

# Contribution of mental and physical disorders to disability in military personnel

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<b>Background</b>	Combat operations in Southwest Asia have exposed millions of military personnel to risk of mental disorders and physical injuries, including traumatic brain injury (TBI). The contribution of specific disorders to disability is, however, uncertain.
<b>Aims</b>	To estimate the contributions of mental and physical health conditions to disability in military personnel.
<b>Methods</b>	The sample consisted of military personnel who participated in the cross-sectional 2013 Canadian Forces Mental Health Survey. Disability was measured using the World Health Organization Disability Assessment. The International Classification of Functioning, Disability, and Health was used to classify participants with moderate/severe disability. Chronic mental disorders and physical conditions were measured by self-reported health professional diagnoses, and their contribution to disability was assessed using logistic regression and resulting population attributable fractions.
<b>Results</b>	Data were collected from 6696 military members. The prevalence of moderate/severe disability was 10%. Mental disorders accounted for 27% (95% confidence interval [CI] 23–31%) and physical conditions 62% (95% CI 56–67%) of the burden of disability. Chronic musculoskeletal problems 33% (95% CI 26–39%), back problems 29% (95% CI 23–35%), mood disorders 16% (95% CI 11–19%) and post-traumatic stress disorder (PTSD) 9% (95% CI 5–12%) were the leading contributors to disability. After-effects of TBI accounted for only 3% (95% CI 1–4%) of disability. Mental and physical health interacted broadly, such that those with mental disorders experienced disproportionate disability in the presence of physical conditions.
<b>Conclusions</b>	Chronic musculoskeletal conditions, back problems, mood disorders and PTSD are primary areas of focus in prevention and control of disability in military personnel.
<b>Key words</b>	Co-morbidity; disability; mental health; military; physical health; traumatic brain injury.

## Introduction

Mental and physical health problems may lead to disability. Work contributes broadly to health and well-being and is, therefore, an important sub-domain of disability [1]. Some health problems clearly contribute more than others to the overall burden of disability, though their precise contribution to disability varies across populations [2]. Conceptually, the relationship between health and disability may be more pronounced in workers in mentally and physically demanding professions, such as emergency responders, and military personnel.

Health-related disability among military personnel is of interest, particularly in nations that participated in the ongoing conflicts in Southwest Asia. Military personnel

have an elevated risk of both psychological and physical injury. The job demands that contribute to an increased risk of injury make it more difficult to accommodate injured personnel due to the risk for subsequent injury and other health problems [3]. Military personnel exhibit a substantial burden of disability; prior research has indicated as much as 8% having moderate and 2% having severe disability [4]. Significant mental and physical health problems in military personnel often lead to premature release from service [5]. The specialized nature of military work makes this unwanted turnover particularly costly for military organizations, and it may be devastating to the service member and their family.

Understanding the relative contributions of physical and mental health problems would inform prevention

and control priorities for military populations. Over the past 16 years of conflict in Southwest Asia, public and scientific attention has focused on certain occupational injuries, notably post-traumatic stress disorder (PTSD), blast-related traumatic brain injury (TBI) and traumatic amputations. Each has been shown to be associated with at least some disability-related outcomes, with the most widely studied outcome being medical discharge from service. PTSD contributes heavily to medical discharge, though other mental disorders clearly also contribute [6]. Research on the contribution of TBI is limited; however, one study suggests a substantial contribution [7] while another similar study suggests minimal contribution [8] to disability. Amputations, though frequently disabling, represent only a small subset of all musculoskeletal problems, even in a war zone [9]. The overall contribution of amputations to the burden of disability is unknown, though it is clearly less than that of more prevalent musculoskeletal problems, such as fractures and acute and repetitive strain injuries [10].

Past research has been constrained by its focus on only a particular subset of the military population (e.g. deployed personnel [6,8]), a single condition (such as TBI [8]) or a single disability-related outcome (e.g. medical discharge [6,8]). Other constraints include consideration of only service limitation as the extent of disability, the failure to adjust for confounding factors (including the presence of multiple conditions driving disability), and the inability to assess interactions between health problems, including those due to sports and physical training.

