
Technicians	26.1	(23.4, 28.8)	0.80	(0.69, 0.93)	0.004
Administration & Support	41.1	(37.3, 44.9)	1.12	(0.96, 1.31)	0.151
Engineers	22.1	(18.4, 25.8)	0.89	(0.73, 1.10)	0.286
Telecommunications	33.7	(28.5, 39.0)	1.06	(0.88, 1.28)	0.539
Air & Ship Crew	14.9	(11.4, 18.3)	0.66	(0.51, 0.87)	0.003
Health Care	35.2	(28.3, 42.1)	1.06	(0.84, 1.35)	0.614
Sensor & Radar	30.4	(23.6, 37.3)	0.97	(0.76, 1.25)	0.827
Public Protection	33.0	(24.8, 41.3)	1.00	(0.76, 1.31)	0.997
Other	29.6	(23.2, 36.0)	0.95	(0.74, 1.21)	0.652

<sup>a</sup> 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.

<sup>b</sup> 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.

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

## References

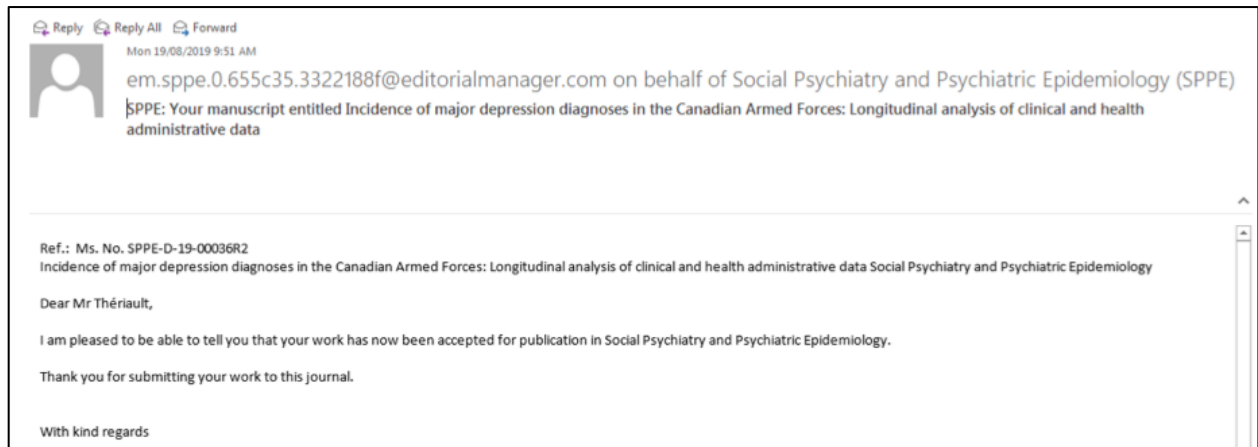
1. Mcfarlane A, Sriapada R, Ganoczy D, et al (2011) Mental health in the Australian Defence Force: 2010 ADF mental health and wellbeing study: Full report. Canberra
2. Rusu C, Zamorski MA, Boulos D, Garber BG (2016) Prevalence Comparison of Past-year Mental Disorders and Suicidal Behaviours in the Canadian Armed Forces and the Canadian General Population. *Can J Psychiatry* 61:46S-55S.  
<https://doi.org/10.1177/0706743716628856>
3. Goodwin L, Wessely S, Hotopf M, et al (2015) Are common mental disorders more prevalent in the UK serving military compared to the general working population? *Psychol Med* 45:1881–91. <https://doi.org/10.1017/S0033291714002980>
4. Gadermann AM, Engel CC, Naifeh JA, et al (2012) Prevalence of DSM-IV major depression among U.S. military personnel: meta-analysis and simulation. *Mil Med* 177:47–59
5. Ursano RJ, Kessler RC, Stein MB, et al (2016) Risk Factors, Methods, and Timing of Suicide Attempts Among US Army Soldiers. *JAMA psychiatry* 73:741–9.  
<https://doi.org/10.1001/jamapsychiatry.2016.0600>
6. Pflanz SE, Ogle AD (2006) Job Stress, Depression, Work Performance, and Perceptions of Supervisors in Military Personnel. *Mil Med* 171:861–865.  
<https://doi.org/10.7205/MILMED.171.9.861>
7. Littman AJ, Jacobson IG, Boyko EJ, et al (2013) Weight change following US military service. *Int J Obes* 37:244–253. <https://doi.org/10.1038/ijo.2012.46>
8. Zamorski MA, Bennett RE, Rusu C, et al (2016) Prevalence of Past-Year Mental Disorders in the Canadian Armed Forces, 2002-2013. *Can J Psychiatry* 61:26S-35S.  
<https://doi.org/10.1177/0706743716628854>
9. Nelson C, Cyr KS, Corbett B, et al (2011) Predictors of posttraumatic stress disorder, depression, and suicidal ideation among Canadian Forces personnel in a National Canadian Military Health Survey. *J Psychiatr Res* 45:1483–8.  
<https://doi.org/10.1016/j.jpsychires.2011.06.014>

10. Weeks M, Zamorski MA, Rusu C, Colman I (2017) Mental Illness-Related Stigma in Canadian Military and Civilian Populations: A Comparison Using Population Health Survey Data. *Psychiatr Serv* 68:710–716. <https://doi.org/10.1176/appi.ps.201600398>
11. Thériault FL, Garber BG, Momoli F, et al (2019) Mental Health Service Utilization in Depressed Canadian Armed Forces Personnel. *Can J Psychiatry* 64:59–67. <https://doi.org/10.1177/0706743718787792>
12. Tannenbaum C, Lexchin J, Tamblyn R, Romans S (2009) Indicators for measuring mental health: towards better surveillance. *Healthc Policy* 5:e177-86
13. Benchimol EI, Smeeth L, Guttman A, et al (2015) The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Med* 12:. <https://doi.org/10.1371/JOURNAL.PMED.1001885>
14. Spettell CM, Wall TC, Allison J, et al (2003) Identifying physician-recognized depression from administrative data: consequences for quality measurement. *Health Serv Res* 38:1081–102
15. Yoon G, Petrakis IL, Rosenheck RA (2015) Correlates of major depressive disorder with and without comorbid alcohol use disorder nationally in the veterans health administration. *Am J Addict* 24:419–426. <https://doi.org/10.1111/ajad.12219>
16. Shrestha A, Cornum BGR, Vie LL, et al (2018) Protective Effects of Psychological Strengths Against Psychiatric Disorders Among Soldiers. *Mil Med* 183:386–395. <https://doi.org/10.1093/milmed/usx189>
17. StataCorp (2015) Stata Statistical Software: Release 14
18. Weiskopf NG, Weng C (2013) Methods and dimensions of electronic health record data quality assessment: enabling reuse for clinical research. *J Am Med Inform Assoc* 20:144–51. <https://doi.org/10.1136/amiajnl-2011-000681>
19. Stahlman S, Oetting AA (2018) Mental health disorders and mental health problems, active component, U.S. Armed Forces, 2007-2016. *MSMR* 25:2–11
20. Hoge CW, Castro CA, Messer SC, et al (2004) Combat Duty in Iraq and Afghanistan, Mental Health Problems, and Barriers to Care. *N Engl J Med* 351:13–22.


- <https://doi.org/10.1056/NEJMoa040603>
21. Welsh MM, Federinko SP, Burnett DG, et al (2014) Deployment-related depression screening, 2001-2008: comparing clinical versus research surveys. *Am J Prev Med* 47:531–40. <https://doi.org/10.1016/j.amepre.2014.07.036>
  22. Morgan JK, Hourani L, Lane ME, Tueller S (2016) Help-Seeking Behaviors Among Active-Duty Military Personnel: Utilization of Chaplains and Other Mental Health Service Providers. *J Health Care Chaplain* 22:102–17. <https://doi.org/10.1080/08854726.2016.1171598>
  23. Office of the Deputy Assistant Secretary of Defense for Military Community and Family Policy (2015) 2015 Demographics Profile of the Military Community
  24. Thériault FL, Gabler K, Naicker K (2016) Health and Lifestyle Information Survey of Canadian Armed Forces Personnel 2013/2014 – Regular Forces Report. Department of National Defence., Ottawa, Canada
  25. Twomey CD, Baldwin DS, Hopfe M, Cieza A (2015) A systematic review of the predictors of health service utilisation by adults with mental disorders in the UK. *BMJ Open* 5:e007575. <https://doi.org/10.1136/bmjopen-2015-007575>
  26. Ferrari AJ, Somerville AJ, Baxter AJ, et al (2013) Global variation in the prevalence and incidence of major depressive disorder: a systematic review of the epidemiological literature. *Psychol Med* 43:471–481. <https://doi.org/10.1017/S0033291712001511>
  27. Hines LA, Goodwin L, Jones M, et al (2014) Factors affecting help seeking for mental health problems after deployment to Iraq and Afghanistan. *Psychiatr Serv* 65:98–105. <https://doi.org/10.1176/appi.ps.004972012>
  28. Fikretoglu D, Liu A, Pedlar D, Brunet A (2010) Patterns and predictors of treatment delay for mental disorders in a nationally representative, active Canadian military sample. *Med Care* 48:10–7. <https://doi.org/10.1097/MLR.0b013e3181bd4bf9>
  29. Boulos D, Zamorski MA (2016) Delay to mental healthcare in a cohort of Canadian Armed Forces personnel with deployment-related mental disorders, 2002-2011: a retrospective cohort study. *BMJ Open* 6:e012384. <https://doi.org/10.1136/bmjopen-2016-012384>

30. Bonde JP, Utzon-Frank N, Bertelsen M, et al (2016) Risk of depressive disorder following disasters and military deployment: systematic review with meta-analysis. *Br J Psychiatry* 208:330–6. <https://doi.org/10.1192/bjp.bp.114.157859>
31. Boulos D, Zamorski MA (2016) Contribution of the Mission in Afghanistan to the Burden of Past-Year Mental Disorders in Canadian Armed Forces Personnel, 2013. *Can J Psychiatry* 61:64S-76S. <https://doi.org/10.1177/0706743716628857>
32. Zamorski MA, Bennett RE, Boulos D, et al (2016) The 2013 Canadian Forces Mental Health Survey. *Can J Psychiatry* 61:10S-25S. <https://doi.org/10.1177/0706743716632731>
33. Katon WJ (2011) Epidemiology and treatment of depression in patients with chronic medical illness. *Dialogues Clin Neurosci* 13:7–23
34. Hom MA, Stanley IH, Schneider ME, Joiner TE (2017) A systematic review of help-seeking and mental health service utilization among military service members. *Clin Psychol Rev* 53:59–78. <https://doi.org/10.1016/j.cpr.2017.01.008>
35. Kendler KS, Karkowski LM, Prescott CA (1999) Causal Relationship Between Stressful Life Events and the Onset of Major Depression. *Am J Psychiatry* 156:837–841. <https://doi.org/10.1176/ajp.156.6.837>
36. Mojtabai R, Olfson M (2006) Treatment Seeking for Depression in Canada and the United States. *Psychiatr Serv* 57:631–639. <https://doi.org/10.1176/ps.2006.57.5.631>
37. Quartana PJ, Wilk JE, Thomas JL, et al (2014) Trends in mental health services utilization and stigma in US soldiers from 2002 to 2011. *Am J Public Health* 104:1671–9. <https://doi.org/10.2105/AJPH.2014.301971>
38. Crumlish N, Kelly BD (2009) How psychiatrists think. *Adv Psychiatr Treat* 15:72–79. <https://doi.org/10.1192/apt.bp.107.005298>

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



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

<b>File Number:</b> H04-17-04B		<b>Date (mm/dd/yyyy):</b> 11/30/2017	
<b>Université d'Ottawa</b> Bureau d'éthique et d'intégrité de la recherche	<b>University of Ottawa</b> Office of Research Ethics and Integrity		
<b>Ethics Approval Notice</b> <b>Health Sciences and Science REB</b>			
<b>Principal Investigator / Supervisor / Co-investigator(s) / Student(s)</b>			
<b><u>First Name</u></b>	<b><u>Last Name</u></b>	<b><u>Affiliation</u></b>	<b><u>Role</u></b>
Ian	Colman	Medicine / Medicine	Supervisor
François	Thériault	Medicine / Medicine	Student Researcher
Robert	Hawes	Others / Others	Other Collaborator
<b>File Number:</b> H04-17-04B			
<b>Type of Project:</b> PhD Thesis			
<b>Title:</b> Major depressive disorders in the Canadian Armed Forces: A longitudinal study of risk factors, care seeking, and treatment outcomes			
<b>Approval Date (mm/dd/yyyy)</b>	<b>Expiry Date (mm/dd/yyyy)</b>	<b>Approval Type</b>	
11/30/2017	11/29/2018	Approval	
<b>Special Conditions / Comments:</b> N/A			
1			
550, rue Cumberland, pièce 154 Ottawa (Ontario) K1N 6N5 Canada (613) 562-5387 • Téléc./Fax (613) 562-5338		550 Cumberland Street, room 154 Ottawa, Ontario K1N 6N5 Canada (613) 562-5387 • Téléc./Fax (613) 562-5338	
<a href="http://www.recherche.uottawa.ca/deontologie/">www.recherche.uottawa.ca/deontologie/</a> <a href="http://www.research.uottawa.ca/ethics/">www.research.uottawa.ca/ethics/</a>			

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

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## Funding and endorsement requests

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Applicants will be required to complete **every** section of the electronic form.

Incomplete proposals or proposals without the supporting administrative documents will not be reviewed by the SGHRB.

If additional information is required concerning these forms or the MH Research Program, please contact the S&T Manager at [CFHS-SSFC-S&T@forces.gc.ca](mailto:CFHS-SSFC-S&T@forces.gc.ca).

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Project ID	Title	Health Research Block	Date Modified	Status	
<a href="#">2017-07-255-010-0001</a>	Major depressive disorders in the Canadian Armed Forces: A longitudinal study of risk factors, care seeking, and treatment outcomes	Mental Health	2017-11-14	Approved by Surgeon General Health Research Block Leader	

## 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..

## **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 Bernoulli 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 Bernoulli 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 ( $nu_{pain}$ ) and without ( $nu_{no}$ ) spinal pain.

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

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<sup>th</sup> and 97.5<sup>th</sup> 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***

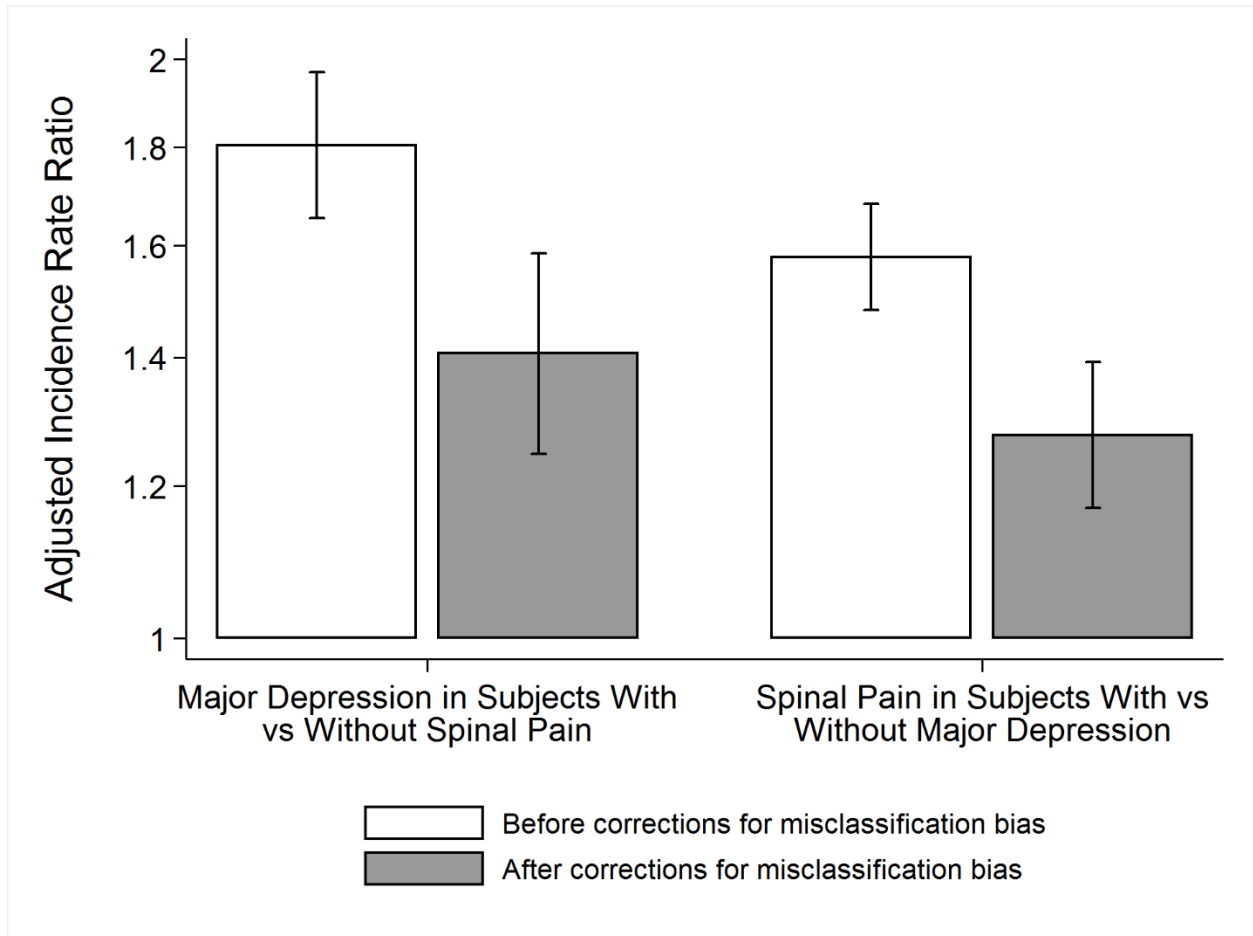
Our study had noteworthy limitations. First, we operationalized major depression and spinal pain as two dichotomous outcomes. However, symptoms of major depression and spinal pain range in severity (40, 41), and previous studies have found that symptom severity is an important effect modifier in the 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.

