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On the Cover

Top left: A member of the Canadian Armed Forces, NATO enhanced Forward Presence Battle Group Latvia, pulls a light armored vehicle (LAV) as part of Canada Day celebrations, and festivities to mark the end of tour for a rotation of personnel, on July 1, 2020, at Camp Ādaži, Latvia. *Photo by Master Corporal Alexandre Paquin/enhanced Forward Presence Battle Group Latvia*

Top right: Veteran Derek Speirs served 22 years with the Canadian Armed Forces before releasing from the military in 2011. He was a cook on Royal Canadian Navy submarines. In October 2004, he was a crew member on the HMCS Chicoutimi when an electrical fire broke out, causing extensive damage and the death of one crew member. *Photo by Marie France L'Ecuyer*

Bottom left: Capt. Lisa Evong, centre, a Public Affairs Officer with the 5th Canadian Division Support Base in Gagetown, NB, is shown with her daughters, Eden Avni (8), and Lyla Avni (6). *Photo by Master Corporal Geneviève Lapointe/Canadian Forces Combat Camera*

Bottom right: Firefighters from the 3rd Canadian Division Support Base (3 CDSB) Garrison Wainwright conduct a mobile aircraft fire exercise in Wainwright, AB, on Sept. 24, 2020. *Photo by Master Corporal Julie Bélisle/ 3 CDS B Detachment Wainwright, Imagery*

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Big changes ahead for *JMVFH*

This year will be one of exciting transformation for the *Journal of Military, Veteran and Family Health* (*JMVFH*). In the last six years, we have worked hard to solidify our place in the world of military, Veteran, and family health research and emerge as a leader in the publication of world-class, multidisciplinary content to improve the health and well-being of our beneficiary population. Now, we are ready to forge ahead, launching *JMVFH* into a new era.

Starting in 2021, *JMVFH* will begin publishing three regular editions per year, along with two themed special editions. Increasing the number of annual offerings from two to five will allow the journal to publish more cutting-edge research about critical topics when it is most needed. This will put essential, reliable information into the hands of practitioners, administrators, and policy makers so they are better able to make evidence-informed decisions that will benefit military members, Veterans, and their families.

In addition, *JMVFH* will also make content more accessible to its audience. Beginning with this issue (7.1), lay summaries will appear with every published article. Lay summaries are an effective way to communicate research to a non-specialist audience. They explain, in plain language, the purpose and goals of a project and its impact on a specific population. Lay summaries tell a compelling story and have the potential to capture the interest of experts and the general public alike. They are a key component in the journal's effort to disseminate research findings more broadly and appeal to a wider readership.

In 2021, *JMVFH* will also embark on a journey to address equity and inclusivity in its content. The journal supports the principles of the Sex and Gender Equity in Research (SAGER) guidelines, a set of international guidelines that encourages a systematic approach to reporting on sex and gender in health research. *JMVFH* encourages awareness of the SAGER guidelines and the ethical value of addressing equity, diversity, and inclusion in research. We are working toward incorporating these principles into our publications, and, as such, a series of questions related to SAGER guidelines has been included as part of our manuscript submission process. Providing authors an opportunity to acknowledge when their research incorporates these principles is the journal's first step toward adopting SAGER guidelines and improving health and well-being for all.

Another exciting development for *JMVFH* is the introduction of Altmetric badges (Altmetric, London, UK, https://www.altmetric.com/) for articles appearing on the journal's website. Altmetrics are a means of tracking measurements and qualitative data that complement traditional citation-based metrics. They capture how and where published research is being used and shared, such as social media networks, research blogs, or mainstream media and policy documents. Altmetric badges display this information in a format that tells a nuanced story of the research's value, influence, and impact. They provide instant feedback on knowledge mobilization and offer insight into the tangible effects of research — an invaluable asset to the journal's ongoing efforts to increase its footprint in the field of military, Veteran, and family health research.

These changes build on our publication's past success and will, no doubt, put us in good stead to lead the charge on changing the face of research for serving members, Veterans, and their families.

Stéphanie A.H. Bélanger, CD, PhD, and
David Pedlar, PhD
Co-Editors-in-Chief, JMVFH

Are we ready for measurement-based care? Examining organizational readiness for change among Canadian Armed Forces mental health care providers

Eva Guérin[a], Bryan Garber[b] and Jennifer E.C. Lee[a]

ABSTRACT

Introduction: Measurement-based care involves the use of routine symptom measures to monitor outcomes and adapt treatments to patients' needs. The Client-Reported Outcomes Monitoring Information System (CROMIS) has been progressively implemented at Canadian Forces (CF) Health Services Centres to assist with clinical decision making and improve mental health outcomes. The central objective of this study was to examine organizational readiness to implement CROMIS among Canadian Armed Forces (CAF) mental health care providers. **Methods**: A cross-sectional online survey was administered to health care providers across 17 CF clinics. Providers completed the Organizational Readiness to Change Assessment tool based on the Promoting Action on Research Implementation in Health Services framework. Analyses were conducted on the Evidence and Facilitation scales of 55 completed surveys to identify implementation barriers and enablers. **Results**: The evidence base for CROMIS was perceived as relatively strong, although several respondents disagreed that CROMIS takes patients' needs and preferences into consideration. Moreover, patient education about CROMIS was not seen as readily available. Despite agreement that CROMIS clinical champions had been designated across clinics, there was some ambivalence about the champion's responsibilities. A high degree of uncertainty was observed regarding plans for evaluating and improving the use of CROMIS. **Discussion**: Although opinions about and attitudes toward CROMIS were generally favorable, its implementation had defined barriers and unknowns. Further research is needed to explore the breadth of modifiable implementation factors that can influence providers' use of CROMIS to monitor treatment progress, thus improving mental health care for CAF patients.

Key words: barriers, evidence-based, implementation, measurement-based care, mental health care, Canadian Armed Forces, CAF

RÉSUMÉ

Introduction : Les soins fondés sur des mesures consistent à mesurer les symptômes habituels pour évaluer les résultats cliniques et adapter les traitements aux besoins des patients. Le Système de surveillance des résultats signalés par les clients (SSRSC) a été progressivement mis en œuvre dans les Centres des services de santé des Forces canadiennes (FC) pour contribuer à la prise de décisions cliniques et améliorer les résultats en santé mentale. La présente étude visait principalement à examiner la préparation organisationnelle nécessaire pour mettre le SSRSC en œuvre chez les fournisseurs/fournisseuses de soins en santé mentale des Forces armées canadiennes (FAC). **Méthodologie** : Les chercheurs ont proposé un sondage transversal en ligne aux fournisseurs/fournisseuses de soins de 17 cliniques des FC. Les fournisseurs/fournisseuses ont rempli l'outil d'évaluation de la préparation organisationnelle au changement d'après la structure de promotion des mesures de mise en œuvre de la recherche dans les services de santé. Les chercheurs ont procédé à des analyses sur les échelles de données probantes et de facilitation de 55 sondages pour déterminer les obstacles et les incitations à la mise en œuvre. **Résultats** : Le fondement du SSRSC sur des données probantes était perçu comme relativement solide, même si plusieurs répondants ne trouvaient pas que le SSRSC tenait compte des besoins et des préférences des patients. De plus, l'éducation des patients au sujet du SSRSC n'était pas considérée comme facile à obtenir. Même si on s'entendait pour dire que des porte-parole cliniques du SSRSC étaient désignés dans les cliniques, il y avait une certaine ambivalence quant à leurs responsabilités. Les chercheurs ont observé un fort degré d'incertitude quant aux plans en vue d'évaluer et d'améliorer l'utilisation du SSRSC. **Discussion** : Les avis et les attitudes envers le SSRSC étaient généralement favorables, mais il y

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avait des obstacles et des inconnues définis à l'égard de sa mise en œuvre. D'autres recherches s'imposent pour explorer l'ampleur des facteurs de mise en œuvre modifiables qui peuvent influer sur l'utilisation du SSRSC afin de surveiller l'évolution des traitements et d'ainsi améliorer les soins en santé mentale des patients des FAC.

Mots-clés : fondé sur des données probantes, mise en œuvre, obstacles, soins fondés sur des mesures, soins en santé mentale, fournisseurs/fournisseuses, Forces armées canadiennes, FAC

LAY SUMMARY

The Client-Reported Outcomes Monitoring Information System (CROMIS) uses regular feedback from patients to guide mental health treatment and to improve mental health outcomes. Since 2018, CROMIS has been implemented in stages across Canadian Forces (CF) Health Services Centres. In this study, an online survey was administered to examine how prepared mental health care providers feel in terms of using CROMIS in their practice. The results from 55 providers revealed generally positive attitudes towards CROMIS and its evidence. However, providers also felt that material to educate patients about this new system was limited and that the needs of patients themselves needed to be considered. Several providers reported not knowing about the roles and responsibilities of CROMIS leaders who were expected to guide others in using this new system. In addition, there was uncertainty about how CROMIS would be evaluated and improved in the future. This study helped to identify factors that could be helping or impairing CF mental health care providers in using CROMIS to improve patient care.