The present study addressed these limitations by using recent, population-based survey data from all Regular Force Canadian military personnel to explore the relative contribution of mental and physical health problems (including TBI specifically) to the burden of disability, adjusting for co-occurring disorders and other potential confounders.

## Methods

Data came from the 2013 Canadian Forces Mental Health Survey (CFMHS). This cross-sectional survey, administered by Canada's national statistics agency (Statistics Canada), used a stratified sampling approach to select a representative sample of Canadian Armed Forces (CAF) personnel in service in September 2012. Our analysis was limited to the surveyed Regular Force members. The data were collected by Statistics Canada personnel in mid-2013 using a computer-assisted, face-to-face interview described in detail elsewhere [11]. The survey was voluntary, and respondents provided informed consent. Data collection and access underwent ethical and privacy review by the relevant entities at Statistics Canada that serve the functions of a Research Ethics Board.

Disability was defined in terms of impairments, activity limitations and participation restrictions using the 12-item version of the World Health Organization Disability Assessment Schedule (WHODAS-2) [12]. The WHODAS-2 captures function in six major life domains: cognition, mobility, self-care, getting along, life activities and participation in society to provide a comprehensive description of disability in the previous 30 days. The WHODAS-2 is reliable and is a valid measure of disability in both general [12] and military populations [4]. Within the CFMHS, total WHODAS-2 scores, ranging from 0 (no disability) to 100 (full disability), were categorized following the International Classification of Functioning, Disability, and Health (ICF) [13]. These ICF categories were dichotomized further such that no disability (WHODAS-2 score: 0–4) and mild disability (5–24) identified a no/mild disability category and moderate disability (25–49) and severe/extreme disability (50–100) a moderate/severe disability category. We chose this approach to simplify presentation and interpretation of results.

Mental and physical disorders were measured using Statistic Canada's Chronic Conditions module, which assesses self-reported conditions that were expected to last or had lasted 6 months or longer and that were diagnosed by a health professional. Three broad mental disorder groupings were assessed: mood disorders (including depression, bipolar/mania and dysthymia), anxiety disorders (phobia, obsessive-compulsive and panic) and PTSD. We elected not to use the symptom-based assessment of disorders available in the survey so as to ensure optimal comparability to the way in which mental and physical disorders were assessed. The chronic physical conditions assessed were asthma, fibromyalgia, arthritis, back pain (excluding fibromyalgia and arthritis), other chronic musculoskeletal problems, hypertension, migraine headaches, diabetes and the after-effects of TBI/concussion (hereafter, 'TBI'). The TBI item was developed specifically for the survey, and it was worded as follows: 'Do you suffer from the effects of a traumatic brain injury (TBI) or concussion?'. The physical conditions assessed represented a subset of a longer list of chronic conditions assessed in Statistics Canada's surveys: chronic physical conditions known to have a low prevalence in military personnel (e.g. after-effects of stroke) or having a limited impact on disability (e.g. allergies) were omitted to limit respondent burden. Having had an amputation was not explicitly assessed, though the prevalence of this is expected to be low [9].

Sex, age group (aged 17–24, 25–34, 35–44 and 45–60 years), rank (junior non-commissioned member [NCM], senior NCM or officer), service (Army, Navy, Air Force) and education (less than secondary, secondary graduate, some post-secondary, post-secondary graduate) were considered when assessing the associations between disorder and disability, as each had previously

been shown to be associated with disability in military populations [14].

The data were largely analysed using SAS software, version 9.3. However, population attributable fractions (PAFs) and associated 95% confidence intervals (CIs) were calculated using the *punaf* module [15] of Stata version 13.1. The PAF quantifies the fraction of outcome cases in a population in which the outcome could have been prevented had the exposure not occurred. PAF estimates assume that the relationship between an exposure and outcome is causal and hence rely on the removal of confounding between exposure and outcome.