	Total count at baseline		Incident major depression diagnosis		Incident spinal pain diagnosis	
	N	(col %)	n	(row %)	n	(row %)
<b>Sex</b>						
Female	6,165	(12.8)	455	(7.4)	1,579	(25.6)
Male	41,842	(87.2)	1,724	(4.1)	7,941	(19.0)
<b>Age at baseline</b>						
17-29 years	17,536	(36.5)	601	(3.4)	2,717	(15.5)
30-39 years	16,753	(34.9)	870	(5.2)	3,453	(20.6)
40-49 years	9,750	(20.3)	539	(5.5)	2,393	(24.5)
50-60 years	3,968	(8.3)	169	(4.3)	957	(24.1)

**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.

Incident spinal pain diagnosis	Incident major depression diagnosis		Total
	Yes	No	
Yes	707	8,813	9,520
No	1,472	37,015	38,487
Total	2,179	45,828	48,007

**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.

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

\* Time-varying exposure

## References

1. Vos T, Abajobir AA, Abate KH, et al (2017) Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 390:1211–1259. [https://doi.org/10.1016/S0140-6736\(17\)32154-2](https://doi.org/10.1016/S0140-6736(17)32154-2)
2. Gadermann AM, Engel CC, Naifeh JA, et al (2012) Prevalence of DSM-IV major depression among U.S. military personnel: meta-analysis and simulation. *Mil Med* 177:47–59
3. Goodwin L, Wessely S, Hotopf M, et al (2015) Are common mental disorders more prevalent in the UK serving military compared to the general working population? *Psychol Med* 45:1881–91. <https://doi.org/10.1017/S0033291714002980>
4. Rusu C, Zamorski MA, Boulos D, Garber BG (2016) Prevalence Comparison of Past-year Mental Disorders and Suicidal Behaviours in the Canadian Armed Forces and the Canadian General Population. *Can J Psychiatry* 61:46S-55S. <https://doi.org/10.1177/0706743716628856>
5. Mcfarlane A, Sriapada R, Ganoczy D, et al (2011) Mental health in the Australian Defence Force: 2010 ADF mental health and wellbeing study: Full report. Canberra
6. Ursano RJ, Kessler RC, Stein MB, et al (2016) Risk Factors, Methods, and Timing of Suicide Attempts Among US Army Soldiers. *JAMA psychiatry* 73:741–9. <https://doi.org/10.1001/jamapsychiatry.2016.0600>
7. Pflanz SE, Ogle AD (2006) Job Stress, Depression, Work Performance, and Perceptions of Supervisors in Military Personnel. *Mil Med* 171:861–865. <https://doi.org/10.7205/MILMED.171.9.861>
8. Littman AJ, Jacobson IG, Boyko EJ, et al (2013) Weight change following US military service. *Int J Obes* 37:244–253. <https://doi.org/10.1038/ijo.2012.46>
9. Clark LL, Hu Z (2015) Diagnoses of low back pain, active component, U.S. Armed Forces, 2010-2014. *MSMR* 22:8–11
10. Armed Forces Health Surveillance Center (AFHSC) (2012) Medical evacuations from

- Operation Iraqi Freedom/Operation New Dawn, active and reserve components, U.S. Armed Forces, 2003-2011. *MSMR* 19:18–21
11. Vun E, Turner S, Sareen J, et al (2018) Prevalence of comorbid chronic pain and mental health conditions in Canadian Armed Forces active personnel: analysis of a cross-sectional survey. *C open* 6:E528–E536. <https://doi.org/10.9778/cmajo.20180093>
  12. Mattila VM, Kyröläinen H, Santtila M, Pihlajamäki H (2017) Low back pain during military service predicts low back pain later in life. *PLoS One* 12:e0173568. <https://doi.org/10.1371/journal.pone.0173568>
  13. Bair MJ, Robinson RL, Katon W, Kroenke K (2003) Depression and Pain Comorbidity. *Arch Intern Med* 163:2433. <https://doi.org/10.1001/archinte.163.20.2433>
  14. Goesling J, Clauw DJ, Hassett AL (2013) Pain and Depression: An Integrative Review of Neurobiological and Psychological Factors. *Curr Psychiatry Rep* 15:421. <https://doi.org/10.1007/s11920-013-0421-0>
  15. Terry EL, DelVentura JL, Bartley EJ, et al (2013) Emotional modulation of pain and spinal nociception in persons with major depressive disorder (MDD). *Pain* 154:2759–68. <https://doi.org/10.1016/j.pain.2013.08.009>
  16. Fernandez M, Colodro-Conde L, Hartvigsen J, et al (2017) Chronic low back pain and the risk of depression or anxiety symptoms: insights from a longitudinal twin study. *Spine J* 17:905–912. <https://doi.org/10.1016/j.spinee.2017.02.009>
  17. Pinheiro MB, Ferreira ML, Refshauge K, et al (2017) Symptoms of Depression and Risk of Low Back Pain. *Clin J Pain* 33:777–785. <https://doi.org/10.1097/AJP.0000000000000466>
  18. Lépine J-P, Briley M (2004) The epidemiology of pain in depression. *Hum Psychopharmacol Clin Exp* 19:S3–S7. <https://doi.org/10.1002/hup.618>
  19. Thériault FL, Hawes RA, Garber BG, et al (2019) Incidence of major depression diagnoses in the Canadian Armed Forces: longitudinal analysis of clinical and health administrative data. *Soc Psychiatry Psychiatr Epidemiol* 1–8. <https://doi.org/10.1007/s00127-019-01754-2>


20. Thériault FL, Lu D, Hawes RA (2019) Development and validation of a case-finding algorithm for neck and back pain in the Canadian Armed Forces using health administrative data. *J Mil Veteran Fam Heal* 5:16–26. <https://doi.org/10.3138/jmvfh.2018-0039>
21. Manchikanti L, Singh V, Datta S, et al (2009) Comprehensive review of epidemiology, scope, and impact of spinal pain. *Pain Physician* 12:E35-70
22. Sinnott PL, Siroka AM, Shane AC, et al (2012) Identifying Neck and Back Pain in Administrative Data. *Spine (Phila Pa 1976)* 37:860–874. <https://doi.org/10.1097/BRS.0b013e3182376508>
23. Deeny SR, Steventon A (2015) Making sense of the shadows: priorities for creating a learning healthcare system based on routinely collected data. *BMJ Qual Saf* 24:505–515. <https://doi.org/10.1136/bmjqs-2015-004278>
24. Thériault FL, Garber BG, Momoli F, et al (2019) Mental Health Service Utilization in Depressed Canadian Armed Forces Personnel. *Can J Psychiatry* 64:59–67. <https://doi.org/10.1177/0706743718787792>
25. Thériault FL, Gabler K, Naicker K (2016) Health and Lifestyle Information Survey of Canadian Armed Forces Personnel 2013/2014 – Regular Forces Report. Department of National Defence., Ottawa, Canada
26. Levine DS, Sripada RK, Ganoczy D, et al (2016) Poorer Physical Health is Associated With Greater Mental Health Service Utilization in a Sample of Depressed U.S. Army National Guard Soldiers. *Mil Med* 181:803–810. <https://doi.org/10.7205/MILMED-D-15-00287>
27. Lash TL, Fox MP, Fink AK (2009) *Applying Quantitative Bias Analysis to Epidemiological Data*. Springer
28. Greenland S (1996) Basic methods for sensitivity analysis of biases. *Int J Epidemiol* 25:1107–16
29. StataCorp (2015) *Stata Statistical Software: Release 14*
30. Schmalings KB, Nounou ZA (2019) Incident Chronic Spinal Pain and Depressive

- Disorders: Data From the National Comorbidity Survey. *J Pain* 20:481–488.  
<https://doi.org/10.1016/j.jpain.2018.11.002>
31. Bondesson E, Larrosa Pardo F, Stigmar K, et al (2018) Comorbidity between pain and mental illness - Evidence of a bidirectional relationship. *Eur J Pain* 22:1304–1311.  
<https://doi.org/10.1002/ejp.1218>
  32. Chang M-H, Hsu J-W, Huang K-L, et al (2015) Bidirectional Association Between Depression and Fibromyalgia Syndrome: A Nationwide Longitudinal Study. *J Pain* 16:895–902. <https://doi.org/10.1016/j.jpain.2015.06.004>
  33. Siu AL, Bibbins-Domingo K, Grossman DC, et al (2016) Screening for Depression in Adults. *JAMA* 315:380. <https://doi.org/10.1001/jama.2015.18392>
  34. Valenstein M, Vijan S, Zeber JE, et al (2001) The Cost–Utility of Screening for Depression in Primary Care. *Ann Intern Med* 134:345. <https://doi.org/10.7326/0003-4819-134-5-200103060-00007>
  35. Joffres M, Jaramillo A, Dickinson J, et al (2013) Recommendations on screening for depression in adults. *CMAJ* 185:775–82. <https://doi.org/10.1503/cmaj.130403>
  36. Edmond SN, Heapy AA, Kerns RD (2019) Engaging Mental Health Professionals in Addressing Pain. *JAMA psychiatry*. <https://doi.org/10.1001/jamapsychiatry.2019.0254>
  37. Parikh S V, Quilty LC, Ravitz P, et al (2016) Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder: Section 2. Psychological Treatments. *Can J Psychiatry* 61:524–39. <https://doi.org/10.1177/0706743716659418>
  38. Richmond H, Hall AM, Copsey B, et al (2015) The Effectiveness of Cognitive Behavioural Treatment for Non-Specific Low Back Pain: A Systematic Review and Meta-Analysis. *PLoS One* 10:e0134192. <https://doi.org/10.1371/journal.pone.0134192>
  39. Kroenke K, Wu J, Bair MJ, et al (2011) Reciprocal relationship between pain and depression: a 12-month longitudinal analysis in primary care. *J Pain* 12:964–73.  
<https://doi.org/10.1016/j.jpain.2011.03.003>
  40. Kroenke K, Spitzer RL (2002) The PHQ-9: A New Depression Diagnostic and Severity

- Measure. *Psychiatr Ann* 32:509–515. <https://doi.org/10.3928/0048-5713-20020901-06>
41. Schmidt CO, Raspe H, Pflingsten M, et al (2007) Back Pain in the German Adult Population. *Spine (Phila Pa 1976)* 32:2005–2011. <https://doi.org/10.1097/BRS.0b013e318133fad8>
  42. Currie SR, Wang J (2004) Chronic back pain and major depression in the general Canadian population. *Pain* 107:54–60
  43. Ohayon MM, Schatzberg AF (2010) Chronic pain and major depressive disorder in the general population. *J Psychiatr Res* 44:454–461. <https://doi.org/10.1016/j.jpsychires.2009.10.013>
  44. Kendler KS, Gardner CO, Prescott CA (2006) Toward a comprehensive developmental model for major depression in men. *Am J Psychiatry* 163:115–24. <https://doi.org/10.1176/appi.ajp.163.1.115>
  45. Crofford LJ (2015) Chronic Pain: Where the Body Meets the Brain. *Trans Am Clin Climatol Assoc* 126:167–83
  46. Brown G, Harris T, Hepworth C (1994) Life events and endogenous depression. A puzzle reexamined. *Arch Gen Psychiatry* 51:525–534
  47. Post RM (2016) Epigenetic basis of sensitization to stress, affective episodes, and stimulants: implications for illness progression and prevention. *Bipolar Disord* 18:315–24. <https://doi.org/10.1111/bdi.12401>
  48. Monroe SM, Harkness KL (2005) Life Stress, the "Kindling" Hypothesis, and the Recurrence of Depression: Considerations From a Life Stress Perspective. *Psychol Rev* 112:417–445. <https://doi.org/10.1037/0033-295X.112.2.417>
  49. Fikretoglu D, Liu A, Pedlar D, Brunet A (2010) Patterns and predictors of treatment delay for mental disorders in a nationally representative, active Canadian military sample. *Med Care* 48:10–7. <https://doi.org/10.1097/MLR.0b013e3181bd4bf9>
  50. Walraven C van (2018) A comparison of methods to correct for misclassification bias from administrative database diagnostic codes. *Int J Epidemiol* 47:605–616. <https://doi.org/10.1093/ije/dyx253>

51. Lash TL, Fox MP, MacLehose RF, et al (2014) Good practices for quantitative bias analysis. *Int J Epidemiol* 43:1969–1985. <https://doi.org/10.1093/ije/dyu149>

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

<b>File Number:</b> H04-17-04B		<b>Date (mm/dd/yyyy):</b> 11/30/2017	
<b>Université d'Ottawa</b> Bureau d'éthique et d'intégrité de la recherche	<b>University of Ottawa</b> Office of Research Ethics and Integrity		
<b>Ethics Approval Notice</b> <b>Health Sciences and Science REB</b>			
<b>Principal Investigator / Supervisor / Co-investigator(s) / Student(s)</b>			
<b><u>First Name</u></b>	<b><u>Last Name</u></b>	<b><u>Affiliation</u></b>	<b><u>Role</u></b>
Ian	Colman	Medicine / Medicine	Supervisor
François	Thériault	Medicine / Medicine	Student Researcher
Robert	Hawes	Others / Others	Other Collaborator
<b>File Number:</b> H04-17-04B			
<b>Type of Project:</b> PhD Thesis			
<b>Title:</b> Major depressive disorders in the Canadian Armed Forces: A longitudinal study of risk factors, care seeking, and treatment outcomes			
<b>Approval Date (mm/dd/yyyy)</b>	<b>Expiry Date (mm/dd/yyyy)</b>	<b>Approval Type</b>	
11/30/2017	11/29/2018	Approval	
<b>Special Conditions / Comments:</b> N/A			
1			
550, rue Cumberland, pièce 154 Ottawa (Ontario) K1N 6N5 Canada (613) 562-5387 • Téléc./Fax (613) 562-5338 <a href="http://www.recherche.uottawa.ca/deontologie/">www.recherche.uottawa.ca/deontologie/</a>		550 Cumberland Street, room 154 Ottawa, Ontario K1N 6N5 Canada (613) 562-5387 • Téléc./Fax (613) 562-5338 <a href="http://www.research.uottawa.ca/ethics/">www.research.uottawa.ca/ethics/</a>	

**Appendix 7B:** Screenshot of online portal for the Surgeon General’s Health Research Program, showing this project was approved on November 14<sup>th</sup>, 2017

Home → [Funding and endorsement requests](#)

Logged in as : francois.theriault3@forces.gc.ca | [Profile](#) | [Logout](#)

## Funding and endorsement requests

Endorsement Request | **Funding Requests** | Change Requests | Additional Funding Requests | Progress Reports

Applicants will be required to complete **every** section of the electronic form.  
 Incomplete proposals or proposals without the supporting administrative documents will not be reviewed by the SGHRB.  
 If additional information is required concerning these forms or the MH Research Program, please contact the S&T Manager at [CFHS-SSFC-S&T@forces.gc.ca](mailto:SSFC-S&T@forces.gc.ca).

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Project ID	Title	Health Research Block	Date Modified	Status	
<a href="#">2017-07-255-010-0001</a>	Major depressive disorders in the Canadian Armed Forces: A longitudinal study of risk factors, care seeking, and treatment outcomes	Mental Health	2017-11-14	Approved by Surgeon General Health Research Block Leader	

## 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 comorbidities, 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 12<sup>th</sup> 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. Interestingly, 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 diagnoses 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

<b>Chapter</b>	<b>Research Findings</b>
4	<ul style="list-style-type: none"> <li>• 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</li> <li>• Among depressed CAF personnel who used mental health services in the past 12 months, 70.3% consulted a mental health specialist</li> <li>• 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.</li> </ul>
5	<ul style="list-style-type: none"> <li>• 12 studies have measured mental health service use in military personnel with past-year major depression in Five Eye nations</li> <li>• Across these 12 studies, the median period prevalence of mental health service use among depressed military personnel was 47.6%</li> </ul>
6	<ul style="list-style-type: none"> <li>• 5.6% of CAF personnel have a past-year clinician diagnosis of major depression in their electronic medical records</li> <li>• The proportion of CAF personnel with past-year diagnosis of major depression is highly consistent with the findings of Chapter 4</li> <li>• Major depression is diagnosed at a rate of 29.2 new cases per 1,000 person-years in CAF personnel</li> <li>• Female sex, older age, and non-officer rank are modestly associated with the incidence rate of new major depression diagnoses in CAF personnel</li> </ul>
7	<ul style="list-style-type: none"> <li>• 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).</li> <li>• 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</li> <li>• The risk of an incident diagnosis of major depression increases 1.67-fold after an incident diagnosis of spinal pain</li> <li>• The risk of an incident diagnosis of spinal pain increases 1.71-fold after an incident diagnosis of major depression</li> </ul>

## 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 20<sup>th</sup> 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].