INTRODUCTION

Measurement-based care (MBC) is an evidence-based practice that refers to the use of routine symptom measurement to inform treatment. MBC involves the use of patient-reported tools by health care providers to monitor outcomes and adapt treatments to patients' evolving needs. In mental health service delivery, inviting users (i.e., clients or patients) to complete standardized symptom assessments increases user involvement and provides functional data to highlight treatment targets, observe progress or deterioration, and help address shortcomings in service provision.[1] The results of randomized controlled trials (RCTs) reveal that MBC, also known as routine outcome monitoring, can reduce treatment failures.[2–4] In various clinical settings, MBC has been linked with patient and provider satisfaction and with improvements in clinical outcomes, such as reduced symptom profiles and enhanced quality of life.[3, 5, 6] It can also enable collaboration among teams of health care providers.[7] MBC is considered a transtheoretical and transdiagnostic approach or framework,[1, 3, 8] and in mental health care, the use of MBC is increasingly being endorsed as a standard of care.[2, 9, 10]

In 2014, the Canadian Armed Forces (CAF) procured the Client-Reported Outcomes Monitoring Information System (CROMIS) as an MBC tool to assist with clinical decision making and improve patient outcomes. Originally developed by Veterans Affairs Canada (VAC) to meet the needs of the Operational Stress Injury Clinic network,[11] CROMIS uses periodic client feedback to help guide treatment and improve mental health outcomes.[12] As one of the first systems of this kind in Canada, it leverages information technology through session-by-session administration of the brief Outcome Questionnaire (OQ–45) and interpretation using the OQ-Analyst software.[13] For its use in the CAF, the e-platform for CROMIS was retooled (i.e., information management security) and rolled out nationally and in phases, including onsite training, across Canadian Forces (CF) Health Services Centres beginning in April 2018. Because the ultimate intent of this initiative is to integrate CROMIS into routine clinical mental health care delivery, there is value in identifying factors that may facilitate, or hinder, its use.

Despite strong empirical support for the value of MBC systems, such as CROMIS, persistent underutilization in mental health care has been noted.[14] At the practitioner level, perceptions of burdensome administration procedures and disruptions to practice have been reported, as have fears of exposure to performance assessment.[15] At a broader level, organizational culture and organizational readiness for change may also contribute to practitioners' uncertainty or resistance to MBC. One theoretical framework that is widely endorsed to represent essential determinants of successful implementation of research into clinical practice is the Promoting Action on Research Implementation in Health Services (PARIHS) framework.[16, 17] PARIHS was the preferred framework to examine factors associated with implementation success of an intensive facilitation strategy to support MBC in the context of the U.S. Department of Veterans Affairs mental health program.[18] Consequently, this framework may offer insights into CAF mental health care providers' readiness to adopt CROMIS in their practice.

The PARIHS framework posits that three core and cumulative elements determine the success of research implementation, and these elements in turn consist of distinct sub-components.[19] The first core element, Evidence, refers to the strength and nature of the evidence as perceived by multiple stakeholders. It encompasses different sources of evidence, from RCT results to the extent to which patient preferences are considered. The second core element is the quality of the Context, or environment in which the research or practice is implemented; it reflects not only elements of the organizational culture, but also leadership characteristics and performance measurement.[19] Finally, Facilitation involves helping individuals and teams understand what they need to change and how to go about it; it focuses on characteristics of the implementation team and processes, including communication and implementation planning (pertaining to the specific innovation).[19]

To assess various elements of the PARIHS framework, researchers developed the Organizational Readiness for Change Assessment (ORCA) tool — a self-reported tool that captures individuals' beliefs regarding a particular evidence-based practice. From a diagnostic perspective, results generated using the ORCA provide a "prognosis" regarding the success of efforts to change a practice at the organizational level, helping to identify needs or conditions that can be targeted by implementation activities or resources.[20] To support the implementation of CROMIS across CF Health Services Centres, a study was therefore conducted that involved administering this tool to CAF mental health care providers. Specifically, the primary intent of this study was to identify key barriers to and facilitators of the use of CROMIS, with a focus on organizational readiness for change. A secondary objective was to explore the validity of using the ORCA to assess organizational readiness for change within the CF Health Services context.

METHODS

Study design and participants

A cross-sectional survey, consisting primarily of the ORCA, was administered between February and May 2019 to 238 health care providers at 17 CF Health Services Centres across Canada. A census approach was attempted, with members of the target population identified by the CF Health Services Group. Specifically, the target population consisted of all military and civilian health care providers who played a role in the provision of mental health care in the CAF at the time the survey was launched and who would thereby be involved in using CROMIS. Complete surveys were received from 55 mental health care providers, for an overall response rate of 23%. This study was approved by the Social Science Research Review Board for the Department of National Defence. Informed consent was provided by all participants.

Survey and measures

The survey was administered online via email. Each clinic was assigned a unique survey URL in order to examine clinic-level participation and implementation trends. The survey consisted of a short series of questions to assess respondents' demographic characteristics, including age, sex, and occupation and the ORCA tool.[20]

The ORCA originated in the Veterans Health Administration Quality Enhancement Research Initiative for Ischemic Heart Disease and consists of 77 items.[20] The tool consists of three scales with multiple subscales developed to assess elements of the PARIHS framework: Evidence (four subscales), Facilitation (nine subscales), and Context (six subscales). Responses were scored on a five-point Likert scale ranging from "strongly disagree" to "strongly agree," with the exception of items pertaining to evidence ("very weak" to "very strong"). The option to respond "don't know/NA" was also available. Higher scores demonstrate a more favourable attitude and reflect a greater readiness for change. Helfrich et al.[20] found general support for the reliability and factor structure of the ORCA.

In this study, the wording of the ORCA items was adapted to reflect the CAF implementation context for CROMIS. In addition, for the purposes of this study, minor changes were made on the basis of pilot testing and feedback from subject matter experts. These changes included a slight reordering of subscales, defining key terms (e.g., CROMIS "Rollout team"), and removing six items on the basis of perceived redundancy; namely, all items in the style (progress) subscale.[21] Cronbach's α for the overall scales was .88, .90, and .93 for Evidence, Context, and Facilitation, respectively, indicating good internal consistency in this study.

Data analyses

Only the Evidence and Facilitation elements of the PARIHS framework are examined in this article because they pertain directly to the implementation of CROMIS. Given that they reflect attitudes about general quality of care and organizational change overall, items in the Context scale were not examined. In total,

responses to 46 items were analyzed. Data were exported from the online survey platform to IBM SPSS Statistics (version 23; IBM Corporation, Armonk, NY). Given the low number of responses (described in the Results section), simple frequency analyses were conducted on demographic variables and ORCA items. Responses for "strongly disagree" and "disagree" were pooled to reflect disagreement and those for "strongly agree" and "agree" were pooled to indicate agreement.

All individual items were examined across clinics and across demographic categories. Stratified analyses (i.e., by clinic or demographic group) were not conducted because of the small sample size.

RESULTS

Demographic information

The majority of respondents were women (64%) and aged between 35 and 54 years (72%). Nearly half of the respondents were social workers (43%), and the remainder consisted of nurses (16%), psychologists or psychiatrists (16%), and other professionals (e.g., addiction counsellor) (4%). These proportions mirror those of the target population, with the exception of psychologists and psychiatrists, who were underrepresented by about half (i.e., 16% vs. 31%). A total of 21% of respondents did not indicate their profession. Health Services Centres (i.e., clinics) with the largest number of respondents included Ottawa, Esquimalt, Kingston, and Borden.

Evidence

The first two items of this scale target discord between respondents and their colleagues about the available evidence, based on the following statement: "The use of CROMIS will help significantly improve outcomes in mental health care." The first question asked respondents about their own opinion of the evidence base for this assertion. A total of 60% of respondents reported that the evidence base for CROMIS was strong, 9% felt that it was weak, and 32% were neutral. The second question asked respondents about the opinions of respected clinical experts at their clinic regarding the evidence base for this statement. Thirty-nine percent felt that others at their clinic regarded the evidence as strong, and 15% felt they regarded it as weak, and a larger proportion were neutral or reported not knowing how other clinical experts perceived the evidence base for CROMIS (46%).

Proportions related to the three remaining Evidence subscales are shown in Figure 1. Multiple stakeholders perceived the evidence base for CROMIS as fairly good overall. More than half of respondents agreed that scientific and clinical evidence for CROMIS was generally strong, and this included favorable perceptions of RCT support. Sixty-one percent agreed that CROMIS has more advantages than disadvantages for CAF patients. However, 58% of respondents disagreed or were ambivalent about whether CROMIS takes into consideration the needs and preferences of patients themselves.

Facilitation

With respect to facilitating and enabling change for CROMIS, Figures 2-4 present proportions for subscales pertaining to CAF clinics' capacity for internal facilitation.