Wald chi-square tests were used to assess associations between each covariate and disability. A series of logistic regression models assessed the unadjusted and covariate-adjusted association of each mental disorder and physical condition grouping with disability. We additionally assessed the two-way additive interactions between each mental disorder grouping and the nine chronic physical conditions using the synergy index (SI) [16]. The SI assesses whether the odds of disability when both mental and physical conditions are present exceeds the sum of the odds for the individual conditions when considered separately. These SI and their associated 95% CIs were calculated as described by Hosmer and Lemeshow [17] and expanded upon by Andersson *et al.* [18]. An SI = 1 would indicate a non-significant additive interaction and an SI >1 provides evidence for a synergistic effect; this would suggest that the presence of the mental disorder concurrent with the physical condition being assessed increased the likelihood of disability more than would be expected by the association of the individual disorders on this outcome.

The survey weightings, provided by Statistics Canada, accounted for the sample design and were applied to all analyses to ensure representativeness of the results. Variance estimates were calculated using bootstrap methods that applied 500 bootstrap replicate weightings that Statistics Canada also provided. Missing values were removed by list-wise deletion, resulting in the exclusion of at most <1% of respondents. In accordance with Statistics Canada's confidentiality protections, unweighted results were not reported, and weighted estimates were rounded to the nearest 20. Prevalence rates were calculated using weighted, rounded cell counts.

## Results

In total, 6696 Regular Force members participated in the survey who represented our study population of 67776 serving CAF Regular Force personnel (response rate = 80% of the 8200 invited to participate, after exclusion of out-of-scope respondents). The majority of the survey population was male (86%), less than 45 years of age (mean 36.8 years) and were post-secondary graduates (61%) (Table 1). Over half consisted of junior NCM

ranks and a similar percentages were in Army service. The mean WHODAS-2 disability score was 7.6 (95% CI 7.3–7.9), which fell in the lower spectrum of mild disability. Women, older members and senior NCMs were found to have a higher prevalence of moderate/severe disability. Respondents reported one or more chronic physical conditions more frequently (53%) than mental disorders (13%). However, a greater percentage of those with mental disorders (35%) had moderate/severe disability relative to those with physical disorders (17%). Of the mental disorders assessed, other mood disorders (47%), PTSD (44%) and depression (43%) had the highest prevalence of moderate/severe disability. Fibromyalgia (35%), TBI (30%) and arthritis (26%) had the highest prevalence of moderate/severe disability among the chronic physical conditions. The number of military personnel with mental disorders was nearly half of those with chronic physical disorders (2880 and 5620, respectively). Of those without any of the assessed mental or physical disorders, 93% had no/mild disability and 7% had moderate/severe disability.

Odds ratios (OR) and PAFs for moderate/severe disability were calculated for the three mental disorder categories (mood, anxiety and PTSD) and for each chronic physical condition (Table 2). The odds of moderate/severe disability were generally greater for mental disorders (in the absence of a given physical condition) than any physical condition (in the absence of a given mental disorder). The adjusted ORs (AOR) of moderate/severe disability were greatest for mood disorders (AOR 8.2) and PTSD (AOR 7.7). The PAFs indicated that mental disorders and physical conditions accounted for 27 and 62%, respectively, of moderate/severe disability.

Of the chronic physical conditions, back problems (excluding fibromyalgia and arthritis) and other chronic musculoskeletal problems resulted in the vast majority of moderate/severe disability. Based on our PAF estimates, much of the burden of moderate/severe disability could be eliminated in the study population by the prevention of chronic musculoskeletal problems (33% reduction in moderate/severe disability), back problems (29% reduction), mood disorders (16% reduction) and PTSD (9% reduction). After-effects of TBI were uncommon (3% of the population), but 30% of those respondents had moderate/severe disability. The AOR of moderate/severe disability for TBI was 4.2, but its PAF indicated that it only accounted for 3% of moderate/severe disability.