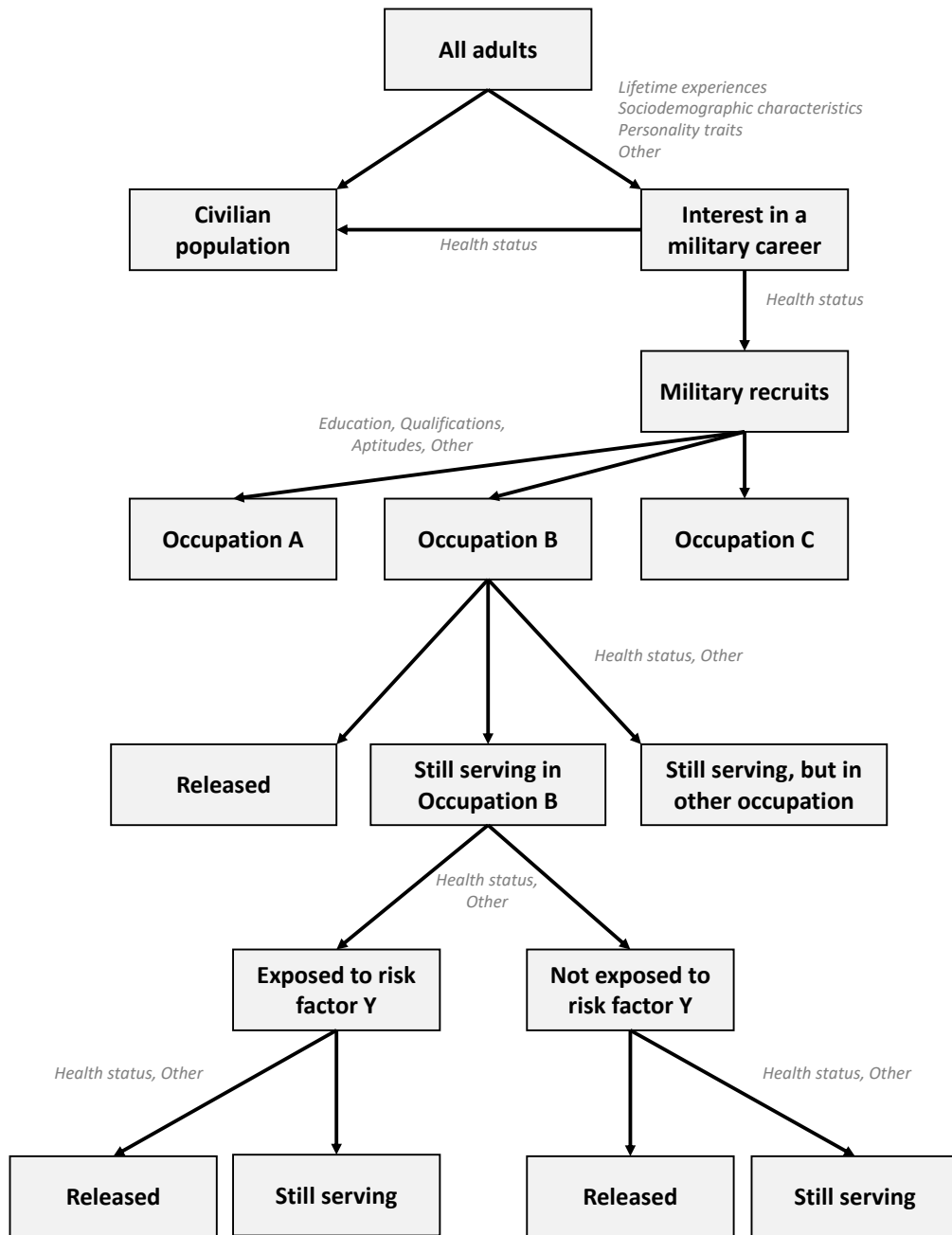
More recently, Kessler *et al* [21] used baseline data from 1,056 World Mental Health Survey respondents to predict depression status over the following 10 years. More specifically, they used Machine Learning applications to derive a predictive risk score for each subject, based on baseline

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

1. Thériault FL, Garber BG, Momoli F, et al (2019) Mental Health Service Utilization in Depressed Canadian Armed Forces Personnel. *Can J Psychiatry* 64:59–67.  
<https://doi.org/10.1177/0706743718787792>
2. Rusu C, Zamorski MA, Boulos D, Garber BG (2016) Prevalence Comparison of Past-year Mental Disorders and Suicidal Behaviours in the Canadian Armed Forces and the Canadian General Population. *Can J Psychiatry* 61:46S-55S.  
<https://doi.org/10.1177/0706743716628856>
3. Mojtabai R, Olfson M (2006) Treatment Seeking for Depression in Canada and the United States. *Psychiatr Serv* 57:631–639. <https://doi.org/10.1176/ps.2006.57.5.631>
4. Burns BJ, Wagner HR, Gaynes BN, et al (2000) General Medical and Specialty Mental Health Service Use for Major Depression. *Int J Psychiatry Med* 30:127–143.  
<https://doi.org/10.2190/TLXJ-YXLX-F4YA-6PHA>
5. Prinsie JC, Fiest KM, Coutts SB, et al (2016) Validating screening tools for depression in stroke and transient ischemic attack patients. *Int J Psychiatry Med* 51:262–77.  
<https://doi.org/10.1177/0091217416652616>
6. Gelaye B, Tadesse MG, Williams MA, et al (2014) Assessing validity of a depression screening instrument in the absence of a gold standard. *Ann Epidemiol* 24:527–531.  
<https://doi.org/10.1016/j.annepidem.2014.04.009>
7. Rona RJ, Hyams KC, Wessely S (2005) Screening for Psychological Illness in Military Personnel. *JAMA* 293:1257. <https://doi.org/10.1001/jama.293.10.1257>
8. Bliese PD (2011) Preventive mental health screening in the military. In: Adler AB, Bliese

- PD, Castro CA (eds) *Deployment psychology: Evidence-based strategies to promote mental health in the military*. American Psychological Association, Washington, pp 175–193
9. Bonde JP, Utzon-Frank N, Bertelsen M, et al (2016) Risk of depressive disorder following disasters and military deployment: systematic review with meta-analysis. *Br J Psychiatry* 208:330–336. <https://doi.org/10.1192/bjp.bp.114.157859>
  10. Zamorski MA, Rusu C, Garber BG (2014) Prevalence and Correlates of Mental Health Problems in Canadian Forces Personnel Who Deployed in Support of the Mission in Afghanistan: Findings from Postdeployment Screenings, 2009–2012. *Can J Psychiatry* 59:319–326. <https://doi.org/10.1177/070674371405900605>
  11. Boulos D, Zamorski MA (2016) Contribution of the Mission in Afghanistan to the Burden of Past-Year Mental Disorders in Canadian Armed Forces Personnel, 2013. *Can J Psychiatry* 61:64S-76S. <https://doi.org/10.1177/0706743716628857>
  12. Gadermann AM, Engel CC, Naifeh JA, et al (2012) Prevalence of DSM-IV major depression among U.S. military personnel: meta-analysis and simulation. *Mil Med* 177:47–59
  13. Ursano RJ, Kessler RC, Stein MB, et al (2016) Risk Factors, Methods, and Timing of Suicide Attempts Among US Army Soldiers. *JAMA psychiatry* 73:741–9. <https://doi.org/10.1001/jamapsychiatry.2016.0600>
  14. Hoge CW, Auchterlonie JL, Milliken CS (2006) Mental Health Problems, Use of Mental Health Services, and Attrition From Military Service After Returning From Deployment to Iraq or Afghanistan. *JAMA* 295:1023. <https://doi.org/10.1001/jama.295.9.1023>

15. Milliken CS, Auchterlonie JL, Hoge CW (2007) Longitudinal Assessment of Mental Health Problems Among Active and Reserve Component Soldiers Returning From the Iraq War. *JAMA* 298:2141. <https://doi.org/10.1001/jama.298.18.2141>
16. Skopp NA, Swanson R, Luxton DD, et al (2012) An Examination of the Diagnostic Efficiency of Post-Deployment Mental Health Screens. *J Clin Psychol* 68:1253–1265. <https://doi.org/10.1002/jclp.21887>
17. Panaite V, Brown R, Henry M, et al (2018) Post-deployment Mental Health Screening: A Systematic Review of Current Evidence and Future Directions. *Adm Policy Ment Heal Ment Heal Serv Res* 45:850–875. <https://doi.org/10.1007/s10488-018-0869-7>
18. Davidson HA (1940) Mental hygiene in our Armed Forces. *Mil Surg* 86:480
19. Rona RJ, Hooper R, Jones M, et al (2006) Mental health screening in armed forces before the Iraq war and prevention of subsequent psychological morbidity: follow-up study. *BMJ* 333:991. <https://doi.org/10.1136/bmj.38985.610949.55>
20. Jones E, Hyams KC, Wessely S (2003) Review: Screening for vulnerability to psychological disorders in the military: an historical survey. *J Med Screen* 10:40–46. <https://doi.org/10.1258/096914103321610798>
21. Kessler RC, van Loo HM, Wardenaar KJ, et al (2016) Testing a machine-learning algorithm to predict the persistence and severity of major depressive disorder from baseline self-reports. *Mol Psychiatry* 21:1366–1371. <https://doi.org/10.1038/mp.2015.198>
22. Belsher BE, Smolenski DJ, Pruitt LD, et al (2019) Prediction Models for Suicide Attempts and Deaths. *JAMA Psychiatry* 76:642. <https://doi.org/10.1001/jamapsychiatry.2019.0174>
23. Franklin JC, Ribeiro JD, Fox KR, et al (2017) Risk factors for suicidal thoughts and

- behaviors: A meta-analysis of 50 years of research. *Psychol Bull* 143:187–232.  
<https://doi.org/10.1037/bul0000084>
24. Colman I, Atallahjan A (2010) Life Course Perspectives on the Epidemiology of Depression. *Can J Psychiatry* 55:622–632. <https://doi.org/10.1177/070674371005501002>
  25. U.S. Department of Defense (2019) Millenium Cohort Study
  26. LeardMann CA, Powell TM, Smith TC, et al (2013) Risk Factors Associated With Suicide in Current and Former US Military Personnel. *JAMA* 310:496.  
<https://doi.org/10.1001/jama.2013.65164>
  27. Rush T, LeardMann CA, Crum-Cianflone NF (2016) Obesity and associated adverse health outcomes among US military members and veterans: Findings from the millennium cohort study. *Obesity* 24:1582–1589. <https://doi.org/10.1002/oby.21513>
  28. Riddle MS, Welsh M, Porter CK, et al (2016) The Epidemiology of Irritable Bowel Syndrome in the US Military: Findings from the Millennium Cohort Study. *Am J Gastroenterol* 111:93–104. <https://doi.org/10.1038/ajg.2015.386>
  29. Armenta RF, Rush T, LeardMann CA, et al (2018) Factors associated with persistent posttraumatic stress disorder among U.S. military service members and veterans. *BMC Psychiatry* 18:48. <https://doi.org/10.1186/s12888-018-1590-5>
  30. Wells TS, LeardMann CA, Fortuna SO, et al (2010) A prospective study of depression following combat deployment in support of the wars in Iraq and Afghanistan. *Am J Public Health* 100:90–9. <https://doi.org/10.2105/AJPH.2008.155432>
  31. Wang L, Seelig A, Wadsworth SM, et al (2015) Associations of military divorce with mental, behavioral, and physical health outcomes. *BMC Psychiatry* 15:128.

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

32. Boyko EJ, Seelig AD, Jacobson IG, et al (2013) Sleep Characteristics, Mental Health, and Diabetes Risk: A prospective study of U.S. military service members in the Millennium Cohort Study. *Diabetes Care* 36:3154–3161. <https://doi.org/10.2337/DC13-0042>
33. Smith TC, Millennium Cohort Study Team (2011) Linking exposures and health outcomes to a large population-based longitudinal study: the Millennium Cohort Study. *Mil Med* 176:56–63. <https://doi.org/10.7205/milmed-d-11-00085>
34. Beliveau PJH, Sampasa-Kanyinga H, Colman I, Zamorski MA (2019) Are personnel with a past history of mental disorders disproportionately vulnerable to the effects of deployment-related trauma? A cross-sectional study of Canadian military personnel. *BMC Psychiatry* 19:156. <https://doi.org/10.1186/s12888-019-2146-z>
35. Abraham N (2017) Childhood Adversity, Deployment-Related Stress, and Mental Health in the Canadian Armed Forces. University of Ottawa
36. Bandoli G, Campbell-Sills L, Kessler RC, et al (2017) Childhood adversity, adult stress, and the risk of major depression or generalized anxiety disorder in US soldiers: a test of the stress sensitization hypothesis. *Psychol Med* 47:2379–2392. <https://doi.org/10.1017/S0033291717001064>

## BIBLIOGRAPHY

- Abraham, Natalia. 2017. "Childhood Adversity, Deployment-Related Stress, and Mental Health in the Canadian Armed Forces." University of Ottawa.
- Adler, Amy B., and Carl Andrew Castro. 2013. "An Occupational Mental Health Model for the Military." *Military Behavioral Health* 1 (1): 41–45.  
<https://doi.org/10.1080/21635781.2012.721063>.
- Afifi, Tracie O., Tamara Taillieu, Mark A. Zamorski, Sarah Turner, Kristene Cheung, and Jitender Sareen. 2016. "Association of Child Abuse Exposure With Suicidal Ideation, Suicide Plans, and Suicide Attempts in Military Personnel and the General Population in Canada." *JAMA Psychiatry* 73 (3): 229. <https://doi.org/10.1001/jamapsychiatry.2015.2732>.
- Aguilar-Gaxiola, Sergio, Gustavo Loera, Daniel Vigo, Efrain Talamantes, and Kate Scott. 2017. "The Burden of Comorbidity: Depressive and Physical Disorders." In *Public Health Perspectives on Depressive Disorders*, edited by Neal L Cohen. Baltimore: Johns Hopkins University Press.
- Alonso, J, M Petukhova, G Vilagut, S Chatterji, S Heeringa, T B Üstün, A O Alhamzawi, et al. 2011. "Days out of Role Due to Common Physical and Mental Conditions: Results from the WHO World Mental Health Surveys." *Molecular Psychiatry* 16 (12): 1234–46.  
<https://doi.org/10.1038/mp.2010.101>.
- Alonzo, Dana M., Jill M. Harkavy-Friedman, Barbara Stanley, Ainsley Burke, J. John Mann, and Maria A. Oquendo. 2011. "Predictors of Treatment Utilization in Major Depression." *Archives of Suicide Research* 15 (2): 160–71.  
<https://doi.org/10.1080/13811118.2011.566052>.
- American Psychiatric Association. 2013. *Diagnostic and Statistical Manual of Mental Disorders*. American Psychiatric Association. <https://doi.org/10.1176/appi.books.9780890425596>.
- Andrade, L. H., J. Alonso, Z. Mneimneh, J. E. Wells, A. Al-Hamzawi, G. Borges, E. Bromet, et al. 2014. "Barriers to Mental Health Treatment: Results from the WHO World Mental Health Surveys." *Psychological Medicine* 44 (6): 1303–17.

<https://doi.org/10.1017/S0033291713001943>.