As shown in Figure 2, respondents' attitudes were favourable regarding the role of senior leadership and clinical management in the use of CROMIS (e.g., agreeing on its goals and being informed and involved in its use). Most respondents were either neutral or agreed that senior leadership proposed a feasible implementation plan with clear patient care goals and deliverables. The majority of respondents recognized that a person at their clinic had been designated as a CROMIS clinical champion, characterized as a well-respected person who assumes responsibility for the success of a change initiative such as CROMIS (and who has the authority to carry this out). However, one-quarter of participants showed signs of ambivalence (i.e., "don't know") for items inquiring about the clinical champion's actions and responsibilities.

Regarding the implementation plan for CROMIS (Figure 3), more than half (56%) believed that the required level of staff support was available, whereas 20% did not. However, opinions were divided regarding the extent to which staff input and opinions were considered in the CROMIS implementation plan. Moreover, although 65% of respondents agreed that appropriate provider training and education was in place in the current CROMIS implementation plan, only 27% felt that patient education was sufficient. Feedback regarding resources to improve the implementation plan and communication for CROMIS was divided (Figure 3). A high percentage of "don't know" responses was observed for items pertaining to communication about CROMIS (32-36%). For example, as shown in Figure 3, 35% of respondents were unsure whether regular feedback on the effects of using CROMIS would be provided.

In terms of tools in place to facilitate the use of CROMIS, more than half (61%) disagreed that staff incentives for implementing CROMIS were available (Figure 4). Likewise, 41% disagreed about the availability

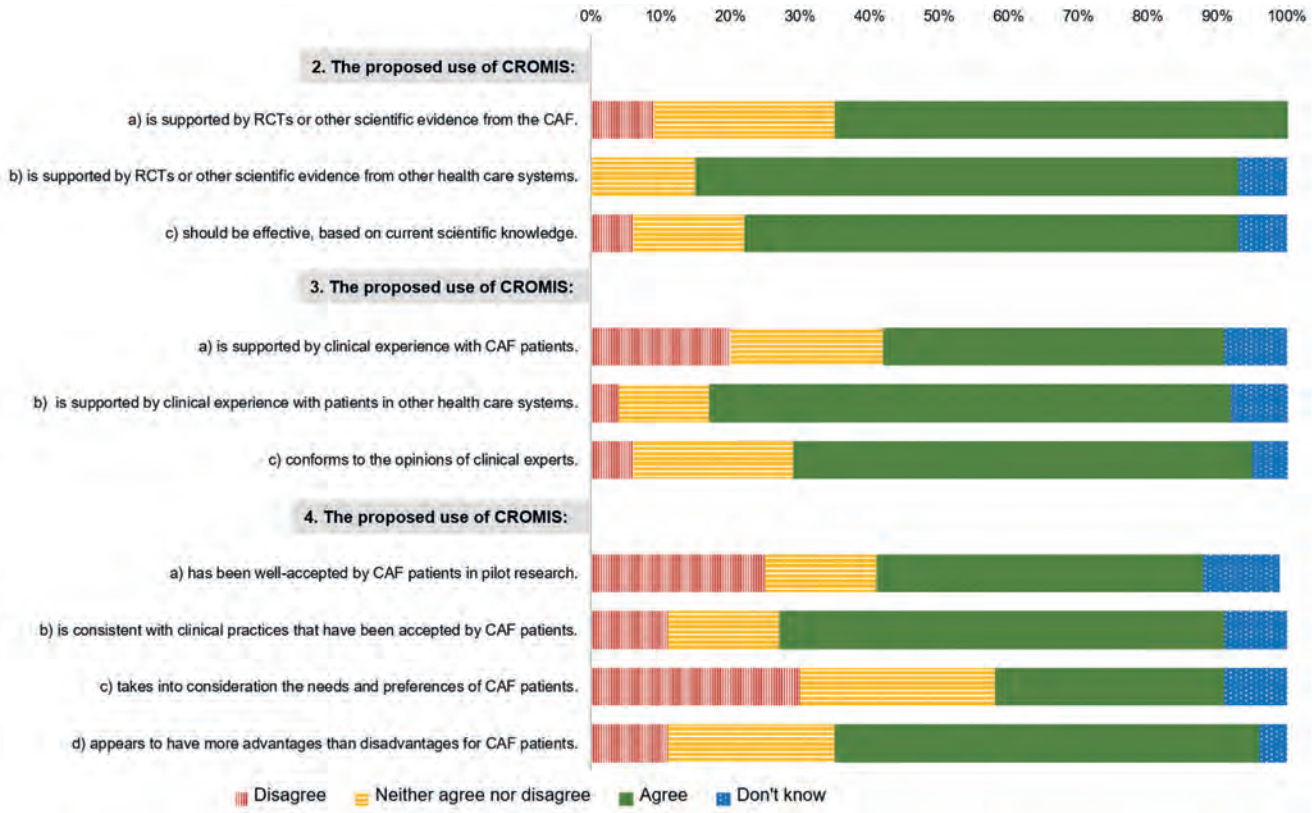

Figure 1. Proportion of responses for the Evidence subscales (2. research evidence; 3. clinical experience; 4. patient preferences)

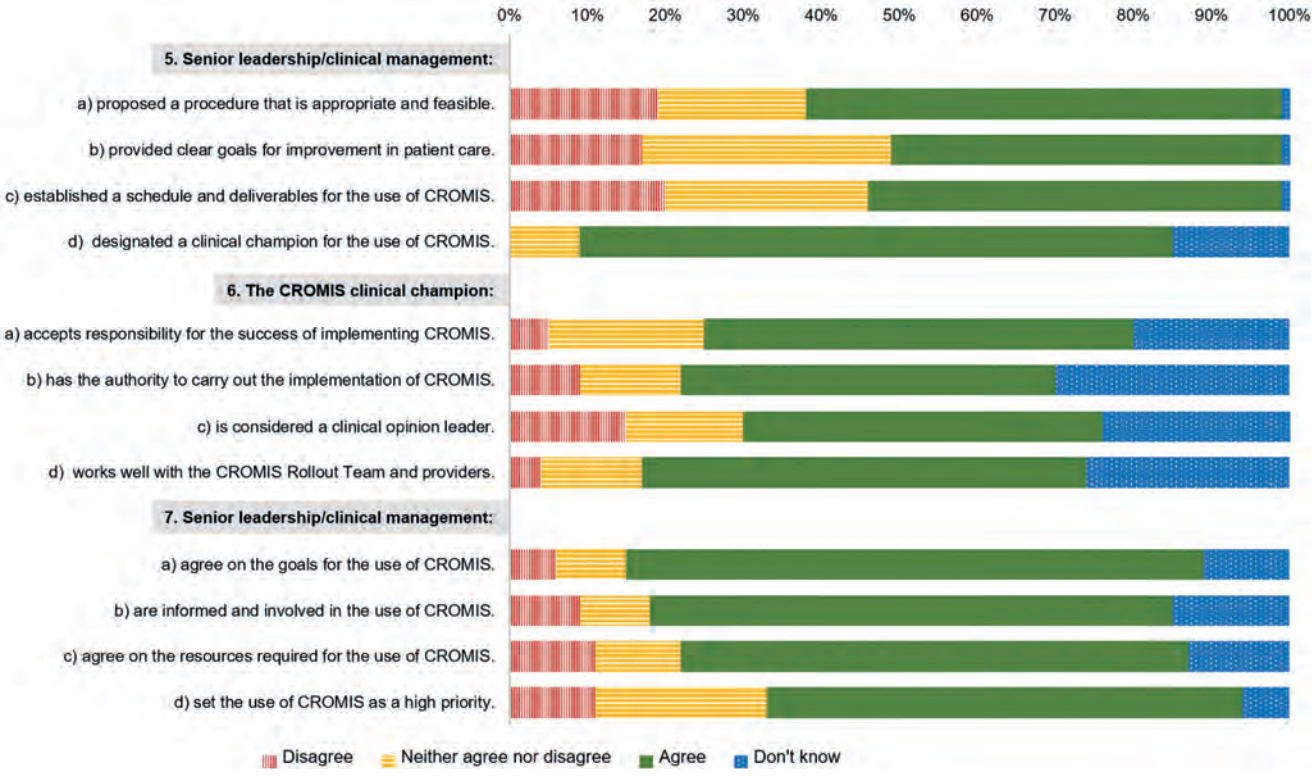

Figure 2. Proportion of responses for Facilitation subscales (5 and 7. senior leadership and management; 6. clinical champion characteristics)