Co-morbid mental disorders and chronic physical conditions were reported by an estimated 10% of the population. AORs for moderate/severe disability and SIs for each additive interaction model were calculated comparing each mental disorder to all chronic physical conditions (Tables 3–5). The odds of disability were mostly greater for those with both mental disorder and co-morbid physical condition, relative to either condition alone. Two thirds of all additive interactions were

**Table 1.** Military and sociodemographic information of Regular Force members with no/mild disability (weighted  $n = 57\,760$ ) and with moderate/severe disability (weighted  $n = 6\,440$ )

Group	Number (weighted %)	Disability severity category $n$ ; % (95% CI)	
		No/mild	Moderate/severe
Sex <sup>a</sup>			
Male	55 300 (86)	50 120; 91 (90–91)	5 180; 9 (9–10)
Female	8 900 (14)	7 640; 86 (83–88)	1 260; 14 (12–17)
Age <sup>a</sup>			
17–24	8 520 (13)	8 140; 96 (94–97)	380; 5 (3–6)
25–34	24 180 (38)	22 300; 92 (91–94)	1 880; 8 (7–9)
35–44	17 820 (28)	15 500; 87 (85–89)	2 320; 13 (11–15)
45–60	13 680 (21)	11 820; 86 (85–88)	1 860; 14 (12–15)
Rank <sup>a</sup>			
Junior NCM	35 320 (55)	31 660; 90 (88–91)	3 660; 10 (9–12)
Senior NCM	15 460 (24)	13 500; 87 (86–89)	1 960; 13 (11–14)
Officer	13 420 (21)	12 600; 94 (93–95)	820; 6 (5–7)
Service <sup>a</sup>			
Army	34 140 (53)	30 380; 89 (88–90)	3 760; 11 (10–12)
Navy	11 060 (17)	10 000; 90 (89–92)	1 060; 10 (8–11)
Air Force	19 020 (30)	17 400; 92 (90–93)	1 620; 9 (7–10)
Education <sup>a</sup>			
Less than secondary	2 600 (4)	2 240; 86 (82–91)	360; 14 (9–19)
Secondary grad	16 520 (26)	14 780; 90 (88–91)	1 740; 11 (9–12)
Some post-secondary	5 660 (9)	5 020; 89 (86–91)	640; 11 (9–14)
Post-secondary grad	39 280 (61)	35 600; 91 (90–92)	3 680; 9 (8–10)
All mental disorders <sup>a</sup>	8 240 (13)	5 360; 65 (62–68)	2 880; 35 (32–38)
Mood disorders	4 540 (7)	2 580; 57 (52–62)	1 960; 43 (38–48)
Depression	4 120 (6)	2 340; 57 (52–62)	1 780; 43 (38–48)
Bipolar/mania	140 (0)	80; 57 (28–87)	60; 43 (14–72)
Dysthymia	160 (0)	100; 63 (36–90)	60; 38 (11–65)
Other	300 (1)	160; 53 (34–72)	140; 47 (28–66)
Anxiety <sup>a</sup>	3 540 (6)	2 320; 66 (60–71)	1 220; 35 (29–40)
Phobia	660 (1)	440; 67 (55–78)	220; 33 (22–45)
Obsessive-compulsive	800 (1)	560; 70 (60–80)	240; 30 (20–40)
Panic	1 420 (2)	820; 58 (49–66)	600; 42 (34–51)
Other	1 040 (2)	720; 69 (60–78)	320; 31 (22–40)
PTSD	3 840 (6)	2 140; 56 (51–61)	1 700; 44 (39–49)
All physical conditions <sup>a</sup>	33 960 (53)	28 340; 84 (82–85)	5 620; 17 (15–18)
Asthma	2 720 (4)	2 220; 82 (77–87)	500; 18 (13–23)
Fibromyalgia	340 (1)	220; 65 (48–82)	120; 35 (19–52)
Arthritis	7 660 (12)	5 660; 74 (71–77)	2 000; 26 (23–29)
Back problems	14 920 (23)	11 200; 75 (73–77)	3 720; 25 (23–27)
Musculoskeletal	19 380 (30)	15 220; 79 (77–80)	4 160; 22 (20–23)
Hypertension	7 620 (12)	6 360; 84 (81–86)	1 260; 17 (14–19)
Migraine	5 860 (9)	4 520; 77 (74–81)	1 340; 23 (19–26)
Diabetes	980 (2)	820; 84 (76–91)	160; 16 (9–24)
TBI	1 960 (3)	1 380; 70 (64–77)	580; 30 (23–36)