- Andrews, Gavin, Kristy Sanderson, Justine Corry, and Helen M. Lapsley. 2000. "Using Epidemiological Data to Model Efficiency in Reducing the Burden of Depression\*." *The Journal of Mental Health Policy and Economics* 3 (4): 175–86.
- Angermeyer, Matthias C, Sandra van der Auwera, Mauro G Carta, and Georg Schomerus. 2017. "Public Attitudes towards Psychiatry and Psychiatric Treatment at the Beginning of the 21st Century: A Systematic Review and Meta-Analysis of Population Surveys." *World Psychiatry : Official Journal of the World Psychiatric Association (WPA)* 16 (1): 50–61. <https://doi.org/10.1002/wps.20383>.
- Arbisi, Paul A, Laura Rusch, Melissa A Polusny, Paul Thuras, and Christopher R Erbes. 2013. "Does Cynicism Play a Role in Failure to Obtain Needed Care? Mental Health Service Utilization among Returning U.S. National Guard Soldiers." *Psychological Assessment* 25 (3): 991–96. <https://doi.org/10.1037/a0032225>.
- Arias-de la Torre, Jorge, Gemma Vilagut, Vicente Martín, Antonio J Molina, and Jordi Alonso. 2018. "Prevalence of Major Depressive Disorder and Association with Personal and Socio-Economic Factors. Results for Spain of the European Health Interview Survey 2014–2015." *Journal of Affective Disorders* 239 (October): 203–7. <https://doi.org/10.1016/j.jad.2018.06.051>.
- Armed Forces Health Surveillance Center (AFHSC). 2012. "Medical Evacuations from Operation Iraqi Freedom/Operation New Dawn, Active and Reserve Components, U.S. Armed Forces, 2003-2011." *MSMR* 19 (2): 18–21.
- Armenta, Richard F., Toni Rush, Cynthia A. LeardMann, Jeffrey Millegan, Adam Cooper, Charles W. Hoge, and Millennium Cohort Study team. 2018. "Factors Associated with Persistent Posttraumatic Stress Disorder among U.S. Military Service Members and Veterans." *BMC Psychiatry* 18 (1): 48. <https://doi.org/10.1186/s12888-018-1590-5>.
- Bair, Matthew J., Rebecca L. Robinson, Wayne Katon, and Kurt Kroenke. 2003. "Depression and Pain Comorbidity." *Archives of Internal Medicine* 163 (20): 2433. <https://doi.org/10.1001/archinte.163.20.2433>.
- Balogun, Rasheed A., Bolanle A. Omotoso, Wenjun Xin, Jennie Z. Ma, Kenneth W. Scully,

- Fatiu A. Arogundade, and Emaad M. Abdel-Rahman. 2017. "Major Depression and Long-Term Outcomes of Acute Kidney Injury." *Nephron* 135 (1): 23–30. <https://doi.org/10.1159/000449474>.
- Bandoli, G., L. Campbell-Sills, R. C. Kessler, S. G. Heeringa, M. K. Nock, A. J. Rosellini, N. A. Sampson, M. Schoenbaum, R. J. Ursano, and M. B. Stein. 2017. "Childhood Adversity, Adult Stress, and the Risk of Major Depression or Generalized Anxiety Disorder in US Soldiers: A Test of the Stress Sensitization Hypothesis." *Psychological Medicine* 47 (13): 2379–92. <https://doi.org/10.1017/S0033291717001064>.
- Bebbington, Paul. 1987. "Misery and the of Disease Theories of Depression." *International Journal of Social Psychiatry* 33 (1): 13–20. <https://doi.org/10.1177/002076408703300102>.
- Beliveau, Peter J.H., Hugues Sampasa-Kanyinga, Ian Colman, and Mark A. Zamorski. 2019. "Are Personnel with a Past History of Mental Disorders Disproportionately Vulnerable to the Effects of Deployment-Related Trauma? A Cross-Sectional Study of Canadian Military Personnel." *BMC Psychiatry* 19 (1): 156. <https://doi.org/10.1186/s12888-019-2146-z>.
- Belsher, Bradley E., Derek J. Smolenski, Larry D. Pruitt, Nigel E. Bush, Erin H. Beech, Don E. Workman, Rebecca L. Morgan, Daniel P. Evatt, Jennifer Tucker, and Nancy A. Skopp. 2019. "Prediction Models for Suicide Attempts and Deaths." *JAMA Psychiatry* 76 (6): 642. <https://doi.org/10.1001/jamapsychiatry.2019.0174>.
- Benchimol, Eric I., Liam Smeeth, Astrid Guttman, Katie Harron, David Moher, Irene Petersen, Henrik T. Sørensen, Erik von Elm, Sinéad M. Langan, and RECORD Working Committee. 2015. "The REporting of Studies Conducted Using Observational Routinely-Collected Health Data (RECORD) Statement." *PLoS Medicine* 12 (10). <https://doi.org/10.1371/JOURNAL.PMED.1001885>.
- Berk-Clark, Carissa van den, Sundari Balan, Manan V. Shroff, Greg Widner, and Rumi Kato Price. 2016. "The Impact of Hazardous Alcohol Use on Behavioral Healthcare Utilization Among National Guard Service Members." *Substance Use & Misuse* 51 (5): 625–36. <https://doi.org/10.3109/10826084.2015.1133644>.
- Biesheuvel-Leliefeld, Karolien E M, Gemma D Kok, Claudi L H Bockting, Pim Cuijpers, Steven D Hollon, Harm W J Van Marwijk, and Filip Smit. 2014. "Effectiveness of Psychological

- Interventions in Preventing Recurrence of Depressive Disorder: Meta-Analysis and Meta-Regression.” *Journal of Affective Disorders* 174: 400–410.  
<https://doi.org/10.1016/j.jad.2014.12.016>.
- Blakey, Shannon M., H. Ryan Wagner, Jennifer Naylor, Mira Brancu, Ilana Lane, Meghann Sallee, Nathan A. Kimbrel, Eric B. Elbogen, and Eric B Elbogen. 2018. “Chronic Pain, TBI, and PTSD in Military Veterans: A Link to Suicidal Ideation and Violent Impulses?” *The Journal of Pain* 19 (7): 797–806. <https://doi.org/10.1016/j.jpain.2018.02.012>.
- Bliese, P.D. 2011. “Preventive Mental Health Screening in the Military.” In *Deployment Psychology: Evidence-Based Strategies to Promote Mental Health in the Military.*, edited by A.B. Adler, P.D. Bliese, and C.A. Castro, 175–93. Washington: American Psychological Association. <https://doi.org/10.1037/12300-007>.
- Blosnich, John R, Melissa E Dichter, Catherine Cerulli, Sonja V Batten, and Robert M Bossarte. 2014. “Disparities in Adverse Childhood Experiences among Individuals with a History of Military Service.” *JAMA Psychiatry* 71 (9): 1041–48.  
<https://doi.org/10.1001/jamapsychiatry.2014.724>.
- Bockting, Claudi L., Steven D. Hollon, Robin B. Jarrett, Willem Kuyken, and Keith Dobson. 2015. “A Lifetime Approach to Major Depressive Disorder: The Contributions of Psychological Interventions in Preventing Relapse and Recurrence.” *Clinical Psychology Review* 41 (November): 16–26. <https://doi.org/10.1016/j.cpr.2015.02.003>.
- Bodegom, Miranda van, Judith R. Homberg, and Marloes J. A. G. Henckens. 2017. “Modulation of the Hypothalamic-Pituitary-Adrenal Axis by Early Life Stress Exposure.” *Frontiers in Cellular Neuroscience* 11 (April): 87. <https://doi.org/10.3389/fncel.2017.00087>.
- Bonar, Erin E, Kipling M Bohnert, Heather M Walters, Dara Ganoczy, and Marcia Valenstein. 2015. “Student and Nonstudent National Guard Service Members/Veterans and Their Use of Services for Mental Health Symptoms.” *Journal of American College Health : J of ACH* 63 (7): 437–46. <https://doi.org/10.1080/07448481.2014.975718>.
- Bonde, J. P., N. Utzon-Frank, M. Bertelsen, M. Borritz, N. H. Eller, M. Nordentoft, K. Olesen, N. H. Rod, and R. Rugulies. 2016. “Risk of Depressive Disorder Following Disasters and Military Deployment: Systematic Review with Meta-Analysis.” *British Journal of*

- Psychiatry* 208 (4): 330–36. <https://doi.org/10.1192/bjp.bp.114.157859>.
- Bondesson, E., F. Larrosa Pardo, K. Stigmar, Å. Ringqvist, I.F. Petersson, A. Jöud, and M.E.C. Schelin. 2018. “Comorbidity between Pain and Mental Illness - Evidence of a Bidirectional Relationship.” *European Journal of Pain* 22 (7): 1304–11. <https://doi.org/10.1002/ejp.1218>.
- Boulos, David, and Mark A Zamorski. 2016. “Contribution of the Mission in Afghanistan to the Burden of Past-Year Mental Disorders in Canadian Armed Forces Personnel, 2013.” *Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie* 61 (1 Suppl): 64S-76S. <https://doi.org/10.1177/0706743716628857>.
- Boyko, E. J., A. D. Seelig, I. G. Jacobson, T. I. Hooper, B. Smith, T. C. Smith, N. F. Crum-Cianflone, and Millennium Cohort Study Team. 2013. “Sleep Characteristics, Mental Health, and Diabetes Risk: A Prospective Study of U.S. Military Service Members in the Millennium Cohort Study.” *Diabetes Care* 36 (10): 3154–61. <https://doi.org/10.2337/DC13-0042>.
- Bramer, Wichor M, Dean Giustini, Gerdien B de Jonge, Leslie Holland, and Tanja Bekhuis. 2016. “De-Duplication of Database Search Results for Systematic Reviews in EndNote.” *Journal of the Medical Library Association : JMLA* 104 (3): 240–43. <https://doi.org/10.3163/1536-5050.104.3.014>.
- Brewin, Chris R., Bernice Andrews, and Jennie Hejdenberg. 2012. “Recognition and Treatment of Psychological Disorders during Military Service in the UK Armed Forces: A Study of War Pensioners.” *Social Psychiatry and Psychiatric Epidemiology* 47 (12): 1891–97. <https://doi.org/10.1007/s00127-012-0505-x>.
- Britt, Thomas W., Kristen S. Jennings, Janelle H. Cheung, Cynthia L. S. Pury, and Heidi M. Zinzow. 2015. “The Role of Different Stigma Perceptions in Treatment Seeking and Dropout among Active Duty Military Personnel.” *Psychiatric Rehabilitation Journal* 38 (2): 142–49. <https://doi.org/10.1037/prj0000120>.
- Brown G, Harris T, and Hepworth C. 1994. Life events and endogenous depression. A puzzle reexamined. *Arch Gen Psychiatry* 51:525–534
- 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

- in the etiology of depression. *Depression and Anxiety* 31:326–334.  
<https://doi.org/10.1002/da.22221>
- Brown GW, Ban M, Craig TKJ, et al (2013) Serotonin transporter length polymorphism, childhood maltreatment, and chronic depression: a specific gene-environment interaction. *Depression and Anxiety* 30:5–13. <https://doi.org/10.1002/da.21982>
- Brown, Mark C, Alisha H Creel, Charles C Engel, Richard K Herrell, and Charles W Hoge. 2011. “Factors Associated with Interest in Receiving Help for Mental Health Problems in Combat Veterans Returning from Deployment to Iraq.” *The Journal of Nervous and Mental Disease* 199 (10): 797–801. <https://doi.org/10.1097/NMD.0b013e31822fc9bf>.
- Bruce, David G, Wendy A Davis, Milan Dragovic, Timothy M E Davis, and Sergio E Starkstein. 2016. “Comorbid Anxiety and Depression and Their Impact on Cardiovascular Disease in Type 2 Diabetes: The Fremantle Diabetes Study Phase II.” *Depression and Anxiety* 33 (10): 960–66. <https://doi.org/10.1002/da.22523>.
- Buckman, J.E.J., A. Underwood, K. Clarke, R. Saunders, S.D. Hollon, P. Fearon, and S. Pilling. 2018. “Risk Factors for Relapse and Recurrence of Depression in Adults and How They Operate: A Four-Phase Systematic Review and Meta-Synthesis.” *Clinical Psychology Review* 64 (August): 13–38. <https://doi.org/10.1016/j.cpr.2018.07.005>.
- Bulloch, Andrew G.M., Jeanne V.A. Williams, Dina H. Lavorato, and Scott B. Patten. 2017. “The Depression and Marital Status Relationship Is Modified by Both Age and Gender.” *Journal of Affective Disorders* 223 (December): 65–68.  
<https://doi.org/10.1016/j.jad.2017.06.007>.
- Bulloch, Andrew, Jeanne Williams, Dina Lavorato, and Scott Patten. 2014. “Recurrence of Major Depressive Episodes Is Strongly Dependent on the Number of Previous Episodes.” *Depression and Anxiety* 31 (1): 72–76. <https://doi.org/10.1002/da.22173>.
- Burns, Barbara J., H. Ryan Wagner, Bradley N. Gaynes, Kenneth B. Wells, and Herbert C. Schulberg. 2000. “General Medical and Specialty Mental Health Service Use for Major Depression.” *The International Journal of Psychiatry in Medicine* 30 (2): 127–43.  
<https://doi.org/10.2190/TLXJ-YXLX-F4YA-6PHA>.
- Bursac, Zoran, C Heath Gauss, David Keith Williams, and David W Hosmer. 2008. “Purposeful

- Selection of Variables in Logistic Regression.” *Source Code for Biology and Medicine* 3 (1): 17. <https://doi.org/10.1186/1751-0473-3-17>.
- Caron, J. 1996. “[The Scale of Social Provisions: Their Validation in Quebec].” *Sante Mentale Au Quebec* 21 (2): 158–80.
- Caspi, A., Karen Sugden, Terrie E Moffitt, Alan Taylor, Ian W Craig, HonaLee Harrington, Joseph McClay, et al. 2003. “Influence of Life Stress on Depression: Moderation by a Polymorphism in the 5-HTT Gene.” *Science* 301 (5631): 386–89. <https://doi.org/10.1126/science.1083968>.
- Chan, Caryn Mei Hsien, Wan Azman Wan Ahmad, Mastura MD Yusof, Gwo-Fuang Ho, and Edward Krupat. 2015. “Effects of Depression and Anxiety on Mortality in a Mixed Cancer Group: A Longitudinal Approach Using Standardised Diagnostic Interviews.” *Psycho-Oncology* 24 (6): 718–25. <https://doi.org/10.1002/pon.3714>.
- Chang, Meng-Han, Ju-Wei Hsu, Kai-Lin Huang, Tung-Ping Su, Ya-Mei Bai, Cheng-Ta Li, Albert C. Yang, et al. 2015. “Bidirectional Association Between Depression and Fibromyalgia Syndrome: A Nationwide Longitudinal Study.” *The Journal of Pain* 16 (9): 895–902. <https://doi.org/10.1016/j.jpain.2015.06.004>.
- Chapman, Daniel P., Charles L. Whitfield, Vincent J. Felitti, Shanta R. Dube, Valerie J. Edwards, and Robert F. Anda. 2004. “Adverse Childhood Experiences and the Risk of Depressive Disorders in Adulthood.” *Journal of Affective Disorders* 82 (2): 217–25. <https://doi.org/10.1016/j.jad.2003.12.013>.
- Chapman, Paula L, Christine Elnitsky, Barbara Pitts, Charles Figley, Ryan M Thurman, and Brian Unwin. 2014. “Mental Health, Help Seeking, and Stigma and Barriers to Care among 3- and 12-Month Postdeployed and Never Deployed U.S. Army Combat Medics.” *Military Medicine* 179 (8 Suppl): 55–62. <https://doi.org/10.7205/MILMED-D-12-00367>.
- Chen, Jiajian, and Feng Hou. 2002. “Unmet Needs for Health Care.” *Health Reports* 13 (2): 23–34.
- Cherkin, Daniel C., Karen J. Sherman, Benjamin H. Balderson, Andrea J. Cook, Melissa L. Anderson, Rene J. Hawkes, Kelly E. Hansen, and Judith A. Turner. 2016. “Effect of Mindfulness-Based Stress Reduction vs Cognitive Behavioral Therapy or Usual Care on

- Back Pain and Functional Limitations in Adults With Chronic Low Back Pain.” *JAMA* 315 (12): 1240. <https://doi.org/10.1001/jama.2016.2323>.
- Chu, Kasi M, Shawn M S Garcia, Hela Koka, Gary H Wynn, and Tzu-Cheg Kao. 2018. “Mental Health Care Utilization and Stigma in the Military: Comparison of Asian Americans to Other Racial Groups.” *Ethnicity & Health*, July, 1–16. <https://doi.org/10.1080/13557858.2018.1494823>.
- Clark, Leslie L, and Zheng Hu. 2015. “Diagnoses of Low Back Pain, Active Component, U.S. Armed Forces, 2010-2014.” *MSMR* 22 (12): 8–11.
- Clever, Molly, and David R. Segal. 2012. “After Conscription: The United States and the All-Volunteer Force.” *Sicherheit Und Frieden (S+F) / Security and Peace*. Nomos Verlagsgesellschaft mbH. <https://doi.org/10.2307/24233116>.
- Cohen S, Murphy MLM, Prather AA. 2019. Ten Surprising Facts About Stressful Life Events and Disease Risk. *Annu Rev Psychol* 70:577–597. <https://doi.org/10.1146/annurev-psych-010418-102857>
- Colman, I., P. B. Jones, D. Kuh, M. Weeks, K. Naicker, M. Richards, and T. J. Croudace. 2014. “Early Development, Stress and Depression across the Life Course: Pathways to Depression in a National British Birth Cohort.” *Psychological Medicine* 44 (13): 2845–54. <https://doi.org/10.1017/S0033291714000385>.
- Colman, Ian, and Anushka Ataullahjan. 2010. “Life Course Perspectives on the Epidemiology of Depression.” *The Canadian Journal of Psychiatry* 55 (10): 622–32. <https://doi.org/10.1177/070674371005501002>.
- Cook, D J, D L Sackett, and W O Spitzer. 1995. “Methodologic Guidelines for Systematic Reviews of Randomized Control Trials in Health Care from the Potsdam Consultation on Meta-Analysis.” *Journal of Clinical Epidemiology* 48 (1): 167–71.
- Cramer, Angélique O J, Claudia D Van Borkulo, Erik J Giltay, Han L J Van Der Maas, Kenneth S Kendler, Marten Scheffer, and Denny Borsboom. 2016. “Major Depression as a Complex Dynamic System.” <https://doi.org/10.1371/journal.pone.0167490>.
- Crofford, Leslie J. 2015. “Chronic Pain: Where the Body Meets the Brain.” *Transactions of the American Clinical and Climatological Association* 126: 167–83.