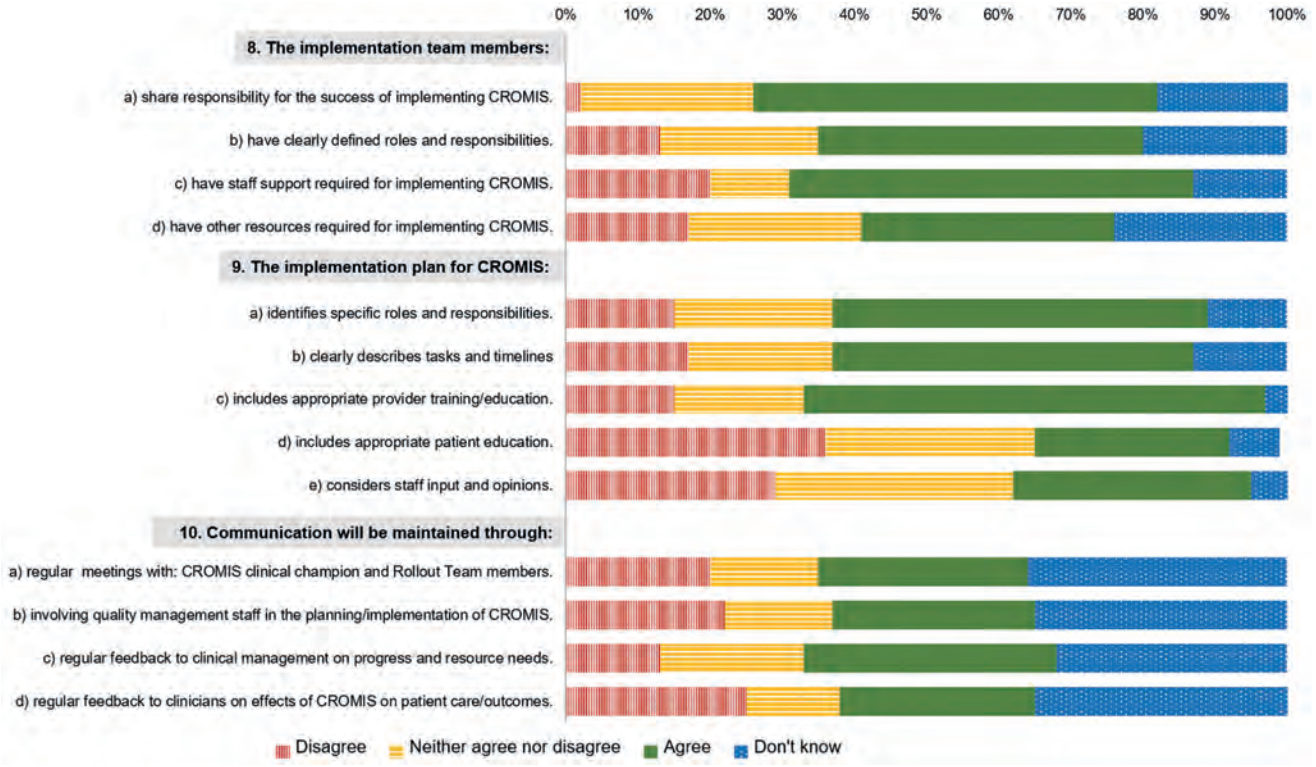

Figure 3. Proportion of responses for Facilitation subscales (8. implementation team roles; 9. implementation plan; 10. communication)

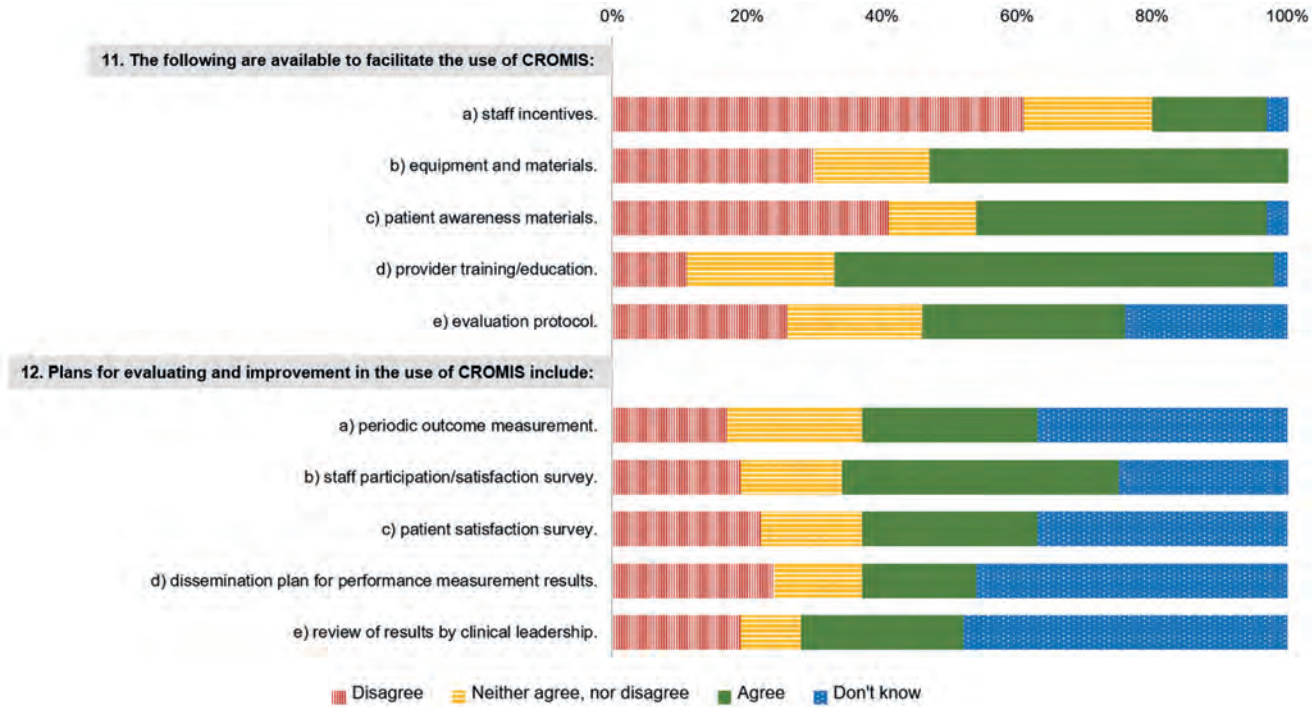

Figure 4. Proportion of responses for Facilitation subscales (11. implementation resources; 12. implementation evaluation).

of material to make patients themselves aware of CROMIS. Similarly, questions about facilitating the use of CROMIS and the plans for evaluating and improving its use also elicited uncertainty among respondents (26%-48%), such as the use of patient and staff satisfaction surveys (Figure 4). In particular, 48% reported not knowing whether clinical leaders would review CROMIS results.

DISCUSSION

Summary of findings and implications

Guided by elements of the PARIHS framework, this study examined organizational readiness for implementing CROMIS (i.e., an MBC system) among mental health providers at CF Health Services Centres. There is robust and consistent support for the use of MBC to objectively monitor treatment progress, benefiting both patient and provider.[2, 22] The results of this study demonstrate that, although opinions about and attitudes toward CROMIS are generally favourable in regard to the evidence base, benefits for patients, and the investment of senior leadership in CROMIS implementation, there are defined barriers to and unknowns in its execution.

In this study, respondents recognized the strength of the evidence from research and professional knowledge of CROMIS, which may encourage their use of it.[12] Indeed, Ross et al.[12] found that there was lower skepticism of the benefits of routine outcome measurement among clinicians who used CROMIS at VAC Operational Stress Injury clinics. However, this study revealed that several respondents disagreed or were ambivalent that CROMIS truly takes into consideration the needs and preferences of patients themselves. Helfrich and colleagues[20] expressed some concern about the psychometric properties of the Evidence subscale and alluded to inconsistencies in the literature about the extent to which patient experiences influence clinicians' level of confidence in a given practice.

Nonetheless, respondents signaled a possible disconnect between the underlying assumptions of CROMIS and what patients themselves might want or require, which could have an impact on their inclination to modify their practice. Although we cannot ignore that these providers operate under the overarching CF Health Services system, the growing interest in shared decision making in mental health care warrants a continued effort to understand how to increase patient involvement with CROMIS.[23] Indeed, the current findings also point to potential gaps in patient education. These gaps could be addressed at the management and clinical levels through targeted patient education tools and engagement strategies. Education is one of the characteristic activities encompassed by the facilitation element of the PARIHS framework. Akin to any broad-level implementation initiative, MBC requires coordination, communication, and awareness among a range of stakeholders, including patients.[15]

Mental health care providers are also critical stakeholders in CROMIS implementation. The findings suggest there may be a lack of ongoing support to sustain the implementation and evaluation of CROMIS, particularly as it pertains to communication and regular feedback regarding its effectiveness. Facilitation, as operationalized in the PARIHS framework, is explicitly responsive and interactive in nature. It is possible that even though education about CROMIS was provided to clarify goals and roles before launch, appropriate feedback mechanisms are not in place to foster sustainable implementation and improvement.[24] Still, there is evidence that providing health care providers with feedback on their adherence to clinical guidelines may not be sufficient.[25] In fact, studies have shown that health care providers who do not regularly use MBC perceive it as time consuming and difficult to use.[3, 12] In the current study, health care providers generally disagreed that staff incentives to facilitate CROMIS were available. As such, there may be a need to further explore the potential impact of incentives relating to time and energy in the context of health care delivery in the CAF. Moreover, there may be several moderating variables unique to each individual (e.g., confidence level, experience with and training in CROMIS, duration of employment at clinic) that could affect readiness for the implementation of CROMIS.