<sup>a</sup>Significant at  $P$  value  $<0.01$  when using a Wald chi-square test comparing Regular Force members with no/mild disability to those with moderate/severe disability.

significantly synergistic indicating that the odds of moderate/severe disability were significantly greater than the sum of the odds for each individual disorder. Generally speaking, back problems and other chronic musculoskeletal problems were found to have the greatest synergistic interaction with each mental disorder. The positive synergistic interaction between mood disorders and chronic physical conditions were less pronounced compared with

the physical conditions interactions with anxiety disorders or PTSD.

## Discussion

This study found that a greater percentage of those with mental disorders reported moderate/severe disability compared to those with physical disorders. However,

**Table 2.** ORs and PAFs for CAF Regular Force members experiencing moderate/severe disability across different mental health and physical health disorders<sup>a</sup>

Disorder or condition	Unadjusted OR—individual regression (95% CI)	AOR <sup>b</sup> —regression with confounders (95% CI)	PAF (95% CI)
All mental disorders	7.9 (6.6–9.5)***	6.8 (5.6–8.2)***	26.8 (22.7–30.6)***
Mood disorder	9.4 (7.6–11.7)***	8.2 (6.5–10.3)***	15.5 (11.4–19.3)***
Anxiety disorder	5.7 (4.4–7.3)***	4.9 (3.8–6.4)***	4.0 (1.2–6.7)**
PTSD	9.4 (7.5–11.9)***	7.7 (6.0–9.9)***	8.9 (5.4–12.3)***
All physical conditions	7.2 (5.5–9.3)***	6.3 (4.9–8.2)***	62.1 (56.2–67.3)***
Asthma	2.2 (1.5–3.0)***	2.0 (1.4–2.8)***	2.2 (0.3–4.1)*
Fibromyalgia	5.2 (2.4–11.2)***	3.6 (1.7–7.9)**	0.1 (–0.8 to 1.0)
Arthritis	4.1 (3.4–5.0)***	3.4 (2.8–4.2)***	6.4 (2.2–10.4)**
Back problems	5.7 (4.7–6.8)***	5.1 (4.3–6.1)***	29.2 (23.1–34.8)***
Chronic MSK	5.1 (4.2–6.2)***	4.8 (3.9–5.8)***	32.7 (25.7–39.1)***
Hypertension	2.0 (1.6–2.4)***	1.6 (1.3–2.0)***	1.9 (–1.3 to 4.9)
Migraine	3.1 (2.5–3.9)***	2.8 (2.2–3.5)***	3.5 (0.0–6.8)*
Diabetes	1.8 (1.1–3.2)*	1.3 (0.8–2.3)	0.0 (–1.1 to 1.1)
After-effects of TBI	4.0 (2.9–5.7)***	4.2 (3.0–5.9)***	2.5 (0.6–4.4)*

MSK, musculoskeletal disorders.

<sup>a</sup>Co-morbid mental disorders and chronic physical conditions were reported by an estimated 10% of the population.<sup>b</sup>ORs were adjusted for sex, age, rank, service and education.\*\*\**P* < 0.001, \*\**P* < 0.01, \**P* < 0.05.**Table 3.** Additive interaction between mood disorders and chronic physical conditions among CAF Regular Force members