- Crumlish, Niall, and Brendan D. Kelly. 2009. "How Psychiatrists Think." *Advances in Psychiatric Treatment* 15 (1): 72–79. <https://doi.org/10.1192/apt.bp.107.005298>.
- Cuijpers, Pim, Hisashi Noma, Eirini Karyotaki, Andrea Cipriani, and Toshi A. Furukawa. 2019. "Effectiveness and Acceptability of Cognitive Behavior Therapy Delivery Formats in Adults With Depression." *JAMA Psychiatry* 76 (7): 700. <https://doi.org/10.1001/jamapsychiatry.2019.0268>.
- Currie, Shawn R, and JianLi Wang. 2004. "Chronic Back Pain and Major Depression in the General Canadian Population." *Pain* 107 (1–2): 54–60.
- Davidson, H.A. 1940. "Mental Hygiene in Our Armed Forces." *Military Surgeon* 86: 480.
- Davidson JRT. 2010. Major Depressive Disorder Treatment Guidelines in America and Europe. *Journal of Clinical Psychiatry* 71:4–4. <https://doi.org/10.4088/JCP.9058se1c.04gry>
- Davis, Katrina A. S., Cathie L. M. Sudlow, and Matthew Hotopf. 2016. "Can Mental Health Diagnoses in Administrative Data Be Used for Research? A Systematic Review of the Accuracy of Routinely Collected Diagnoses." *BMC Psychiatry* 16 (1): 263. <https://doi.org/10.1186/s12888-016-0963-x>.
- Davison, Kenneth. 2009. "Historical Aspects of Mood Disorders." *Psychiatry* 8 (2): 47–51. <https://doi.org/10.1016/j.mppsy.2008.10.019>.
- Deeny, Sarah R, and Adam Steventon. 2015. "Making Sense of the Shadows: Priorities for Creating a Learning Healthcare System Based on Routinely Collected Data." *BMJ Quality & Safety* 24 (8): 505–15. <https://doi.org/10.1136/bmjqs-2015-004278>.
- Dersh, Jeffrey, Peter B Polatin, and Robert J Gatchel. n.d. "Chronic Pain and Psychopathology: Research Findings and Theoretical Considerations." *Psychosomatic Medicine* 64 (5): 773–86.
- DeWaters, Ami L., Matthieu Chansard, Antonio Anzueto, Mary Jo Pugh, and Eric M. Mortensen. 2018. "The Association Between Major Depressive Disorder and Outcomes in Older Veterans Hospitalized With Pneumonia." *The American Journal of the Medical Sciences* 355 (1): 21–26. <https://doi.org/10.1016/j.amjms.2017.08.015>.
- Drummet, Amy Reinkober, Marilyn Coleman, and Susan Cable. 2003. "Military Families Under

- Stress: Implications for Family Life Education\*." *Family Relations* 52 (3): 279–87.  
<https://doi.org/10.1111/j.1741-3729.2003.00279.x>.
- Eaton, William W., Huibo Shao, Gerald Nestadt, Ben Hochang Lee, O. Joseph Bienvenu, Peter Zandi, and Peter Zandi. 2008. "Population-Based Study of First Onset and Chronicity in Major Depressive Disorder." *Archives of General Psychiatry* 65 (5): 513.  
<https://doi.org/10.1001/archpsyc.65.5.513>.
- Edmond, Sara N, Alicia A Heapy, and Robert D Kerns. 2019. "Engaging Mental Health Professionals in Addressing Pain." *JAMA Psychiatry*, April.  
<https://doi.org/10.1001/jamapsychiatry.2019.0254>.
- El-Den, Sarira, Timothy F Chen, Yuh-Lin Gan, Eling Wong, and Claire L O'Reilly. 2018. "The Psychometric Properties of Depression Screening Tools in Primary Healthcare Settings: A Systematic Review." *Journal of Affective Disorders* 225 (January): 503–22.  
<https://doi.org/10.1016/j.jad.2017.08.060>.
- Eliasson, Arn, Mariam Kashani, Georgia Dela Cruz, and Marina Vernalis. 2012. "Readiness and Associated Health Behaviors and Symptoms in Recently Deployed Army National Guard Solders." *Military Medicine* 177 (11): 1254–60.
- Faa, Gavino, Mirko Manchia, Roberta Pintus, Clara Gerosa, Maria Antonietta Marcialis, and Vassilios Fanos. 2016. "Fetal Programming of Neuropsychiatric Disorders." *Birth Defects Research Part C: Embryo Today: Reviews* 108 (3): 207–23.  
<https://doi.org/10.1002/bdrc.21139>.
- Fernandez, Matt, Lucia Colodro-Conde, Jan Hartvigsen, Manuela L. Ferreira, Kathryn M. Refshauge, Marina B. Pinheiro, Juan R. Ordoñana, and Paulo H. Ferreira. 2017. "Chronic Low Back Pain and the Risk of Depression or Anxiety Symptoms: Insights from a Longitudinal Twin Study." *The Spine Journal* 17 (7): 905–12.  
<https://doi.org/10.1016/j.spinee.2017.02.009>.
- Ferrari, A. J., A. J. Somerville, A. J. Baxter, R. Norman, S. B. Patten, T. Vos, and H. A. Whiteford. 2013. "Global Variation in the Prevalence and Incidence of Major Depressive Disorder: A Systematic Review of the Epidemiological Literature." *Psychological Medicine* 43 (3): 471–81. <https://doi.org/10.1017/S0033291712001511>.

- Ferrari, Alize J., Fiona J. Charlson, Rosana E. Norman, Scott B. Patten, Greg Freedman, Christopher J.L. Murray, Theo Vos, and Harvey A. Whiteford. 2013. "Burden of Depressive Disorders by Country, Sex, Age, and Year: Findings from the Global Burden of Disease Study 2010." Edited by Phillipa J. Hay. *PLoS Medicine* 10 (11): e1001547. <https://doi.org/10.1371/journal.pmed.1001547>.
- Fiest, Kirsten M, Nathalie Jette, Hude Quan, Christine St. Germaine-Smith, Amy Metcalfe, Scott B Patten, and Cynthia A Beck. 2014. "Systematic Review and Assessment of Validated Case Definitions for Depression in Administrative Data." *BMC Psychiatry* 14 (1): 289. <https://doi.org/10.1186/s12888-014-0289-5>.
- Fikretoglu, Deniz, Stéphane Guay, David Pedlar, and Alain Brunet. 2008. "Twelve Month Use of Mental Health Services in a Nationally Representative, Active Military Sample." *Medical Care* 46 (2): 217–23. <https://doi.org/10.1097/MLR.0b013e31815b979a>.
- Fikretoglu, Deniz, Aihua Liu, Dave Pedlar, and Alain Brunet. 2010. "Patterns and Predictors of Treatment Delay for Mental Disorders in a Nationally Representative, Active Canadian Military Sample." *Medical Care* 48 (1): 10–17. <https://doi.org/10.1097/MLR.0b013e3181bd4bf9>.
- Flint, Jonathan, and Kenneth S. Kendler. 2014. "The Genetics of Major Depression." *Neuron* 81 (5): 1214. <https://doi.org/10.1016/j.neuron.2014.02.033>.
- Franklin, Joseph C., Jessica D. Ribeiro, Kathryn R. Fox, Kate H. Bentley, Evan M. Kleiman, Xieyining Huang, Katherine M. Musacchio, Adam C. Jaroszewski, Bernard P. Chang, and Matthew K. Nock. 2017. "Risk Factors for Suicidal Thoughts and Behaviors: A Meta-Analysis of 50 Years of Research." *Psychological Bulletin* 143 (2): 187–232. <https://doi.org/10.1037/bul0000084>.
- Frasure-Smith, Nancy, and François Lespérance. 2008. "Depression and Anxiety as Predictors of 2-Year Cardiac Events in Patients With Stable Coronary Artery Disease." *Archives of General Psychiatry* 65 (1): 62. <https://doi.org/10.1001/archgenpsychiatry.2007.4>.
- Freedland, Kenneth E., Michael J. Hesseler, Robert M. Carney, Brian C. Steinmeyer, Judith A. Skala, Victor G. Dávila-Román, and Michael W. Rich. 2016. "Major Depression and Long-Term Survival of Patients With Heart Failure." *Psychosomatic Medicine* 78 (8): 896–903.

<https://doi.org/10.1097/PSY.0000000000000346>.

Gadermann, Anne M, Charles C Engel, James A Naifeh, Matthew K Nock, Maria Petukhova, Patcho N Santiago, Benjamin Wu, Alan M Zaslavsky, and Ronald C Kessler. 2012. "Prevalence of DSM-IV Major Depression among U.S. Military Personnel: Meta-Analysis and Simulation." *Military Medicine* 177 (8 Suppl): 47–59.

Garber, Bryan G, Mark A Zamorski, and Col Rakesh Jetly. 2012. "Mental Health of Canadian Forces Members While on Deployment to Afghanistan." *The Canadian Journal of Psychiatry* 57 (12): 736–44. <https://doi.org/10.1177/070674371205701205>.

Gaynes, Bradley N, A John Rush, Madhukar H Trivedi, Stephen R Wisniewski, G K Balasubramani, Patrick J McGrath, Michael E Thase, et al. 2008. "Primary versus Specialty Care Outcomes for Depressed Outpatients Managed with Measurement-Based Care: Results from STAR\*D." *Journal of General Internal Medicine* 23 (5): 551–60. <https://doi.org/10.1007/s11606-008-0522-3>.

GBD 2017 Disease and Injury Incidence and Prevalence Collaborators, Spencer L, Degu Abate, Kalkidan Hassen Abate, Solomon M Abay, Cristiana Abbafati, Nooshin Abbasi, Hedayat Abbastabar, et al. 2018. "Global, Regional, and National Incidence, Prevalence, and Years Lived with Disability for 354 Diseases and Injuries for 195 Countries and Territories, 1990–2017: A Systematic Analysis for the Global Burden of Disease Study 2017." *Lancet (London, England)* 392 (10159): 1789–1858. [https://doi.org/10.1016/S0140-6736\(18\)32279-7](https://doi.org/10.1016/S0140-6736(18)32279-7).

Gelaye, Bizu, Mahlet G. Tadesse, Michelle A. Williams, Jesse R. Fann, Ann Vander Stoep, and Xiao-Hua Andrew Zhou. 2014. "Assessing Validity of a Depression Screening Instrument in the Absence of a Gold Standard." *Annals of Epidemiology* 24 (7): 527–31. <https://doi.org/10.1016/j.annepidem.2014.04.009>.

Global Burden of Disease Collaborative Network. 2018. "Global Burden of Disease Study 2017 (GBD 2017) Disability Weights." Seattle, United States.

Goesling, Jenna, Daniel J. Clauw, and Afton L. Hassett. 2013. "Pain and Depression: An Integrative Review of Neurobiological and Psychological Factors." *Current Psychiatry Reports* 15 (12): 421. <https://doi.org/10.1007/s11920-013-0421-0>.

- Goodwin, L, S Wessely, M Hotopf, M Jones, N Greenberg, R J Rona, L Hull, and N T Fear. 2015. "Are Common Mental Disorders More Prevalent in the UK Serving Military Compared to the General Working Population?" *Psychological Medicine* 45 (9): 1881–91. <https://doi.org/10.1017/S0033291714002980>.
- Goodwin, Renee D, Gregory H Cohen, Marijo Tamburrino, Joseph R Calabrese, Israel Liberzon, and Sandro Galea. 2014. "Mental Health Service Use in a Representative Sample of National Guard Soldiers." *Psychiatric Services (Washington, D.C.)* 65 (11): 1347–53. <https://doi.org/10.1176/appi.ps.201300282>.
- Gorman, Lisa A., Adrian J. Blow, Barbara D. Ames, and Philip L. Reed. 2011. "National Guard Families After Combat: Mental Health, Use of Mental Health Services, and Perceived Treatment Barriers." *Psychiatric Services* 62 (1): 28–34. [https://doi.org/10.1176/ps.62.1.pss6201\\_0028](https://doi.org/10.1176/ps.62.1.pss6201_0028).
- Gould, Matthew, Amy Adler, Mark Zamorski, Carl Castro, Natalie Hanily, Nicole Steele, Steve Kearney, and Neil Greenberg. 2010. "Do Stigma and Other Perceived Barriers to Mental Health Care Differ across Armed Forces?" *Journal of the Royal Society of Medicine* 103 (4): 148–56. <https://doi.org/10.1258/jrsm.2010.090426>.
- Greenberg, Paul E., Andree-Anne Fournier, Tammy Sisitsky, Crystal T. Pike, and Ronald C. Kessler. 2015. "The Economic Burden of Adults With Major Depressive Disorder in the United States (2005 and 2010)." *The Journal of Clinical Psychiatry* 76 (02): 155–62. <https://doi.org/10.4088/JCP.14m09298>.
- Greenland, S. 1996. "Basic Methods for Sensitivity Analysis of Biases." *International Journal of Epidemiology* 25 (6): 1107–16.
- Greenland, Sander. 2004. "Model-Based Estimation of Relative Risks and Other Epidemiologic Measures in Studies of Common Outcomes and in Case-Control Studies." *American Journal of Epidemiology* 160 (4): 301–5. <https://doi.org/10.1093/aje/kwh221>.
- Gruenberg, Alan M., Reed D. Goldstein, and Harold Alan Pincus. n.d. "Classification of Depression: Research and Diagnostic Criteria: DSM-IV and ICD-10." In *Biology of Depression*, 1–12. Weinheim, Germany: Wiley-VCH Verlag GmbH. <https://doi.org/10.1002/9783527619672.ch1>.

- Hammen, Constance. 2005. "Stress and Depression." *Annual Review of Clinical Psychology* 1 (1): 293–319. <https://doi.org/10.1146/annurev.clinpsy.1.102803.143938>.
- Haro, Josep Maria, Saena Arbabzadeh-Bouchez, Traolach S Brugha, Giovanni de Girolamo, Margaret E Guyer, Robert Jin, Jean Pierre Lepine, et al. 2006. "Concordance of the Composite International Diagnostic Interview Version 3.0 (CIDI 3.0) with Standardized Clinical Assessments in the WHO World Mental Health Surveys." *International Journal of Methods in Psychiatric Research* 15 (4): 167–80.
- Heim, Christine, D Jeffrey Newport, Tanja Mletzko, Andrew H Miller, and Charles B Nemeroff. 2008. "The Link between Childhood Trauma and Depression: Insights from HPA Axis Studies in Humans." *Psychoneuroendocrinology* 33 (6): 693–710. <https://doi.org/10.1016/j.psyneuen.2008.03.008>.
- Heim, Christine, D Jeffrey Newport, Dieter Wagner, Molly M Wilcox, Andrew H Miller, and Charles B Nemeroff. 2002. "The Role of Early Adverse Experience and Adulthood Stress in the Prediction of Neuroendocrine Stress Reactivity in Women: A Multiple Regression Analysis." *Depression and Anxiety* 15 (3): 117–25. <https://doi.org/10.1002/da.10015>.
- Hellems, Kim G C, Joanna H Sliwowska, Pamela Verma, and Joanne Weinberg. 2010. "Prenatal Alcohol Exposure: Fetal Programming and Later Life Vulnerability to Stress, Depression and Anxiety Disorders." *Neuroscience and Biobehavioral Reviews* 34 (6): 791–807. <https://doi.org/10.1016/j.neubiorev.2009.06.004>.
- Hickling, Edward J., Susanne Gibbons, Scott D. Barnett, and Dorraine Watts. 2011. "The Psychological Impact of Deployment on OEF/OIF Healthcare Providers." *Journal of Traumatic Stress* 24 (6): 726–34. <https://doi.org/10.1002/jts.20703>.
- Hoge, Charles W., Jennifer L. Auchterlonie, and Charles S. Milliken. 2006. "Mental Health Problems, Use of Mental Health Services, and Attrition From Military Service After Returning From Deployment to Iraq or Afghanistan." *JAMA* 295 (9): 1023. <https://doi.org/10.1001/jama.295.9.1023>.
- Hoge, Charles W., Carl A. Castro, Stephen C. Messer, Dennis McGurk, Dave I. Cotting, and Robert L. Koffman. 2004. "Combat Duty in Iraq and Afghanistan, Mental Health Problems, and Barriers to Care." *New England Journal of Medicine* 351 (1): 13–22.