Last, the results point to some uncertainty surrounding the CROMIS clinical champion role and the champion's responsibilities. Clinical champions are meant to serve an important facilitative function in spearheading innovation efforts and in supporting and encouraging colleagues through the change process.[26, 27] Thus, it may be worth clarifying this role to all staff members in forthcoming CROMIS implementation endeavours by emphasizing their authority, commitment, and knowledge, as well as their capacity to liaise with the CROMIS Rollout Team. Doing so may prove valuable in identifying and minimizing potential barriers throughout the implementation and evaluation process.

Although these findings provide insight into the magnitude of potential facilitators of and barriers to

use of CROMIS, respondents' inclination to respond to various items either toward the midpoint of the Likert scale or "don't know" is also noteworthy. High frequencies for the latter have been reported using the ORCA.[28] Endorsement of the midpoint could indicate either that respondents were undecided or ambivalent about CROMIS or that they did not have a defined attitude regarding CROMIS (i.e., they were neutral), perhaps because of a lack of knowledge about — or experience in using — CROMIS. Others have argued that staff may lack knowledge about organizational processes that are not fully in place.[28] An alternative explanation may be that endorsement of the midpoint indicates low item readability or lack of perceived clarity.[29]

Limitations

Although this was among the first studies to examine barriers and facilitators to MBC in the context of mental health services delivery in the CAF, the participation rate was low. Lusk et al.[30] noted that, depending on the goal of the survey, the means of administration (e.g., mail or email), and the target population, the typical response rate for health professionals varies widely (i.e., from 16% to 91%). Still, the small sample precludes the generalizability of findings to all CAF mental health care providers. In particular, the response rate and, hence, representation of psychologists and psychiatrists in the study was low. This could reflect either a lack of support for CROMIS or a lack of connection to this change in their work, which may reflect underlying readiness concerns worthy of further examination.[31] Lack of interest and the burden of completing an online questionnaire may have contributed to low participation overall; however, the administration of the ORCA early in the implementation cycle may also have played a role, because mental health care providers may not have had sufficient experience with using CROMIS to develop an opinion about it. Because of the small sample size, it was also not possible to examine the psychometric properties of the ORCA in the CF Health Services Centre context. Although modifications to the wording and ordering of some of the items, including deletions, have been reported in other studies using the ORCA,[28,32] the impact of these changes on the validity of the current findings remains unknown.

Future directions

This study may have benefited from using the ORCA because of its theoretically grounded, standardized approach and low administration costs. However, the ORCA also has pitfalls that are common in survey research, including its length and the use of closed-ended questions, which may not capture the full breadth of implementation barriers. This latter point emphasizes the need for more qualitative research to further explore some of the leading organizational obstacles that can influence the implementation of MBC. To further support the implementation of CROMIS across CF Health Services Centres, more recent endeavours have included following up with CAF mental health staff and other stakeholders through focus groups about their experiences with CROMIS. It is expected that these findings, guided in part by elements of the theoretical domains framework,[33] will help identify additional barriers to and enablers of the uptake of CROMIS, such as skills, professional roles, and technological issues.

There has been a proliferation of research in the field of implementation science, with more than 100 theories in use across various disciplines.[34] Founded in action theory, normalization process theory (NPT) provides an alternative framework for understanding how a new intervention becomes part of normal practice.[35] Unlike the PARIHS framework, which prioritizes attitudes and beliefs, NPT places more emphasis on what people do, including their engagement and collective action. Given some of the limitations of the ORCA, it may be worth exploring whether other tools would be more suitable to assess implementation drivers in the context of CROMIS. For example, grounded in NPT, the NoMAD tool is shorter than the ORCA and more granular in content (e.g., "I can easily integrate [the intervention] into my existing work").[36] Still, it is only one of many tools available, and the appropriate selection of tools and theories in implementation research is recognized as an important challenge.[34] To aid in selecting an appropriate, valid, and reliable measure of organizational readiness for change, researchers have even developed an online decision support tool.[37,38] Hence, it may also be worth exploring this decision aid to inform the design of future implementation studies within CF Health Services clinics to track early adoption issues through to continuous performance metrics.

Conclusion

There is a growing evidence base in favour of using MBC to improve clinical outcomes in mental health care.[2] This carries important implications for Regular Forces members of the CAF, who tend to have higher rates of anxiety and depression symptoms than the general population.[39] The findings of this study, and of other studies, highlight

various organizational readiness factors that can influence the implementation of patient-centred MBC systems, such as CROMIS. Finding ways to address these barriers should lead to improvements in mental health care and confer more timely recommendations and improved outcomes for CAF members.[11,40]

REFERENCES

1. Lambert MJ, Harmon C, Slade K, et al. Providing feedback to psychotherapists on their patients' progress: clinical results and practice suggestions. J Clin Psychol. 2005;61(2):165–74. https://doi.org/10.1002/jclp.20113. Medline:15609358
2. Fortney JC, Unutzer J, Wrenn G, et al. A tipping point for measurement-based care. Psychiatr Serv. 2017;68(2):179–88. https://doi.org/10.1176/appi.ps.201500439. Medline:27582237
3. Scott K, Lewis CC. Using measurement-based care to enhance any treatment. Cogn Behav Pract. 2015;22(1):49–59. https://doi.org/10.1016/j.cbpra.2014.01.010. Medline:27330267
4. Shimokawa K, Lambert MJ, Smart DW. Enhancing treatment outcome of patients at risk of treatment failure: meta-analytic and mega-analytic review of a psychotherapy quality assurance system. J Consult Clin Psychol. 2010;78(3):298–311. https://doi.org/10.1037/a0019247. Medline:20515206
5. Krageloh CU, Czuba KJ, Billington DR, et al. Using feedback from patient-reported outcome measures in mental health services: a scoping study and typology. Psychiatr Serv. 2015;66(3):224–41. https://doi.org/10.1176/appi.ps.201400141. Medline:25727110
6. Steinfeld B, Franklin A, Mercer B, et al. Progress monitoring in an integrated health care system: tracking behavioral health vital signs. Adm Policy Ment Health. 2016;43(3):369–78. https://doi.org/10.1007/s10488-015-0648-7. Medline:25840521
7. Katon WJ, Lin EH, Von Korff M, et al. Collaborative care for patients with depression and chronic illnesses. N Engl J Med. 2010;363(27):2611–20. https://doi.org/10.1056/nejmoa1003955. Medline:21190455
8. Lambert MJ. Prevention of treatment failure: the use of measuring, monitoring, and feedback in clinical practice. Washington (DC): American Psychological Association; 2010.
9. Valenstein M, Adler DA, Berlant J, et al. Implementing standardized assessments in clinical care: now's the time. Psychiatr Serv. 2009;60(10):1372–5. https://doi.org/10.1176/ps.2009.60.10.1372. Medline:19797378
10. Mellor-Clark J, Cross S, Macdonald J, et al. Leading horses to water: lessons from a decade of helping psychological therapy services use routine outcome measurement to improve practice. Adm Policy Ment Health. 2016;43(3):279–85. https://doi.org/10.1007/s10488-014-0587-8. Medline:25179755
11. Canadian Armed Forces and Veterans Affairs Canada. Canadian Armed Forces and Veterans Affairs Canada joint suicide prevention strategy [Internet]. Ottawa: Canadian Armed Forces and Veterans Affairs Canada; 2017 [cited 2020 Feb 21]. Available from: https://www.canada.ca/content/dam/dnd-mdn/documents/reports/2017/caf-vac-joint-suicide-prevention-strategy.pdf.
12. Ross DF, Ionita G, Stirman SW. System-wide implementation of routine outcome monitoring and measurement feedback system in a national network of operational stress injury clinics. Adm Policy Ment Health. 2016;43(6):927–44. https://doi.org/10.1007/s10488-016-0749-y. Medline:27444375
13. Lambert MJ. Progress feedback and the OQ-system: the past and the future. Psychotherapy (Chic). 2015;52(4):381–90. https://doi.org/10.1037/pst0000027. Medline:26641368
14. Goldstein DA, Meyers K, Endsley M, et al. Measurement-based care implementation in a Veterans Affairs primary care-mental health integration program. Psychol Serv. 2019;17(3):323–31. https://doi.org/10.1037/ser0000370. Medline:31318239
15. Boswell JF, Kraus DR, Miller SD, et al. Implementing routine outcome monitoring in clinical practice: benefits, challenges, and solutions. Psychother Res. 2015;25(1):6–19. https://doi.org/10.1080/10503307.2013.817696. Medline:23885809
16. Kitson A, Harvey G, McCormack B. Enabling the implementation of evidence based practice: a conceptual framework. Qual Health Care. 1998;7(3):149–58. https://doi.org/10.1136/qshc.7.3.149. Medline:10185141
17. Rycroft-Malone J, Harvey G, Kitson A, et al. Getting evidence into practice: ingredients for change. Nurs Stand. 2002;16(37):38–43. https://doi.org/10.7748/ns2002.05.16.37.38.c3201. Medline:12068568
18. Wray LA, Ritchie MJ, Oslin DW, et al. Enhancing implementation of measurement-based mental health care in primary care: a mixed-methods randomized effectiveness evaluation of implementation facilitation. BMC Health Serv Res. 2018;18(1):753. https://doi.org/10.1186/s12913-018-3493-z. Medline:30285718
19. Rycroft-Malone J. The PARIHS framework: a framework for guiding the implementation of evidence-based practice. J Nurs Care Qual. 2004;19(4):297–304. https://doi.org/10.1097/00001786-200410000-00002. Medline:15535533
20. Helfrich CD, Li YF, Sharp ND, et al. Organizational Readiness to Change Assessment (ORCA): development of an instrument based on the Promoting Action on Research in Health Services (PARIHS)