PC	PC <sup>a</sup> , AOR (95% CI) <sup>b</sup>	MD <sup>c</sup> , AOR (95% CI) <sup>b</sup>	MD + PC, AOR (95% CI) <sup>b</sup>	SI <sup>d</sup> (95% CI)
Asthma	8.4 (6.7–10.7)	2.2 (1.5–3.4)	11.5 (4.2–31.6)	1.2 (0.9–1.6)
Fibromyalgia	8.2 (6.5–10.4)	3.7 (1.4–9.8)	9.7 (0.7–144.7)	0.9 (0.5–1.4)
Arthritis	8.7 (6.6–11.5)	3.4 (2.7–4.3)	18.0 (11.7–27.8)	1.7 (1.5–2.1)
Back problems	10.4 (7.5–14.6)	5.4 (4.3–6.7)	26.7 (18.9–37.6)	1.9 (1.7–2.1)
Musculoskeletal	9.0 (6.2–13.0)	4.7 (3.7–5.9)	28.2 (20.1–39.4)	2.3 (2.1–2.7)
Hypertension	8.9 (6.9–11.6)	1.6 (1.3–2.1)	8.2 (5.3–12.8)	0.9 (0.7–1.0)
Migraine	9.6 (7.5–12.5)	2.9 (2.2–3.8)	9.0 (5.7–14.1)	0.8 (0.7–0.9)
Diabetes	–	–	–	–
After-effects of TBI	8.5 (6.7–10.8)	4.4 (3.0–6.6)	12.5 (6.1–25.8)	1.1 (0.8–1.3)

(–) Non-convergence. AOR adjusted for sex, age, rank, service and education. MD, mental disorder; PC, physical condition.

<sup>a</sup>PC: specified physical condition in the absence of mental disorder.<sup>b</sup>Common reference group were those with neither mental disorder nor physical condition.<sup>c</sup>MD: specified mental condition in the absence of chronic physical conditions.<sup>d</sup>SI =  $[(OR_{MD+PC} - 1) / ((OR_{MD} - 1) + (OR_{PC} - 1))]$ , SI = 1 indicates a purely additive interaction, >1 indicates a positive synergistic effect and <1 indicates a negative synergistic effect.

due to their higher prevalence, chronic physical disorders contributed more than mental disorders to the burden of moderate/severe disability in Canadian military personnel. Among physical disorders, chronic musculoskeletal problems and back problems (excluding fibromyalgia and arthritis) had the largest PAFs. After-effects of TBI accounted for only a small proportion of the burden of disability. Among mental disorders, mood disorders had the greatest PAF; the PAF for PTSD was smaller, though the CIs for these PAFs overlapped. The interaction between co-morbid mental disorders and chronic physical conditions generally had synergistic effects on disability.

Our study had some limitations. Firstly, PAF estimates assume that the relationship between the exposure (e.g. presence of a disorder), and an outcome is unidirectional and causal. However, it has been shown that chronic, painful musculoskeletal problems can lead to depression [19], with disability being a potential mediating factor [20]; depression also contributes to the development of chronic pain. As a result, our analysis may have under- or over-estimated the corresponding PAFs. Mental disorders and chronic physical conditions were self-reported, though these have reasonable reliability relative to medical records data [21]. At the time of the survey, no electronic health data were available to

**Table 4.** Additive interaction between anxiety disorders and chronic physical conditions among CAF Regular Force members

PC	PC <sup>a</sup> , AOR (95% CI) <sup>b</sup>	MD <sup>c</sup> , AOR (95% CI) <sup>b</sup>	MD + PC, AOR (95% CI) <sup>b</sup>	SI <sup>d</sup> (95% CI)
Asthma	4.8 (3.7–6.2)	1.9 (1.3–2.8)	9.1 (3.3–25.6)	1.7 (1.3–2.3)
Fibromyalgia	4.7 (3.7–6.2)	2.7 (0.9–8.0)	15.5 (0.0–999.9)	2.7 (1.6–4.9)
Arthritis	4.1 (3.0–5.7)	3.0 (2.4–3.8)	19.8 (11.9–33.0)	3.7 (3.1–4.8)
Back problems	5.0 (3.3–7.4)	4.9 (4.0–6.1)	18.7 (13.0–26.8)	2.2 (2.0–2.6)
Musculoskeletal	3.9 (2.5–6.1)	4.4 (3.5–5.4)	19.2 (13.6–27.1)	2.9 (2.6–3.3)
Hypertension	4.5 (3.3–6.1)	1.5 (1.2–1.9)	9.5 (5.7–15.8)	2.1 (1.8–2.7)
Migraine	5.0 (3.7–6.8)	2.6 (2.0–3.4)	7.2 (4.4–11.8)	1.1 (0.9–1.3)
Diabetes	4.7 (3.6–6.1)	1.1 (0.5–2.3)	12.3 (3.3–45.9)	3.0 (1.6–4.1)
After-effects of TBI	4.7 (3.6–6.2)	3.8 (2.6–5.8)	11.8 (5.6–25.0)	1.7 (1.2–2.0)