<https://doi.org/10.1056/NEJMoa040603>.

Hoge, Charles W, Sandra E Lesikar, Ramon Guevara, Jeff Lange, John F Brundage, Charles C Engel, Stephen C Messer, and David T Orman. 2002. "Mental Disorders among U.S. Military Personnel in the 1990s: Association with High Levels of Health Care Utilization and Early Military Attrition." *The American Journal of Psychiatry* 159 (9): 1576–83. <https://doi.org/10.1176/appi.ajp.159.9.1576>.

Hom, Melanie A, Ian H Stanley, Matthew E Schneider, and Thomas E Joiner. 2017. "A Systematic Review of Help-Seeking and Mental Health Service Utilization among Military Service Members." *Clinical Psychology Review* 53 (April): 59–78. <https://doi.org/10.1016/j.cpr.2017.01.008>.

Hourani, L L, and H Yuan. 1999. "The Mental Health Status of Women in the Navy and Marine Corps: Preliminary Findings from the Perceptions of Wellness and Readiness Assessment." *Military Medicine* 164 (3): 174–81.

Iglesias-González M, Aznar-Lou I, Peñarrubia-María MT, et al. 2018. Effectiveness of watchful waiting versus antidepressants for patients diagnosed of mild to moderate depression in primary care: A 12-month pragmatic clinical trial (INFAP study). *European Psychiatry* 53: 66–73. <https://doi.org/10.1016/j.eurpsy.2018.06.005>

Iversen, Amy C, Lauren van Staden, Jamie Hacker Hughes, Tess Browne, Neil Greenberg, Matthew Hotopf, Roberto J Rona, Simon Wessely, Graham Thornicroft, and Nicola T Fear. 2010. "Help-Seeking and Receipt of Treatment among UK Service Personnel." *The British Journal of Psychiatry : The Journal of Mental Science* 197 (2): 149–55. <https://doi.org/10.1192/bjp.bp.109.075762>.

Jaworska-Andryszewska, Paulina, and Janusz K Rybakowski. 2019. "Childhood Trauma in Mood Disorders: Neurobiological Mechanisms and Implications for Treatment." *Pharmacological Reports : PR* 71 (1): 112–20. <https://doi.org/10.1016/j.pharep.2018.10.004>.

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* :

- Canadian Medical Association Journal = Journal de l'Association Medicale Canadienne* 185 (9): 775–82. <https://doi.org/10.1503/cmaj.130403>.
- Jones, E, K C Hyams, and S Wessely. 2003. “Review: Screening for Vulnerability to Psychological Disorders in the Military: An Historical Survey.” *Journal of Medical Screening* 10 (1): 40–46. <https://doi.org/10.1258/096914103321610798>.
- Jorm, A F, J Medway, H Christensen, A E Korten, P A Jacomb, and B Rodgers. 2000. “Attitudes towards People with Depression: Effects on the Public’s Help-Seeking and Outcome When Experiencing Common Psychiatric Symptoms.” *The Australian and New Zealand Journal of Psychiatry* 34 (4): 612–18. <https://doi.org/10.1080/j.1440-1614.2000.00743.x>.
- Kaplan, Robert M, David A Chambers, and Russell E Glasgow. 2014. “Big Data and Large Sample Size: A Cautionary Note on the Potential for Bias.” *Clinical and Translational Science* 7 (4): 342–46. <https://doi.org/10.1111/cts.12178>.
- Kapoor, Amita, Elizabeth Dunn, Alice Kostaki, Marcus H. Andrews, and Stephen G. Matthews. 2006. “Fetal Programming of Hypothalamo-Pituitary-Adrenal Function: Prenatal Stress and Glucocorticoids.” *The Journal of Physiology* 572 (1): 31–44. <https://doi.org/10.1113/jphysiol.2006.105254>.
- Karg, Katja, Margit Burmeister, Kerby Shedden, and Srijan Sen. 2011. “The Serotonin Transporter Promoter Variant (5-HTTLPR), Stress, and Depression Meta-Analysis Revisited: Evidence of Genetic Moderation.” *Archives of General Psychiatry* 68 (5): 444–54. <https://doi.org/10.1001/archgenpsychiatry.2010.189>.
- Kehle, Shannon M, Melissa A Polusny, Maureen Murdoch, Christopher R Erbes, Paul A Arbisi, Paul Thuras, and Laura A Meis. 2010. “Early Mental Health Treatment-Seeking among U.S. National Guard Soldiers Deployed to Iraq.” *Journal of Traumatic Stress* 23 (1): 33–40. <https://doi.org/10.1002/jts.20480>.
- Kendler, Kenneth S., Margaret Gatz, Charles O. Gardner, and Nancy L. Pedersen. 2006. “A Swedish National Twin Study of Lifetime Major Depression.” *American Journal of Psychiatry* 163 (1): 109–14. <https://doi.org/10.1176/appi.ajp.163.1.109>.
- Kendler, Kenneth S., Laura M. Karkowski, and Carol A. Prescott. 1999. “Causal Relationship Between Stressful Life Events and the Onset of Major Depression.” *American Journal of*

- Psychiatry* 156 (6): 837–41. <https://doi.org/10.1176/ajp.156.6.837>.
- Kendler, Kenneth S., Michael C. Neale, Ronald C. Kessler, Andrew C. Heath, and Lindon J. Eaves. 1993. “A Longitudinal Twin Study of Personality and Major Depression in Women.” *Archives of General Psychiatry* 50 (11): 853. <https://doi.org/10.1001/archpsyc.1993.01820230023002>.
- Kendler, Kenneth S., Laura M. Thornton, and Charles O. Gardner. 2000. “Stressful Life Events and Previous Episodes in the Etiology of Major Depression in Women: An Evaluation of the ‘Kindling’ Hypothesis.” *American Journal of Psychiatry* 157 (8): 1243–51. <https://doi.org/10.1176/appi.ajp.157.8.1243>.
- Kendler, Kenneth S, Charles O Gardner, and Carol A Prescott. 2006. “Toward a Comprehensive Developmental Model for Major Depression in Men.” *The American Journal of Psychiatry* 163 (1): 115–24. <https://doi.org/10.1176/appi.ajp.163.1.115>.
- Kennedy, Carrie H., and Eric. Zillmer. 2012. *Military Psychology : Clinical and Operational Applications*. Guilford Press.
- Kennedy, Sidney H., Raymond W. Lam, Roger S. McIntyre, S. Valérie Tourjman, Venkat Bhat, Pierre Blier, Mehrul Hasnain, et al. 2016. “Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder.” *The Canadian Journal of Psychiatry* 61 (9): 540–60. <https://doi.org/10.1177/0706743716659417>.
- Kessing, Lars Vedel, and Per Kragh Andersen. 1999. “The Effect of Episodes on Recurrence in Affective Disorder: A Case Register Study.” *Journal of Affective Disorders* 53 (3): 225–31. [https://doi.org/10.1016/S0165-0327\(98\)00125-6](https://doi.org/10.1016/S0165-0327(98)00125-6).
- Kessler, R C, C G Davis, and K S Kendler. 1997. “Childhood Adversity and Adult Psychiatric Disorder in the US National Comorbidity Survey.” *Psychological Medicine* 27 (5): 1101–19.
- Kessler, R C, H M van Loo, K J Wardenaar, R M Bossarte, L A Brenner, T Cai, D D Ebert, et al. 2016. “Testing a Machine-Learning Algorithm to Predict the Persistence and Severity of Major Depressive Disorder from Baseline Self-Reports.” *Molecular Psychiatry* 21 (10): 1366–71. <https://doi.org/10.1038/mp.2015.198>.

- Kessler, Ronald C. 2012. "The Costs of Depression." *Psychiatric Clinics of North America* 35 (1): 1–14. <https://doi.org/10.1016/j.psc.2011.11.005>.
- Kessler, Ronald C., Patricia Berglund, Olga Demler, Robert Jin, Doreen Koretz, Kathleen R. Merikangas, A. John Rush, Ellen E. Walters, and Philip S. Wang. 2003. "The Epidemiology of Major Depressive Disorder." *JAMA* 289 (23): 3095. <https://doi.org/10.1001/jama.289.23.3095>.
- Kessler, Ronald C., and Evelyn J. Bromet. 2013. "The Epidemiology of Depression Across Cultures." *Annual Review of Public Health* 34 (1): 119–38. <https://doi.org/10.1146/annurev-publhealth-031912-114409>.
- Kessler, Ronald C., Evelyn J. Bromet, Peter de Jonge, Victoria Shahly, and Marsha Wilcox. 2017. "The Burden of Depressive Illness." In *Public Health Perspectives on Depressive Disorders*, edited by Neal L Cohen. Baltimore: Johns Hopkins University Press.
- Kessler, Ronald C, and T Bedirhan Ustün. 2004. "The World Mental Health (WMH) Survey Initiative Version of the World Health Organization (WHO) Composite International Diagnostic Interview (CIDI)." *International Journal of Methods in Psychiatric Research* 13 (2): 93–121.
- Kim, Paul Y, Jeffrey L Thomas, Joshua E Wilk, Carl A Castro, and Charles W Hoge. 2010. "Stigma, Barriers to Care, and Use of Mental Health Services among Active Duty and National Guard Soldiers after Combat." *Psychiatric Services (Washington, D.C.)* 61 (6): 582–88. <https://doi.org/10.1176/ps.2010.61.6.582>.
- Kim, Paul Y, Robin L Toblin, Lyndon A Riviere, Brian C Kok, Sasha H Grossman, and Joshua E Wilk. 2016. "Provider and Nonprovider Sources of Mental Health Help in the Military and the Effects of Stigma, Negative Attitudes, and Organizational Barriers to Care." *Psychiatric Services (Washington, D.C.)* 67 (2): 221–26. <https://doi.org/10.1176/appi.ps.201400519>.
- Kloet, E. Ron de, Marian Joëls, and Florian Holsboer. 2005. "Stress and the Brain: From Adaptation to Disease." *Nature Reviews Neuroscience* 6 (6): 463–75. <https://doi.org/10.1038/nrn1683>.
- Kohn, Robert, Shekhar Saxena, Itzhak Levav, and Benedetto Saraceno. 2004. "The Treatment

- Gap in Mental Health Care.” *Bulletin of the World Health Organization* 82 (11): 858–66. <https://doi.org/S0042-96862004001100011>.
- Kolkow, Tonya T., James L. Spira, Jennifer S. Morse, and Thomas A. Grieger. 2007. “Post-Traumatic Stress Disorder and Depression in Health Care Providers Returning from Deployment to Iraq and Afghanistan.” *Military Medicine* 172 (5): 451–55. <https://doi.org/10.7205/MILMED.172.5.451>.
- Kopala-Sibley, Daniel C., and Daniel N. Klein. 2017. “Depressive Disorders: Presentation, Classification, Developmental Trajectories, and Course.” In *Public Health Perspectives on Depressive Disorders*, edited by Neal L. Cohen, 442. Johns Hopkins University Press.
- Kraepelin, Emil. 1921. *Manic-Depressive Insanity and Paranoia*. Edited by E. & S. Livingstone. Edinburgh, Scotland.
- Kramer, M S. 1987. “Determinants of Low Birth Weight: Methodological Assessment and Meta-Analysis.” *Bulletin of the World Health Organization* 65 (5): 663–737.
- Kroenke, Kurt, and Robert L Spitzer. 2002. “The PHQ-9: A New Depression Diagnostic and Severity Measure.” *Psychiatric Annals* 32 (9): 509–15. <https://doi.org/10.3928/0048-5713-20020901-06>.
- Kroenke, Kurt, Robert L Spitzer, and Janet B W Williams. 2003. “The Patient Health Questionnaire-2: Validity of a Two-Item Depression Screener.” *Medical Care* 41 (11): 1284–92. <https://doi.org/10.1097/01.MLR.0000093487.78664.3C>.
- Kroenke, Kurt, Jingwei Wu, Matthew J Bair, Erin E Krebs, Teresa M Damush, and Wanzhu Tu. 2011. “Reciprocal Relationship between Pain and Depression: A 12-Month Longitudinal Analysis in Primary Care.” *The Journal of Pain : Official Journal of the American Pain Society* 12 (9): 964–73. <https://doi.org/10.1016/j.jpain.2011.03.003>.
- Kurdyak, Paul A, and William H Gnam. 2005. “Small Signal, Big Noise: Performance of the CIDI Depression Module.” *Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie* 50 (13): 851–56. <https://doi.org/10.1177/070674370505001308>.
- Langston, Victoria, Matthew Gould, and Neil Greenberg. 2007. “Culture: What Is Its Effect on Stress in the Military?” *Military Medicine* 172 (9): 931–35. <https://doi.org/10.7205/MILMED.172.9.931>.

- Lash, T. L., M. P. Fox, R. F. MacLehose, G. Maldonado, L. C. McCandless, and S. Greenland. 2014. "Good Practices for Quantitative Bias Analysis." *International Journal of Epidemiology* 43 (6): 1969–85. <https://doi.org/10.1093/ije/dyu149>.
- Lash, Timothy L., M.P. Fox, and A.K. Fink. 2009. *Applying Quantitative Bias Analysis to Epidemiological Data*. Springer.
- LeardMann, Cynthia A., Teresa M. Powell, Tyler C. Smith, Michael R. Bell, Besa Smith, Edward J. Boyko, Tomoko I. Hooper, Gary D. Gackstetter, Mark Ghamsary, and Charles W. Hoge. 2013a. "Risk Factors Associated With Suicide in Current and Former US Military Personnel." *JAMA* 310 (5): 496. <https://doi.org/10.1001/jama.2013.65164>.
- LeardMann, Cynthia A, Teresa M Powell, Tyler C Smith, Michael R Bell, Besa Smith, Edward J Boyko, Tomoko I Hooper, Gary D Gackstetter, Mark Ghamsary, and Charles W Hoge. 2013b. "Risk Factors Associated with Suicide in Current and Former US Military Personnel." *JAMA* 310 (5): 496–506. <https://doi.org/10.1001/jama.2013.65164>.
- Lépine, Jean-Pierre, and Mike Briley. 2004. "The Epidemiology of Pain in Depression." *Human Psychopharmacology: Clinical and Experimental* 19 (S1): S3–7. <https://doi.org/10.1002/hup.618>.
- Levine, Debra S., Rebecca K. Sripada, Dara Ganoczy, Heather Walters, Lisa A. Gorman, and Marcia Valenstein. 2016. "Poorer Physical Health Is Associated With Greater Mental Health Service Utilization in a Sample of Depressed U.S. Army National Guard Soldiers." *Military Medicine* 181 (8): 803–10. <https://doi.org/10.7205/MILMED-D-15-00287>.
- Lewis, Aubrey J. 1934. "Melancholia: A Historical Review." *Journal of Mental Science* 80 (328): 1–42. <https://doi.org/10.1192/bjp.80.328.1>.
- Lima, Silvana Andréa Molina, Regina Paolucci El Dib, Meline Rossetto Kron Rodrigues, Guilherme Augusto Rago Ferraz, Ana Claudia Molina, Carlos Alberto Pilan Neto, Marcelo Aparecido Ferraz de Lima, and Marilza Vieira Cunha Rudge. 2018. "Is the Risk of Low Birth Weight or Preterm Labor Greater When Maternal Stress Is Experienced during Pregnancy? A Systematic Review and Meta-Analysis of Cohort Studies." Edited by Martin Gerbert Frasch. *PLOS ONE* 13 (7): e0200594. <https://doi.org/10.1371/journal.pone.0200594>.