framework. Implement Sci. 2009;4(1):38. https://doi.org/10.1186/1748-5908-4-38. Medline:19594942
21. Guerin E, Lee JE. Formative assessment of a new client-reported mental health outcome monitoring information system: initial findings of an organizational readiness assessment tool. Report No. DRDC-RDDC-2019-L186. Ottawa: Defence Research and Development Canada; 2019.
22. Greenhalgh J. The applications of PROs in clinical practice: what are they, do they work, and why? Qual Life Res. 2009;18(1):115–23. https://doi.org/10.1007/s11136-008-9430-6. Medline:19105048
23. Langer DA, Mooney TK, Wills CE. Shared decision-making for treatment planning in mental health care: theory, evidence, and tools. Oxford (UK): Oxford University Press; 2015.
24. Kauth MR, Sullivan G, Cully J, et al. Facilitating practice changes in mental health clinics: a guide for implementation development in health care systems. Psychol Serv. 2011;8(1):36–47. https://doi.org/10.1037/a0022250.
25. Hysong SJ, Best RG, Pugh JA. Audit and feedback and clinical practice guideline adherence: making feedback actionable. Implement Sci. 2006;1(1):9. https://doi.org/10.1186/1748-5908-1-9. Medline:16722539
26. Dollar KM, Kirchner JE, DePhilippis D, et al. Steps for implementing measurement-based care: implementation planning guide development and use in quality improvement. Psychol Serv. 2019;17(3):247–61. https://doi.org/10.1037/ser0000368. Medline:31318240
27. Williams I. Organizational readiness for innovation in health care: some lessons from the recent literature. Health Serv Manage Res. 2011;24(4):213–8. https://doi.org/10.1258/hsmr.2011.011014. Medline:22040949
28. Harris M, Jones P, Heartfield M, et al. Changing practice to support self-management and recovery in mental illness: application of an implementation model. Aust J Prim Health. 2015;21(3):279–85. https://doi.org/10.1071/py13103. Medline:24685120
29. Velez P, Ashworth SD. The impact of item readability on the endorsement of the midpoint response in surveys. Surv Res Methods. 2007;1(2):69–74.
30. Lusk C, Delclos GL, Burau K, et al. Mail versus Internet surveys: determinants of method of response preferences among health professionals. Eval Health Prof. 2007;30(2):186–201. https://doi.org/10.1177/0163278707300634. Medline:17476030
31. Abrahamsen C, Norgaard B, Draborg E. Health care professionals' readiness for an interprofessional orthogeriatric unit: a cross-sectional survey. Int J Orthop Trauma Nurs. 2017;26:18–23. https://doi.org/10.1016/j.ijotn.2016.10.002. Medline:28259736
32. Noe TD, Kaufman CE, Kaufmann LJ, et al. Providing culturally competent services for American Indian and Alaska Native Veterans to reduce health care disparities. Am J Public Health. 2014;104(Suppl 4):S548–54. https://doi.org/10.2105/ajph.2014.302140. Medline:25100420
33. Cane J, O'Connor D, Michie S. Validation of the theoretical domains framework for use in behaviour change and implementation research. Implement Sci. 2012;7(1):37. https://doi.org/10.1186/1748-5908-7-37. Medline:22530986
34. Birken SA, Powell BJ, Shea CM, et al. Criteria for selecting implementation science theories and frameworks: results from an international survey. Implement Sci. 2017;12(1):124. https://doi.org/10.1186/s13012-017-0656-y. Medline:29084566
35. May C, Finch T. Implementing, embedding, and integrating practices: an outline of normalization process theory. Sociology. 2009;43(3):535–54. https://doi.org/10.1177/0038038509103208.
36. Finch TL, Girling M, May CR, et al. Improving the normalization of complex interventions: part 2 – validation of the NoMAD instrument for assessing implementation work based on normalization process theory (NPT). BMC Med Res Methodol. 2018;18(1):135. https://doi.org/10.1186/s12874-018-0590-y. Medline:30442093
37. Khan S, Timmings C, Moore JE, et al. The development of an online decision support tool for organizational readiness for change. Implement Sci. 2014;9(1):56. https://doi.org/10.1186/1748-5908-9-56. Medline:24886072
38. Timmings C, Khan S, Moore JE, et al. Ready, set, change! Development and usability testing of an online readiness for change decision support tool for healthcare organizations. BMC Med Inform Decis Mak. 2016;16(1):24. https://doi.org/10.1186/s12911-016-0262-y. Medline:26907792
39. Pearson C, Zamorski M, Janz T. Mental health of the Canadian Armed Forces. Ottawa: Statistics Canada; 2014.
40. Harding KJ, Rush AJ, Arbuckle M, et al. Measurement-based care in psychiatric practice: a policy framework for implementation. J Clin Psychiatry. 2011;72(8):1136–43. https://doi.org/10.4088/jcp.10r06282whi. Medline:21295000

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COMPETING INTERESTS

The authors have nothing to disclose.

CONTRIBUTORS

Eva Guérin aided in the adaptation of the survey, administered the survey, analyzed the results, and drafted the manuscript. Eva Guérin, Jennifer E.C. Lee, and Bryan Garber all took part in the interpretation of findings. Jennifer E.C. Lee and Bryan Garber helped conceive the design of the study and select the research questions and made significant contributions to revising the manuscript. All authors approved the final version submitted for publication.

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Identifying release-related precursors to suicide among Canadian Veterans between 1976 and 2012

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ABSTRACT

Introduction: Veteran suicide is a top public health concern, and researching and preventing suicides is a priority for Veterans Affairs Canada. Over the period 1976 to 2012, Canadian Veterans had a significantly higher risk of suicide than did the Canadian general population. This article examines risk factors at release from the Canadian military to inform suicide prevention efforts. **Methods:** The Veteran Suicide Mortality Study examined suicide deaths in a cohort of more than 220,000 Canadian Veterans released from the military between 1976 and 2012. Military data from the Department of National Defence were linked to mortality records at Statistics Canada. Cox proportional models, hazard ratios, and hazard function graphs were used to identify risk factors at release and suicide mortality risk by years since release. **Results:** For men, increased suicide risk was associated with Junior Non-Commissioned Member (NCM) rank, and younger age at release. For male Junior NCMs, the risk of suicide death peaked around four years after release from the military, then decreased to a lower risk that remained stable 10-30 years after release. For women, increased suicide risk was associated with NCM rank, and the suicide risk was lowest in the early years after release and peaked around 20 years after. **Discussion:** These findings suggest that the risk of suicide varies across subgroups of the Veteran population and extends beyond the first few years after release from the Canadian Armed Forces. These findings provide evidence to ensure prevention and treatment efforts take into account different risk profiles for male and female Veterans.

Key words: cohort study, Cox model, data linkage, military, NCM, suicide, suicide mortality risk, survival analysis, VAC, Veteran, Veterans Affairs Canada, Veteran Suicide Mortality Study, VSMS

RÉSUMÉ

Introduction : Le suicide des vétéran(e)s est une préoccupation de santé publique importante, et la prévention du suicide est une priorité pour Anciens Combattants Canada. Les vétéran(e)s canadiens présentaient un risque de suicide nettement plus élevé que la population générale canadienne entre 1976 et 2012. Cet article porte sur les facteurs de risque à la libération de l'armée canadienne afin d'éclairer les efforts de prévention du suicide. **Méthodologie :** L'Étude sur la mortalité par suicide chez les vétéran(e)s s'est penchée sur les décès par suicide d'une cohorte de plus de 220 000 vétéran(e)s canadiens libérés des forces armées entre 1976 et 2012. Les données militaires du ministère de la Défense nationale étaient liées aux registres des décès de Statistique Canada. Les modèles à risque proportionnels de Cox, les rapports de risque et les graphiques de fonction du risque ont permis de déterminer les facteurs de risque à la libération et le risque de mortalité par suicide au fil des ans depuis la libération. **Résultats :** Chez les hommes, un risque accru de suicide était lié aux militaires du rang subalternes et à un âge plus jeune à la libération. Chez les militaires du rang subalternes de sexe masculin, le risque de décès par suicide a atteint son point culminant quatre ans après la libération de l'armée, puis le risque a diminué pour se stabiliser de dix à 30 ans après la libération. Chez les femmes, le risque accru de suicide était lié aux militaires de rang subalternes. Le risque de suicide était plus faible dans les quelques années suivant la libération pour atteindre son point culminant au bout d'environ 20 ans. **Discussion :** Selon ces observations, le risque de suicide varie entre les sous-groupes de la population de vétéran(e)s et ne se limite pas aux quelques premières années après la libération des Forces armées canadiennes. Ces observations fournissent des données probantes pour que les efforts de prévention et de traitement tiennent compte des divers profils de risque des vétéran(e)s de sexe masculin et féminin.