AOR adjusted for sex, age, rank, service and education. MD, mental disorder; PC, physical condition.

<sup>a</sup>PC: specified physical condition in the absence of mental disorder.

<sup>b</sup>Common reference group were those with neither mental disorder nor physical condition.

<sup>c</sup>MD: specified mental condition in the absence of chronic physical conditions.

<sup>d</sup>SI =  $[\text{OR}_{\text{MD}^*\text{PC}} - 1] / [(\text{OR}_{\text{MD}} - 1) + (\text{OR}_{\text{PC}} - 1)]$ , SI = 1 indicates a purely additive interaction, >1 indicates a positive synergistic effect and <1 indicates a negative synergistic effect.

**Table 5.** Additive interaction between PTSD and chronic physical conditions among CAF Regular Force members

PC	PC <sup>a</sup> , AOR (95% CI) <sup>b</sup>	MD <sup>c</sup> , AOR (95% CI) <sup>b</sup>	MD + PC, AOR (95% CI) <sup>b</sup>	SI <sup>d</sup> (95% CI)
Asthma	7.6 (5.9–9.8)	1.9 (1.3–2.9)	12.6 (5.1–31.4)	1.6 (1.1–2.0)
Fibromyalgia	7.8 (6.1–10.0)	4.5 (1.8–11.2)	5.2 (0.0–999.9)	0.4 (0.2–0.7)
Arthritis	8.0 (5.9–10.7)	3.2 (2.5–4.1)	15.3 (10.3–22.6)	1.6 (1.4–1.8)
Back problems	6.3 (4.2–9.4)	4.4 (3.6–5.5)	25.4 (18.3–35.2)	2.8 (2.5–3.2)
Musculoskeletal	6.8 (4.6–10.1)	4.3 (3.5–5.3)	26.5 (19.3–36.5)	2.8 (2.5–3.2)
Hypertension	7.6 (5.8–10.0)	1.5 (1.2–2.0)	10.6 (6.5–17.2)	1.4 (1.1–1.6)
Migraine	7.8 (5.9–10.4)	2.5 (1.9–3.3)	11.7 (7.5–18.1)	1.3 (1.1–1.5)
Diabetes	7.6 (5.9–9.7)	1.3 (0.6–2.5)	8.9 (0.6–131.4)	1.1 (0.7–1.7)
After-effects of TBI	7.2 (5.5–9.3)	3.3 (2.2–5.1)	21.5 (10.8–42.6)	2.4 (1.9–3.0)

AOR adjusted for sex, age, rank, service and education.

<sup>a</sup>PC: specified physical condition in the absence of mental disorder.

<sup>b</sup>Common reference group were those with neither mental disorder nor physical condition.

<sup>c</sup>MD: specified mental condition in the absence of chronic physical conditions.

<sup>d</sup>SI =  $[\text{OR}_{\text{MD}^*\text{PC}} - 1] / [(\text{OR}_{\text{MD}} - 1) + (\text{OR}_{\text{PC}} - 1)]$ , SI = 1 indicates a purely additive interaction, >1 indicates a positive synergistic effect and <1 indicates a negative synergistic effect.

confirm these self-reported conditions. In addition, some respondents may have had undiagnosed mental or physical health problems (including TBI), and this could have resulted in our reported PAFs being underestimates. Our analyses were unable to tease apart contributions of occupational versus non-occupational health problems. Finally, the impact of undiagnosed conditions cannot be surmised from our results, though the large fraction of disability accounted for by the measured factors is reassuring. However, of those who did not report any of the assessed conditions, few (7%) had moderate/severe disability.