- Littman, A J, I G Jacobson, E J Boyko, T M Powell, and T C Smith. 2013. "Weight Change Following US Military Service." *International Journal of Obesity* 37 (2): 244–53. <https://doi.org/10.1038/ijo.2012.46>.
- Liu, Xian, Daniel P Evatt, and Bradley E Belsher. 2019. "Development of Longitudinal Data Analysis in Mental Health Research For Military Service Members." *Military Medicine* 184 (5–6): e227–32. <https://doi.org/10.1093/milmed/usy370>.
- Lucyk, Kelsey, Karen Tang, and Hude Quan. 2017. "Barriers to Data Quality Resulting from the Process of Coding Health Information to Administrative Data: A Qualitative Study." *BMC Health Services Research* 17 (1): 766. <https://doi.org/10.1186/s12913-017-2697-y>.
- Malhi, Gin S, and J John Mann. 2018. "Depression." *Lancet (London, England)* 392 (10161): 2299–2312. [https://doi.org/10.1016/S0140-6736\(18\)31948-2](https://doi.org/10.1016/S0140-6736(18)31948-2).
- Manchikanti, Laxmaiah, Vijay Singh, Sukdeb Datta, Steven P Cohen, Joshua A Hirsch, and American Society of Interventional Pain Physicians. 2009. "Comprehensive Review of Epidemiology, Scope, and Impact of Spinal Pain." *Pain Physician* 12 (4): E35-70.
- Manuel, D. G., L. C. Rosella, and T. A. Stukel. 2010. "Importance of Accurately Identifying Disease in Studies Using Electronic Health Records." *BMJ* 341 (aug19 1): c4226–c4226. <https://doi.org/10.1136/bmj.c4226>.
- Mattila, Ville M., Heikki Kyröläinen, Matti Santtila, and Harri Pihlajamäki. 2017. "Low Back Pain during Military Service Predicts Low Back Pain Later in Life." Edited by Florian P Thomas. *PLOS ONE* 12 (3): e0173568. <https://doi.org/10.1371/journal.pone.0173568>.
- Mcfarlane, AC., RK. Sriapada, D. Ganoczy, D. Walters, LA. Gorman, and M. Valenstein. 2011. "Mental Health in the Australian Defence Force: 2010 ADF Mental Health and Wellbeing Study: Full Report." Canberra.
- Meng, Xiangfei, Alain Brunet, Gustavo Turecki, Aihua Liu, Carl D'Arcy, and Jean Caron. 2017. "Risk Factor Modifications and Depression Incidence: A 4-Year Longitudinal Canadian Cohort of the Montreal Catchment Area Study." *BMJ Open* 7 (6): e015156. <https://doi.org/10.1136/bmjopen-2016-015156>.
- 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>.
- Mitchell, Alex J, Amol Vaze, and Sanjay Rao. 2009. “Clinical Diagnosis of Depression in Primary Care: A Meta-Analysis.” *The Lancet* 374 (9690): 609–19.  
[https://doi.org/10.1016/S0140-6736\(09\)60879-5](https://doi.org/10.1016/S0140-6736(09)60879-5).
- Mitchell, Philip B, Gordon B Parker, Gemma L Gladstone, Kay Wilhelm, and Marie-Paule V Austin. 2003. “Severity of Stressful Life Events in First and Subsequent Episodes of Depression: The Relevance of Depressive Subtype.” *Journal of Affective Disorders*. Vol. 73.
- Moher, D., A. Liberati, J. Tetzlaff, D. G Altman, and PRISMA Group. 2009. “Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement.” *BMJ* 339 (jul21 1): b2535–b2535. <https://doi.org/10.1136/bmj.b2535>.
- Mojtabai, Ramin, and Mark Olfson. 2006. “Treatment Seeking for Depression in Canada and the United States.” *Psychiatric Services* 57 (5): 631–39.  
<https://doi.org/10.1176/ps.2006.57.5.631>.
- Mojtabai, Ramin, Mark Olfson, and David Mechanic. 2002. “Perceived Need and Help-Seeking in Adults with Mood, Anxiety, or Substance Use Disorders.” *Archives of General Psychiatry* 59 (1): 77–84.
- Mola, Christian Loret De, Giovanny Vinícius Araújo De França, Luciana de Avila Quevedo, and Bernardo Lessa Horta. 2014. “Low Birth Weight, Preterm Birth and Small for Gestational Age Association with Adult Depression: Systematic Review and Meta-Analysis.” *British Journal of Psychiatry* 205 (5): 340–47. <https://doi.org/10.1192/bjp.bp.113.139014>.
- Monroe, Scott M., and Kate L. Harkness. 2005. “Life Stress, the "Kindling" Hypothesis, and the Recurrence of Depression: Considerations From a Life Stress Perspective.” *Psychological Review* 112 (2): 417–45. <https://doi.org/10.1037/0033-295X.112.2.417>.
- Morgan, Jessica Kelley, Laurel Hourani, Marian E Lane, and Stephen Tueller. 2016. “Help-Seeking Behaviors Among Active-Duty Military Personnel: Utilization of Chaplains and Other Mental Health Service Providers.” *Journal of Health Care Chaplaincy* 22 (3): 102–17. <https://doi.org/10.1080/08854726.2016.1171598>.

- Murphy, Dominic, Elizabeth Hunt, Olga Luzon, and Neil Greenberg. 2014. "Exploring Positive Pathways to Care for Members of the UK Armed Forces Receiving Treatment for PTSD: A Qualitative Study." *European Journal of Psychotraumatology* 5 (1): 21759. <https://doi.org/10.3402/ejpt.v5.21759>.
- Murray, John B. 1982. "Psychological Aspects of Low Back Pain: Summary." *Psychological Reports* 50 (2): 343–51. <https://doi.org/10.2466/pr0.1982.50.2.343>.
- NATO Science and Technology Organization. 2014. "A NATO Guide for Assessing Deployability for Military Personnel with Medical Conditions." <https://doi.org/STO-TR-HFM-174>.
- Nelson, Elliot C, Andrew C Heath, Pamela A F Madden, M Lynne Cooper, Stephen H Dinwiddie, Kathleen K Bucholz, Anne Glowinski, et al. 2002. "Association between Self-Reported Childhood Sexual Abuse and Adverse Psychosocial Outcomes: Results from a Twin Study." *Archives of General Psychiatry* 59 (2): 139–45.
- Nicholls, Stuart G, Sinéad M Langan, and Eric I Benchimol. 2017. "Routinely Collected Data: The Importance of High-Quality Diagnostic Coding to Research." *CMAJ: Canadian Medical Association Journal = Journal de l'Association Médicale Canadienne* 189 (33): E1054–55. <https://doi.org/10.1503/cmaj.170807>.
- Nock, Matthew K., Murray B. Stein, Steven G. Heeringa, Robert J. Ursano, Lisa J. Colpe, Carol S. Fullerton, Irving Hwang, et al. 2014. "Prevalence and Correlates of Suicidal Behavior Among Soldiers." *JAMA Psychiatry* 71 (5): 514. <https://doi.org/10.1001/jamapsychiatry.2014.30>.
- Ohayon, Maurice M., and Alan F. Schatzberg. 2010. "Chronic Pain and Major Depressive Disorder in the General Population." *Journal of Psychiatric Research* 44 (7): 454–61. <https://doi.org/10.1016/j.jpsychires.2009.10.013>.
- Otte, Christian, Stefan M. Gold, Brenda W. Penninx, Carmine M. Pariante, Amit Etkin, Maurizio Fava, David C. Mohr, and Alan F. Schatzberg. 2016. "Major Depressive Disorder." *Nature Reviews Disease Primers* 2 (1): 16065. <https://doi.org/10.1038/nrdp.2016.65>.
- Panaite, Vanessa, Racine Brown, Michelle Henry, Amanda Garcia, Gail Powell-Cope, Rodney D. Vanderploeg, and Heather G. Belanger. 2018. "Post-Deployment Mental Health

Screening: A Systematic Review of Current Evidence and Future Directions.”

*Administration and Policy in Mental Health and Mental Health Services Research* 45 (6): 850–75. <https://doi.org/10.1007/s10488-018-0869-7>.

Parikh, Sagar V., Lena C. Quilty, Paula Ravitz, Michael Rosenbluth, Barbara Pavlova, Sophie Grigoriadis, Vytas Velyvis, et al. 2016a. “Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder.” *The Canadian Journal of Psychiatry* 61 (9): 524–39. <https://doi.org/10.1177/0706743716659418>.

Parikh, Sagar V, Lena C Quilty, Paula Ravitz, Michael Rosenbluth, Barbara Pavlova, Sophie Grigoriadis, Vytas Velyvis, et al. 2016b. “Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder: Section 2. Psychological Treatments.” *Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie* 61 (9): 524–39. <https://doi.org/10.1177/0706743716659418>.

Park, Subin, Ahmad Hatim, Tian-Mei Si, Hong Jin Jeon, Manit Srisurapanont, Dianne Bautista, Shen-ing Liu, Hong Choon Chua, and Jin Pyo Hong. 2015. “Stressful Life Events Preceding the Onset of Depression in Asian Patients with Major Depressive Disorder.” *The International Journal of Social Psychiatry* 61 (8): 735–42. <https://doi.org/10.1177/0020764015577842>.

Patten, S. B., T. C. R. Wilkes, J. V. A. Williams, D. H. Lavorato, N. el-Guebaly, D. Schopflocher, C. Wild, I. Colman, and A. G. M. Bulloch. 2015. “Retrospective and Prospectively Assessed Childhood Adversity in Association with Major Depression, Alcohol Consumption and Painful Conditions.” *Epidemiology and Psychiatric Sciences* 24 (2): 158–65. <https://doi.org/10.1017/S2045796014000018>.

Patten, Scott B. 2013. “Major Depression Epidemiology from a Diathesis-Stress Conceptualization.” *BMC Psychiatry* 13 (1): 19. <https://doi.org/10.1186/1471-244X-13-19>.

Patten, Scott B, Jeanne V A Williams, Dina H Lavorato, Jian Li Wang, Keltie McDonald, and Andrew G M Bulloch. 2015. “Descriptive Epidemiology of Major Depressive Disorder in Canada in 2012.” *The Canadian Journal of Psychiatry* 60 (1): 23–30.

<https://doi.org/10.1177/070674371506000106>.

- Pflanz, Steven E., and Alan D. Ogle. 2006. "Job Stress, Depression, Work Performance, and Perceptions of Supervisors in Military Personnel." *Military Medicine* 171 (9): 861–65. <https://doi.org/10.7205/MILMED.171.9.861>.
- Pilipenko, Nataliya, Maria Karekla, Andreas Georgiou, and Jonathan Feldman. 2016. "Impact of Psychiatric Illness upon Asthma Patients' Health Care Utilization and Illness Control. Are All Psychiatric Comorbidities Created Equal?" *Psychology, Health & Medicine* 21 (7): 787–99. <https://doi.org/10.1080/13548506.2015.1131995>.
- Pinheiro, Marina B., Manuela L. Ferreira, Kathryn Refshauge, Lucia Colodro-Conde, Francisca González-Javier, John L. Hopper, Juan R. Ordoñana, and Paulo H. Ferreira. 2017. "Symptoms of Depression and Risk of Low Back Pain." *The Clinical Journal of Pain* 33 (9): 777–85. <https://doi.org/10.1097/AJP.0000000000000466>.
- Poisson, Robert. 2015. "The Imperative of Military Medical Research and the Duty to Protect, Preserve, and Provide Advanced Evidence-Informed Care." *Journal of Military, Veteran and Family Health* 1 (1): 11–13. <https://doi.org/10.3138/jmvfh.2014-11>.
- Post, Robert M. 2016. "Epigenetic Basis of Sensitization to Stress, Affective Episodes, and Stimulants: Implications for Illness Progression and Prevention." *Bipolar Disorders* 18 (4): 315–24. <https://doi.org/10.1111/bdi.12401>.
- Primack, Jennifer M, Brian Borsari, Madeline B Benz, Madhavi K Reddy, and M Tracie Shea. 2017. "Mental Health Treatment Utilization in OIF/OEF National Guard and Reserve Troops with and without DSM Diagnoses." *The American Journal of Orthopsychiatry* 87 (2): 157–65. <https://doi.org/10.1037/ort0000226>.
- Prisnie, Joey C, Kirsten M Fiest, Shelagh B Coutts, Scott B Patten, Callie Am Atta, Laura Blaikie, Andrew Gm Bulloch, et al. 2016. "Validating Screening Tools for Depression in Stroke and Transient Ischemic Attack Patients." *International Journal of Psychiatry in Medicine* 51 (3): 262–77. <https://doi.org/10.1177/0091217416652616>.
- Qaseem, Amir, Michael J Barry, Devan Kansagara, and Clinical Guidelines Committee of the American College of Physicians. 2016. "Nonpharmacologic Versus Pharmacologic Treatment of Adult Patients With Major Depressive Disorder: A Clinical Practice Guideline

- From the American College of Physicians.” *Annals of Internal Medicine* 164 (5): 350–59.  
<https://doi.org/10.7326/M15-2570>.
- Quartana, Phillip J, Joshua E Wilk, Jeffrey L Thomas, Robert M Bray, Kristine L Rae Olmsted, Janice M Brown, Jason Williams, Paul Y Kim, Kristina Clarke-Walper, and Charles W Hoge. 2014. “Trends in Mental Health Services Utilization and Stigma in US Soldiers from 2002 to 2011.” *American Journal of Public Health* 104 (9): 1671–79.  
<https://doi.org/10.2105/AJPH.2014.301971>.
- Raghupathi, Wullianallur, and Viju Raghupathi. 2014. “Big Data Analytics in Healthcare: Promise and Potential.” *Health Information Science and Systems* 2: 3.  
<https://doi.org/10.1186/2047-2501-2-3>.
- REHMAN, U, J GOLLAN, and A MORTIMER. 2008. “The Marital Context of Depression: Research, Limitations, and New Directions☆.” *Clinical Psychology Review* 28 (2): 179–98.  
<https://doi.org/10.1016/j.cpr.2007.04.007>.
- Richmond, Helen, Amanda M Hall, Bethan Copsey, Zara Hansen, Esther Williamson, Nicolette Hoxey-Thomas, Zafra Cooper, and Sarah E Lamb. 2015. “The Effectiveness of Cognitive Behavioural Treatment for Non-Specific Low Back Pain: A Systematic Review and Meta-Analysis.” *PloS One* 10 (8): e0134192. <https://doi.org/10.1371/journal.pone.0134192>.
- Riddle, Mark S, Marleen Welsh, Chad K Porter, Chiping Nieh, Edward J Boyko, Gary Gackstetter, and Tomoko I Hooper. 2016. “The Epidemiology of Irritable Bowel Syndrome in the US Military: Findings from the Millennium Cohort Study.” *American Journal of Gastroenterology* 111 (1): 93–104. <https://doi.org/10.1038/ajg.2015.386>.
- Riihimäki, K., H. Sintonen, M. Vuorilehto, P. Jylhä, S. Saarni, and E. Isometsä. 2016. “Health-Related Quality of Life of Primary Care Patients with Depressive Disorders.” *European Psychiatry* 37 (September): 28–34. <https://doi.org/10.1016/j.eurpsy.2016.04.008>.
- Risch, Neil, Richard Herrell, Thomas Lehner, Kung-Yee Liang, Lindon Eaves, Josephine Hoh, Andrea Griem, Maria Kovacs, Jurg Ott, and Kathleen Ries Merikangas. 2009. “Interaction between the Serotonin Transporter Gene (5-HTTLPR), Stressful Life Events, and Risk of Depression: A Meta-Analysis.” *JAMA* 301 (23): 2462–71.  
<https://doi.org/10.1001/jama.2009.878>.

- Robins, Clive J., and Paul Block. 1989. "Cognitive Theories of Depression Viewed from a Diathesis-Stress Perspective: Evaluations of the Models of Beck and of Abramson, Seligman, and Teasdale." *Cognitive Therapy and Research* 13 (4): 297–313.  
<https://doi.org/10.1007/BF01173475>.
- Robinson, W David, Jenenne A Geske, Layne A Prest, and Rachel Barnacle. n.d. "Depression Treatment in Primary Care." *The Journal of the American Board of Family Practice* 18 (2): 79–86.
- Rona, Roberto J., Kenneth C Hyams, and Simon Wessely. 2005. "Screening for Psychological Illness in Military Personnel." *JAMA* 293 (10): 1257.  
<https://doi.org/10.1001/jama.293.10.1257>.
- Rona, Roberto J, Richard Hooper, Margaret Jones, Lisa Hull, Tess Browne, Oded Horn, Dominic Murphy, Matthew Hotopf, and Simon Wessely. 2006. "Mental Health Screening in Armed Forces before the Iraq War and Prevention of Subsequent Psychological Morbidity: Follow-up Study." *BMJ* 333 (7576): 991. <https://doi.org/10.1136/bmj.38985.610949.55>.
- Rost, K, P Nutting, J Smith, J C Coyne, L Cooper-Patrick, and L Rubenstein. 2000. "The Role of Competing Demands in the Treatment Provided Primary Care Patients with Major Depression." *Archives of Family Medicine* 9 (2): 150–54.
- Rush, Toni, Cynthia A. LeardMann, and Nancy F. Crum-Cianflone. 2016. "Obesity and Associated Adverse Health Outcomes among US Military Members and Veterans: Findings from the Millennium Cohort Study." *Obesity* 24 (7): 1582–89.  
<https://doi.org/10.1002/oby.21513>.
- Rusu, Corneliu, Mark A Zamorski, David Boulos, and Bryan G Garber. 2016. "Prevalence Comparison of Past-Year Mental Disorders and Suicidal Behaviours in the Canadian Armed Forces and the Canadian General Population." *Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie* 61 (1 Suppl): 46S-55S.  
<https://doi.org/10.1177/0706743716628856>.
- Salomon, Joshua A, Juanita A Haagsma, Adrian Davis, Charline Maertens de Noordhout, Suzanne Polinder, Arie H Havelaar, Alessandro Cassini, et al. 2015. "Disability Weights for the Global Burden of Disease 2013 Study." *The Lancet Global Health* 3 (11): e712–23.

[https://doi.org/10.1016/S2214-109X\(15\)00069-8](https://doi.org/10.1016/S2214-109X(15)00069-8).

Salomon, Joshua A, Theo Vos, Daniel R Hogan, Michael Gagnon, Mohsen Naghavi, Ali Mokdad, Nazma Begum, et al. 2012. "Common Values in Assessing Health Outcomes from Disease and Injury: Disability Weights Measurement Study for the Global Burden of Disease Study 2010." *Lancet (London, England)* 380 (9859): 2129–43.  
[https://doi.org/10.1016/S0140-6736\(12\)61680-8](https://doi.org/10.1016/S0140-6736(12)61680-8).