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Mots-clés : ACC, analyse de survie, Anciens Combattants Canada, couplage des données, étude de cohorte, ÉMSV, Étude sur la mortalité par suicide chez les vétérans/vétéranes, militaire, militaires du rang, modèle de Cox, risque de mortalité par suicide, suicide, vétéran, vétéranes

LAY SUMMARY

The Veteran Suicide Mortality Study describes the risk of death by suicide for Canadian Veterans using data linkage at Statistics Canada. The study includes Veterans released with Regular Force or Reserve Force Class C service over the period 1976-2012. Both male and female Veterans had higher risk of suicide if they released at non-officer ranks. For men, the risk of suicide death peaked around four years after release from the military. For women, the risk of suicide death peaked around 20 years after release. This study provides information for the timing of prevention efforts.

INTRODUCTION

The influence of Veteran suicide deaths is far reaching. It affects families, communities, and the broader Canadian society. In response, suicide surveillance, research, and prevention are public health priorities for Veterans Affairs Canada (VAC).[1] Unfortunately, there are many barriers to providing the information required to support this effort because VAC is not able to access death records for its clients and is not able to identify Veterans who are not clients. Many study barriers were overcome by recent data linkage that required the collaboration of VAC, the Department of National Defence (DND), and Statistics Canada (STC) to initiate the Veteran Suicide Mortality Study (VSMS).[2]

The first VSMS results quantified the risk of suicide in the Veteran population compared with that for the general population of Canadians and examined trends over time.[2, 3] Male Veterans were found to have an overall 1.4 times higher risk of dying by suicide than their age-standardized Canadian counterparts (using Standardized Mortality Ratios). Female Veterans had an overall 1.8 times higher risk of dying by suicide than their age-standardized Canadian counterparts. When examining trends over time, the risk of suicide for both sexes remained higher than that for age-standardized Canadians and relatively unchanged over the four decades studied.

This article builds on these findings by using the same VSMS cohort that represents the largest and most representative suicide mortality study of Canadian Veterans. The objective was to examine release-related risk factors for suicide among Canadian Veterans, including age at release, rank at release, military component, and time since release.

METHODS

The VSMS cohort used for this study included 220,734 Canadian Veterans, a census of all who released from the Canadian Armed Forces between 1976 and 2012. The use of DND administrative pay data ensured that the number of records is complete.[2] However, this source provides a limited number of variables for all Veterans. These variables included information on date of release, rank at release (officer, Senior Non-Commissioned Member [NCM], Junior NCM), age at release, sex, and component (Regular Force or Class C Reserve Force without Regular Force service). Environment (army, navy, air force) and years of service were missing for more than 35% of the records; therefore, these variables were not included in this analysis. The cohort was linked to death records from the provinces and territories maintained at STC, which included date and cause of death. Suicide deaths were identified via *International Classification of Diseases* revisions 8 and 9 codes E950–E959 and revision 10 codes X60–X84 and Y87.0.[4, 5, 6] This definition does not include deaths of undetermined intent, which is consistent with STC's definition of suicide.[7]

To examine the risk factors for suicide among Canadian Veterans, the authors opted to build Cox proportional hazard models (CPHM). Although CPHMs do not account for competing hazards, they are commonly used in the context of Veteran suicide mortality,[8–11] which facilitates the comparison between findings.

CPHMs were developed separately for men and women because the combined model violated the proportional hazards assumption ($p = 0.0021$). This was expected, given prior published evidence of an over-representation of men in the cohort (89% of the cohort),[2] combined with heterogeneous suicide characteristics and trends by sex (e.g., the male Veteran suicide rate being three times higher than the female Veteran suicide rate).

The sex-specific models examined the risk of suicide over time since release, controlled for component, rank, and age at release. Hazard function graphs were generated from the multivariable models, and hazard ratios (HRs) were calculated with 95% confidence intervals

(CIs). The models' goodness of fit was considered appropriate when the distribution of Cox–Snell residuals was similar to the Nelson–Aalen cumulative hazard function.[11] Proportionality was assessed via Schoenfeld and scaled Schoenfeld residuals, and proportionality was assumed for the $p > 0.10$ global proportional hazards test.

In compliance with STC privacy regulations, all risk factor categories and rates were collapsed and presented in age groups, or time period categories, that ensured minimum cell counts of 10. This also resulted in the smoothing of hazard function graphs. Other publications provide additional details on the methods.[12,13] The VSMS study protocol is part of the Canadian Forces Cancer and Mortality Study II and approved by an external institutional review board (QUORUM Review Institutional Review Board, reference no. QR31460CDN/1).

RESULTS

Cohort description

The VSMS cohort accumulated 220,734 Canadian Veterans who provided 4.6 million person-years of observation over the 37-year study period. Veterans were predominately (89%) male (Table 1). Class C Reserve Force service without Regular Force service accounted for 5% of the male Veterans in the cohort and 8% of the female Veterans. Among both sexes, the majority were released as NCMs (82%), and more than a third (37%) released from the military before age 25 years. Suicide deaths were rare; fewer than 1% of Veterans in the cohort died by suicide over the 37-year study period.

Male Veterans

Among male Veterans, rank at release, age at release, and component all influenced the risk of dying by suicide in the univariate models. The younger a male Veteran was at release, the greater the risk of dying by suicide. However, in the adjusted multivariable model, component was not significant, whereas rank and age at release remained significant (see Table 2). Junior NCMs were 1.9 times more likely to die by suicide than those who released as junior officers while controlling for age at release.

The adjusted risk of suicide death remained generally constant for male officers and senior NCMs (Figure 1). For junior NCMs, the risk of suicide death peaked around four years after release from the military, then decreased to a lower risk that remained stable 10-30 years after release.

Table 1. Characteristics of Canadian Veterans released from 1976 to 2012 (N = 220,734)

Characteristic	*n*		%
	Men	Women	
Age at release			
<25	72,319	9,915	37
25–34	37,768	13,570	63
35–44	39,613		
≥45	47,549		
Rank at release			
Jr NCM	117,133	18,655	82
Sr NCM	44,264		
Jr Officer	24,016	4,808	18
Sr Officer	11,557		
Missing	279	22	
Component			
Reg Service	187,555	21,500	95
Res C Service Only	9,694	1,985	5
Total	197,249	23,485	100
Release year			
1976–1987	87,520	8,578	44
1988–1999	60,465	7,479	31
2000–2012	49,264	7,428	26
Suicide deaths	1,421	65	0.7

Notes: NCM = Non-Commissioned Member.

Female Veterans

Among female Veterans, NCMs were three times more likely to die by suicide than those who released as officers, while controlling for age at release and component (Table 3). Age at release and component were not significantly associated with increased suicide risk.

The risk of suicide death, controlling for all other factors, increased only marginally over time for female officers (Figure 2). For female NCMs, the risk of suicide death was lowest in the early years after release and peaked around 20 years. The trend beyond 20 years after military release should be interpreted with caution because of small numbers.

DISCUSSION

Summary of findings

Researching Veteran suicide is a priority for VAC and the government of Canada, and studies such as VSMS continue to provide a better understanding of suicide trends and risk factors among the Canadian Veteran

Table 2. Hazard Ratio for Suicide of Male Veterans, Canada 1976–2012, adjusted and unadjusted Cox model*

Variable	Univariate estimates			Multivariable-adjusted estimates		
	HR	95% CI	*p*-value	HR	95% CI	*p*-value
Age at release, y						
<25	3.86	3.15–4.73	<0.001	2.82	2.17–3.67	<0.001
25–34	2.74	2.19–3.44	<0.001	2.13	1.61–2.81	<0.001
35–44	1.68	1.31–2.15	<0.001	1.45	1.12–1.87	0.005
≥45 (Ref.)						
Rank at release						
Jr. NCM	2.09	1.72–2.54	<0.001	1.90	1.56–2.31	<0.001
Sr. NCM	0.74	0.57–0.95	0.019	1.32	0.98–1.77	0.069
Jr. Officer (Ref.)						
Sr Officer	0.47	0.29–0.76	0.002	0.91	0.55–1.51	0.703
Component Regular Force (Ref.)						
Class C Reserve Force	1.27	1.03–1.58	0.026	0.95	0.76–1.18	0.634

Notes: HR = hazard ratio; CI = confidence interval; Ref. = reference; NCM = Non-Commissioned Member.

*Goodness of fit appropriate, proportionality assumed (p = 0.2958).