We were unable to locate any studies that were suitable for direct comparison with the present study. However, our findings do agree with studies showing significant contributions of mental disorders [22] and musculoskeletal conditions [23] to disability in military personnel and veterans. This agreement of findings across populations and methods is reassuring. Our findings also agree

with a recent Canadian study that found that neurological problems (including TBI) were rarely identified as the primary diagnosis contributing to limitations likely to lead to medical discharge [8]. However, a similar US study found that TBI was the third most common primary diagnosis accounting for similar limitations [7]. The divergence of these two findings may relate to differences in the underlying populations or in clinical practices regarding attribution of disability to TBI.

Our findings agree with studies on the contributors to disability in the general population, in which low back pain, depressive disorders, other musculoskeletal disorders and anxiety disorders were important contributors to disability in industrialized countries [24]. In France, psychiatric disorders (27%) and musculoskeletal conditions (18%) accounted for the greatest amount of disability among those aged 40 years or less [25]. In contrast, we found that chronic physical conditions (62%) accounted for moderate/severe disability to a much greater extent

than mental disorders (27%). The high physical demands placed on military personnel may explain the difference between civilian and military populations with regards to disability related to physical health. Differences in the age distribution in these populations may also be relevant. Unlike in the general population, our study showed that PTSD was a leading contributor to moderate/severe disability among military personnel. The lower exposure to events that may cause PTSD in the general population [26] compared to the military [11] may explain this difference. The interactions between mental and physical health problems with respect to disability have been shown in studies in the general population [27] and in veterans [14], though many such studies have focused on a particular disorder.

Our study has added to the body of literature on conditions associated with disability by focusing on a population of special significance (the military population in Canada), which is subject to both high rates of physical and psychological injury and high physical and psychological job demands. We were able to estimate the contributions of both mental disorders and chronic physical conditions to disability, which we measured using a comprehensive and valid tool, the WHODAS-2. We used an interpretable metric (PAF) to assess the contribution of conditions to disability, and our estimates controlled for confounding factors, notably the presence of all of the other assessed conditions.

Additional research is needed to explore the specific diagnoses captured within our broad categories of back problems and of other musculoskeletal conditions, as each diagnosis may present different prevention and control opportunities. Investigation of the drivers of disability in those without the chronic conditions assessed in this study is important. The role of undiagnosed mental disorders is especially relevant, given that many individuals with such disorders are not receiving care [28]. Additional research should be directed towards comparison of contributors to disability in other key populations, such as the Canadian general population, other military populations and public safety personnel [29]. Longitudinal studies would help to characterize the timescale of the key factors (mental conditions, physical conditions and disability), ultimately leading to more reliable PAF estimates.

We have identified that musculoskeletal problems (other than arthritis or fibromyalgia) and back problems are key targets for the prevention and control of disability in the CAF. Mental disorders are another important target, and the focus should extend beyond PTSD to include mood disorders. The after-effects of TBI, in contrast, are not a priority target given their very small PAF. The interaction of mental and physical disorders with regard to disability argues for the careful assessment and appropriate treatment of physical health problems in those with mental disorders, and vice versa.

## Key points

- In Canadian military personnel, chronic physical conditions were more prevalent than mental disorders but mental disorders were associated with greater levels of disability.
- Back problems (excluding fibromyalgia and arthritis), other chronic musculoskeletal problems, mood disorders and post-traumatic stress disorder accounted for a large proportion of moderate/severe disability.
- Those reporting the after-effects of traumatic brain injury had a high prevalence of disability, but only accounted for a small percentage of the burden of moderate/severe disability.

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## Competing interests

None declared.

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