Sanders, George, and Clare Stevinson. 2017. "Associations between Retirement Reasons, Chronic Pain, Athletic Identity, and Depressive Symptoms among Former Professional Footballers." *European Journal of Sport Science* 17 (10): 1311–18.  
<https://doi.org/10.1080/17461391.2017.1371795>.

Sareen, Jitender, Brian J Cox, Tracie O Afifi, Murray B Stein, Shay-Lee Belik, Graham Meadows, and Gordon J G Asmundson. 2007. "Combat and Peacekeeping Operations in Relation to Prevalence of Mental Disorders and Perceived Need for Mental Health Care: Findings from a Large Representative Sample of Military Personnel." *Archives of General Psychiatry* 64 (7): 843–52. <https://doi.org/10.1001/archpsyc.64.7.843>.

Scarinci, Isabel C, Bettina M Beech, Wendy Naumann, Kristen W Kovach, Letha Pugh, and Bolaji Fapohunda. 2002. "Depression, Socioeconomic Status, Age, and Marital Status in Black Women: A National Study." *Ethnicity & Disease* 12 (3): 421–28.

Schmaling, Karen B., and Zachary A. Nounou. 2019. "Incident Chronic Spinal Pain and Depressive Disorders: Data From the National Comorbidity Survey." *The Journal of Pain* 20 (4): 481–88. <https://doi.org/10.1016/j.jpain.2018.11.002>.

Schmidt, Carsten Oliver, Heiner Raspe, Michael Pflingsten, Monika Hasenbring, Heinz Dieter Basler, Wolfgang Eich, and Thomas Kohlmann. 2007. "Back Pain in the German Adult Population." *Spine* 32 (18): 2005–11. <https://doi.org/10.1097/BRS.0b013e318133fad8>.

Sharp, M.-L., N. T. Fear, R. J. Rona, S. Wessely, N. Greenberg, N. Jones, and L. Goodwin. 2015. "Stigma as a Barrier to Seeking Health Care Among Military Personnel With Mental Health Problems." *Epidemiologic Reviews* 37 (1): 144–62.  
<https://doi.org/10.1093/epirev/mxu012>.

Sheehan, D V, K Harnett-Sheehan, and B A Raj. 1996. "The Measurement of Disability."

*International Clinical Psychopharmacology* 11 Suppl 3 (June): 89–95.

Shen, Yu-Chu, Jeremy Arkes, and Thomas V Williams. 2012. “Effects of Iraq/Afghanistan Deployments on Major Depression and Substance Use Disorder: Analysis of Active Duty Personnel in the US Military.” *American Journal of Public Health* 102 Suppl 1 (Suppl 1): S80-7. <https://doi.org/10.2105/AJPH.2011.300425>.

Simon, Gregory E, Marcelo Fleck, Ramona Lucas, Donald M Bushnell, and LIDO Group. 2004. “Prevalence and Predictors of Depression Treatment in an International Primary Care Study.” *The American Journal of Psychiatry* 161 (9): 1626–34. <https://doi.org/10.1176/appi.ajp.161.9.1626>.

Sinnott, Patricia L., Andrew M. Siroka, Andrea C. Shane, Jodie A. Trafton, and Todd H. Wagner. 2012. “Identifying Neck and Back Pain in Administrative Data.” *Spine* 37 (10): 860–74. <https://doi.org/10.1097/BRS.0b013e3182376508>.

Siu, Albert L., Kirsten Bibbins-Domingo, David C. Grossman, Linda Ciofu Baumann, Karina W. Davidson, Mark Ebell, Francisco A. R. García, et al. 2016. “Screening for Depression in Adults.” *JAMA* 315 (4): 380. <https://doi.org/10.1001/jama.2015.18392>.

Skopp, Nancy A., Robert Swanson, David D. Luxton, Mark A. Reger, Lily Trofimovich, Michael First, James Maxwell, and Gregory A. Gahm. 2012. “An Examination of the Diagnostic Efficiency of Post-Deployment Mental Health Screens.” *Journal of Clinical Psychology* 68 (12): 1253–65. <https://doi.org/10.1002/jclp.21887>.

Smith, Tyler C, and Millennium Cohort Study Team. 2011. “Linking Exposures and Health Outcomes to a Large Population-Based Longitudinal Study: The Millennium Cohort Study.” *Military Medicine* 176 (7 Suppl): 56–63. <https://doi.org/10.7205/milmed-d-11-00085>.

Solomon, D. A., M B Keller, A C Leon, T I Mueller, P W Lavori, M T Shea, W Coryell, et al. 2000. “Multiple Recurrences of Major Depressive Disorder.” *American Journal of Psychiatry* 157 (2): 229–33. <https://doi.org/10.1176/appi.ajp.157.2.229>.

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*

- Journal of Psychiatry : The Journal of Mental Science* 181 (September): 208–13.
- Spiranovic, Caroline, Allison Matthews, Joel Scanlan, and Kenneth C. Kirkby. 2016. “Increasing Knowledge of Mental Illness through Secondary Research of Electronic Health Records: Opportunities and Challenges.” *Advances in Mental Health* 14 (1): 14–25. <https://doi.org/10.1080/18387357.2015.1063635>.
- Stahlman, Shauna, and Alexis A Oetting. 2018. “Mental Health Disorders and Mental Health Problems, Active Component, U.S. Armed Forces, 2007-2016.” *MSMR* 25 (3): 2–11.
- StataCorp. 2015. “Stata Statistical Software: Release 14.” College Station, TX: StataCorp LP.
- Stecker, Tracy, John Fortney, Francis Hamilton, Cathy D Sherbourne, and Icek Ajzen. 2010. “Engagement in Mental Health Treatment among Veterans Returning from Iraq.” *Patient Preference and Adherence* 4 (March): 45–49.
- Stein, Murray B, and Thomas W McAllister. 2009. “Exploring the Convergence of Posttraumatic Stress Disorder and Mild Traumatic Brain Injury.” *The American Journal of Psychiatry* 166 (7): 768–76. <https://doi.org/10.1176/appi.ajp.2009.08101604>.
- Stetz, Melba C, Joshua J McDonald, Brian J Lukey, and Robert K Gifford. 2005. “Psychiatric Diagnoses as a Cause of Medical Evacuation.” *Aviation, Space, and Environmental Medicine* 76 (7 Suppl): C15-20.
- “Strong, Secure, Engaged: Canada’s Defence Policy.” 2017. Ottawa (Canada).
- Sudom, Kerry, Mark A. Zamorski, and Bryan G. Garber. 2012. “Stigma and Barriers to Mental Health Care in Deployed Canadian Forces Personnel.” *Military Psychology* 24 (4): 414–31.
- Sullivan, Patrick F., Michael C. Neale, and Kenneth S. Kendler. 2000. “Genetic Epidemiology of Major Depression: Review and Meta-Analysis.” *American Journal of Psychiatry* 157 (10): 1552–62. <https://doi.org/10.1176/appi.ajp.157.10.1552>.
- Tang, Karen L, Kelsey Lucyk, and Hude Quan. 2017. “Coder Perspectives on Physician-Related Barriers to Producing High-Quality Administrative Data: A Qualitative Study.” *CMAJ Open* 5 (3): E617–22. <https://doi.org/10.9778/cmajo.20170036>.
- Terry, Ellen L, Jennifer L DelVentura, Emily J Bartley, Ashley L Vincent, and Jamie L Rhudy. 2013. “Emotional Modulation of Pain and Spinal Nociception in Persons with Major

- Depressive Disorder (MDD).” *Pain* 154 (12): 2759–68.  
<https://doi.org/10.1016/j.pain.2013.08.009>.
- Thériault, François L., K. Gabler, and Kiyuri. Naicker. 2016. *Health and Lifestyle Information Survey of Canadian Armed Forces Personnel 2013/2014 – Regular Forces Report*. Edited by BA. Strauss and J. Whitehead. Ottawa, Canada: Department of National Defence.
- Thériault, François L., and Ian Colman. 2017. “Awareness of Treatment History in Family and Friends, and Mental Health Care Seeking Propensity.” *Social Psychiatry and Psychiatric Epidemiology* 52 (4): 485–92. <https://doi.org/10.1007/s00127-017-1349-1>.
- Thériault, François L, Bryan G Garber, Franco Momoli, William Gardner, Mark A Zamorski, and Ian Colman. 2019. “Mental Health Service Utilization in Depressed Canadian Armed Forces Personnel.” *Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie* 64 (1): 59–67. <https://doi.org/10.1177/0706743718787792>.
- Thornicroft, Graham, Somnath Chatterji, Sara Evans-Lacko, Michael Gruber, Nancy Sampson, Sergio Aguilar-Gaxiola, Ali Al-Hamzawi, et al. 2017. “Undertreatment of People with Major Depressive Disorder in 21 Countries.” *The British Journal of Psychiatry: The Journal of Mental Science* 210 (2): 119–24. <https://doi.org/10.1192/bjp.bp.116.188078>.
- Townsend, Lisa, James T Walkup, Stephen Crystal, and Mark Olfson. 2012. “A Systematic Review of Validated Methods for Identifying Depression Using Administrative Data.” *Pharmacoepidemiology and Drug Safety* 21 (January): 163–73.  
<https://doi.org/10.1002/pds.2310>.
- Twomey, Conal D, David S Baldwin, Maren Hopfe, and Alarcos Cieza. 2015. “A Systematic Review of the Predictors of Health Service Utilisation by Adults with Mental Disorders in the UK.” *BMJ Open* 5 (7): e007575. <https://doi.org/10.1136/bmjopen-2015-007575>.
- Tylee, Andre. 2006. “Identifying and Managing Depression in Primary Care in the United Kingdom.” *The Journal of Clinical Psychiatry* 67 Suppl 6: 41–45.
- U.S. Department of Defense. 2019. “Millenium Cohort Study.” 2019.
- Ursano, Robert J, Ronald C Kessler, Murray B Stein, James A Naifeh, Pablo A Aliaga, Carol S Fullerton, Gary H Wynn, et al. 2016. “Risk Factors, Methods, and Timing of Suicide Attempts Among US Army Soldiers.” *JAMA Psychiatry* 73 (7): 741–49.

<https://doi.org/10.1001/jamapsychiatry.2016.0600>.

Valenstein, Marcia, Sandeep Vijan, John E. Zeber, Kathryn Boehm, and Amna Buttar. 2001.

“The Cost–Utility of Screening for Depression in Primary Care.” *Annals of Internal Medicine* 134 (5): 345. <https://doi.org/10.7326/0003-4819-134-5-200103060-00007>.

Vanderploeg, Rodney D., Sarra Nazem, Lisa A. Brenner, Heather G. Belanger, Alison J.

Donnell, and Steven G. Scott. 2015. “Suicidal Ideation among Florida National Guard Members: Combat Deployment and Non-Deployment Risk and Protective Factors.” *Archives of Suicide Research* 19 (4): 453–71.

<https://doi.org/10.1080/13811118.2014.957454>.

Varkis, D.L. 2016. “The Impact of Marital Satisfaction on the Utilization of Mental Health Services among Soldiers.” Clemson University.

Viera, Anthony J, and Joanne M Garrett. 2005. “Understanding Interobserver Agreement: The Kappa Statistic.” *Family Medicine* 37 (5): 360–63.

Vogt, Dawne. 2011. “Mental Health-Related Beliefs as a Barrier to Service Use for Military Personnel and Veterans: A Review.” *Psychiatric Services (Washington, D.C.)* 62 (2): 135–42. [https://doi.org/10.1176/ps.62.2.pss6202\\_0135](https://doi.org/10.1176/ps.62.2.pss6202_0135).

Vos, Theo, Amanuel Alemu Abajobir, Kalkidan Hassen Abate, Cristiana Abbafati, Kaja M Abbas, Foad Abd-Allah, Rizwan Suliankatchi Abdulkader, et al. 2017. “Global, Regional, and National Incidence, Prevalence, and Years Lived with Disability for 328 Diseases and Injuries for 195 Countries, 1990–2016: A Systematic Analysis for the Global Burden of Disease Study 2016.” *The Lancet* 390 (10100): 1211–59. [https://doi.org/10.1016/S0140-6736\(17\)32154-2](https://doi.org/10.1016/S0140-6736(17)32154-2).

Vun, Everett, Sarah Turner, Jitender Sareen, Natalie Mota, Tracie O Afifi, and Renée El-Gabalawy. 2018. “Prevalence of Comorbid Chronic Pain and Mental Health Conditions in Canadian Armed Forces Active Personnel: Analysis of a Cross-Sectional Survey.” *CMAJ Open* 6 (4): E528–36. <https://doi.org/10.9778/cmajo.20180093>.

Wadhwa, P D, C A Sandman, M Porto, C Dunkel-Schetter, and T J Garite. 1993. “The Association between Prenatal Stress and Infant Birth Weight and Gestational Age at Birth: A Prospective Investigation.” *American Journal of Obstetrics and Gynecology* 169 (4):

- 858–65. [https://doi.org/10.1016/0002-9378\(93\)90016-c](https://doi.org/10.1016/0002-9378(93)90016-c).
- Walraven, Carl van. 2018. “A Comparison of Methods to Correct for Misclassification Bias from Administrative Database Diagnostic Codes.” *International Journal of Epidemiology* 47 (2): 605–16. <https://doi.org/10.1093/ije/dyx253>.
- Wang, J L, N Schmitz, and C S Dewa. 2010. “Socioeconomic Status and the Risk of Major Depression: The Canadian National Population Health Survey.” *Journal of Epidemiology & Community Health* 64 (5): 447–52. <https://doi.org/10.1136/JECH.2009.090910>.
- Wang, Lawrence, Amber Seelig, Shelley MacDermid Wadsworth, Hope McMaster, John E. Alcaraz, and Nancy F. Crum-Cianflone. 2015. “Associations of Military Divorce with Mental, Behavioral, and Physical Health Outcomes.” *BMC Psychiatry* 15 (1): 128. <https://doi.org/10.1186/s12888-015-0517-7>.
- Weeks, Murray, Mark A Zamorski, Corneliu Rusu, and Ian Colman. 2017. “Mental Illness-Related Stigma in Canadian Military and Civilian Populations: A Comparison Using Population Health Survey Data.” *Psychiatric Services (Washington, D.C.)* 68 (7): 710–16. <https://doi.org/10.1176/appi.ps.201600398>.
- Wells, Timothy S, Cynthia A LeardMann, Sarah O Fortuna, Besa Smith, Tyler C Smith, Margaret A K Ryan, Edward J Boyko, Dan Blazer, and Millennium Cohort Study Team. 2010. “A Prospective Study of Depression Following Combat Deployment in Support of the Wars in Iraq and Afghanistan.” *American Journal of Public Health* 100 (1): 90–99. <https://doi.org/10.2105/AJPH.2008.155432>.
- Wichers, M, N Geschwind, J van Os, and F Peeters. 2010. “Scars in Depression: Is a Conceptual Shift Necessary to Solve the Puzzle?” *Psychological Medicine* 40 (3): 359–65.
- Xiong, Fuxia, and Lubo Zhang. 2013. “Role of the Hypothalamic–Pituitary–Adrenal Axis in Developmental Programming of Health and Disease.” *Frontiers in Neuroendocrinology* 34 (1): 27–46. <https://doi.org/10.1016/j.yfrne.2012.11.002>.
- Young, A S, R Klap, C D Sherbourne, and K B Wells. 2001. “The Quality of Care for Depressive and Anxiety Disorders in the United States.” *Archives of General Psychiatry* 58 (1): 55–61.
- Zamorski, Mark A., Rachel E. Bennett, David Boulos, Bryan G. Garber, Rakesh Jetly, and

- Jitender Sareen. 2016. "The 2013 Canadian Forces Mental Health Survey." *The Canadian Journal of Psychiatry* 61 (1\_suppl): 10S-25S. <https://doi.org/10.1177/0706743716632731>.
- Zamorski, Mark A., Rachel E. Bennett, Corneliu Rusu, Murray Weeks, David Boulos, and Bryan G. Garber. 2016. "Prevalence of Past-Year Mental Disorders in the Canadian Armed Forces, 2002-2013." *The Canadian Journal of Psychiatry* 61 (1\_suppl): 26S-35S. <https://doi.org/10.1177/0706743716628854>.
- Zamorski, Mark A, Corneliu Rusu, and Bryan G Garber. 2014. "Prevalence and Correlates of Mental Health Problems in Canadian Forces Personnel Who Deployed in Support of the Mission in Afghanistan: Findings from Postdeployment Screenings, 2009-2012." *Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie* 59 (6): 319-26. <https://doi.org/10.1177/070674371405900605>.
- Zimmerman, Frederick J., and Wayne Katon. 2005. "Socioeconomic Status, Depression Disparities, and Financial Strain: What Lies behind the Income-Depression Relationship?" *Health Economics* 14 (12): 1197-1215. <https://doi.org/10.1002/hec.1011>.