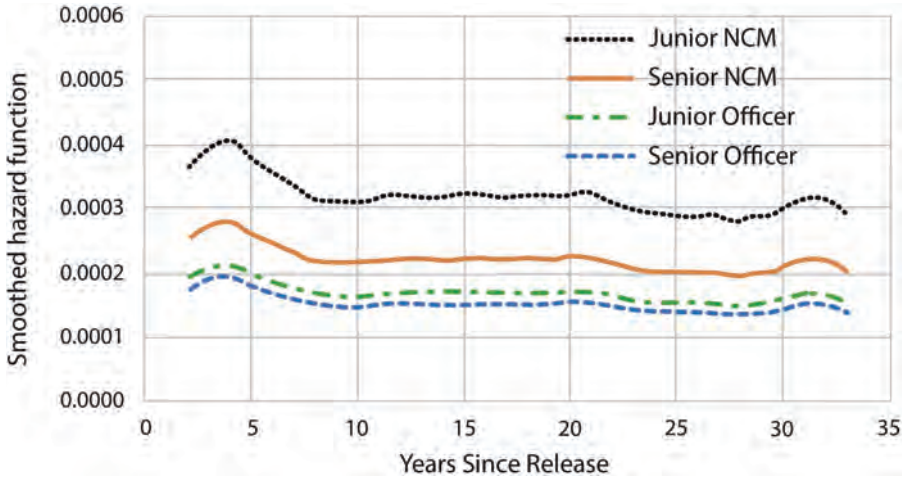

Figure 1. Male Veteran risk of suicide death over time since release, by military rank

Notes: NCM = Non-Commissioned Member.

population. Although earlier VSMS findings have established the consistently higher risk of suicide death among Canadian Veterans than their age-standardized Canadian counterparts,[2,3] these findings provide more detail on the characteristics of Veterans who were at increased risk and the timing of their increased suicide risk.

To the best of the authors' knowledge, this is the first study to publish the risk of suicide for female Veterans by time since release and age at release, in Canada or elsewhere. Female Veterans were at lowest risk of suicide death in the early years after release and at greatest risk around 20 years afterward. Female Veterans had similar risk of suicide death, regardless of their age at release. This was consistent with the findings that female Veterans had similar risk regardless of age at death.[12]

In contrast, male Veterans' greatest risk of suicide occurred approximately four years after release, then decreased to a lower risk that remained stable 10-30 years after release. This is consistent with trends reported in the United Kingdom and the United

Table 3. Hazard ratio for suicide of female Veterans, Canada 1976–2012, adjusted and unadjusted Cox model*

Variable	Univariate estimates				Multivariable-adjusted estimates			
	HR	95% CI		*p*-value	HR	95% CI		*p*-value
Age at release								
<25	1.6	0.93	2.77	0.091	1.44	0.82	2.5	0.201
≥25 (Ref.)								
Rank at release								
NCM	3.3	1.2	9.1	0.021	3.05	1.1	8.46	0.032
Officer (Ref.)								
Component Regular Force (Ref.)								
Class C Reserve Force	1.12	0.51	2.45	0.783	1.01	0.46	2.23	0.973

Notes: HR = hazard ratio; CI = confidence interval; Ref. = reference; NCM = Non-Commissioned Member.

*Goodness of fit appropriate, proportionality assumed (p = 0.8141).

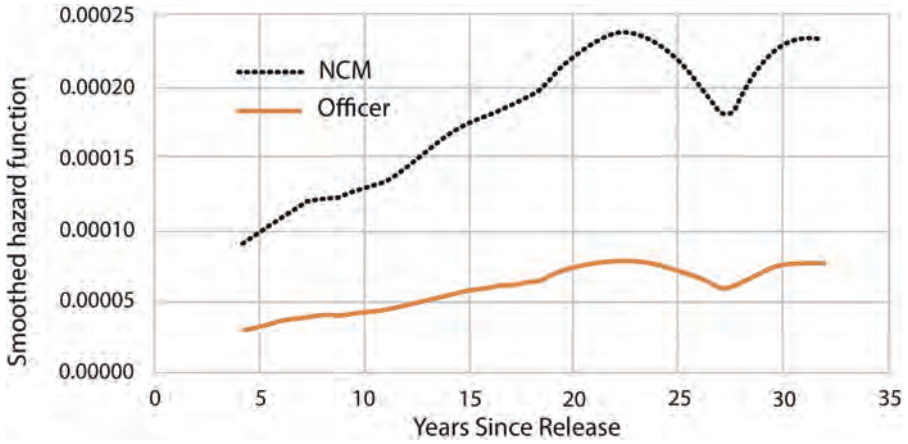

Figure 2. Female Veteran risk of suicide death over time since release, by military rank

Notes: NCM = Non-Commissioned Member.

States.[14,15] By 20 years after release, the suicide rate among male Veterans reduced to Canadian male levels.[12] Male Veterans also had an age trend that contrasted with that of female Veterans. Male Veterans who released before age 25 years had the highest risk of suicide death, and the risk decreased with increasing age. This was consistent with trends in the United Kingdom,[14] although those were for both sexes combined. In addition, this finding aligned with decreased suicide risk with increasing age at death.[2] The effect of age also explained the contradictory findings in a smaller study of Ontario Veterans that under-represented those who released before age 25 years.[16]

The risk of suicide was greatest among those who were junior NCMs at release for men and among those who were NCMs for women. The significance of rank persisted when the models controlled for age at release. Similar studies in Australia,[17] the United Kingdom,[14] and the United States[18] found that officers had significantly lower risk and rates of suicide than their non-commissioned counterparts. Rank at release may serve as a proxy for length of service; however, senior officers with more years of service than junior officers had statistically similar risks of suicide. The higher risk of suicide for Veterans who release at NCM ranks than as officers is similar to the pattern with other characteristics, such as their higher rates of mental disorders, suicide ideation, dissatisfaction with finances, and weak community belonging.[19] Compared with officers, serving military at NCM ranks also had higher rates of mental disorders, but similar rates of suicide ideation.[20] Differences in sociodemographic composition and history of childhood

trauma partially account for suicide ideation rates in the serving military,[21] and this may contribute to the higher risk of suicide for NCM ranks at release compared with officers.

Among both male and female Veterans, Regular Force and Class C Reserve Force service had similar risk of suicide. This was consistent with suicide studies of serving and released military personnel from Australia and the United States.[17,18] Canadian full-time Reserve Force Veterans (predominantly Class C) also had other similar characteristics as Regular Force Veterans, using measures of self-rated health, chronic condition diagnoses, and difficult adjustment to civilian life.[22] Future analyses will combine these components to increase statistical power.

Limitations and strengths

The major limitation of this study is that VSMS was only able to examine deaths by suicide; few military characteristics were available, and those that were available described the time point at release from the military. No data were available to describe Veterans' life before service, during service, or after service. The risk factors identified in this study describe groups of Veterans that are too broad to be used for screening or prediction of suicide deaths. However, the complete ascertainment of Canadian Veterans, regardless of age or years of service, was confirmed by the use of DND administrative pay data to create the longest time period published to study Veteran suicide deaths — nearly 40 years. The longitudinal design of this study ensured that the risk factors preceded the final outcome of suicide mortality.

Conclusion and implications

These findings highlight that suicide prevention efforts must not focus only on the initial military-to-civilian transition period and that support for Veterans may be required for many years, or decades, after release. Female Veterans exhibit very different suicide patterns from their male counterparts by age and years since release. Suicide prevention strategies, interventions, and treatments need to take into account the different risk profiles of male and female Veterans and the vulnerability of Veterans who release at NCM ranks. VSMS findings should be considered in conjunction with other research on suicidality. There is a broad literature on suicide, beyond the scope of this study, that can provide some direction for intervention efforts. VAC will continue to work with DND to examine suicidality and related mental health issues before service, during service, and after the transition to life after service, using a life course approach.[23]

REFERENCES

1. Canadian Armed Forces, Veterans Affairs Canada. Canadian Armed Forces and Veterans Affairs Canada joint suicide prevention strategy [Internet]. Ottawa: Canadian Armed Forces and Veterans Affairs Canada; 2017 [cited 2020 Aug 4]. Available from: https://www.canada.ca/content/dam/dnd-mdn/documents/reports/2017/caf-vac-joint-suicide-prevention-strategy.pdf/.
2. Simkus K, VanTil L, Pedlar D. 2017 Veteran suicide mortality study: 1976 to 2012. Charlottetown (PE): Veterans Affairs Canada, Research Directorate; 2017 [cited 2020 Aug 4]. Available from: http://www.publications.gc.ca/pub?id=9.847961&sl=0.
3. VanTil LD, Simkus K, Rolland-Harris E, et al. Veteran suicide mortality in Canada from 1976 to 2012. J Mil Veteran Fam Health. 2018;4(2):110–16. https://doi.org/10.3138/jmvfh.2017-0045.
4. International classification of diseases, revision 8. Geneva: World Health Organization; 1965.
5. International classification of diseases, ninth revision. Geneva: World Health Organization; 1978.
6. International statistical classification of diseases and related health problems 10th revision. Geneva: World Health Organization; 2016.
7. Navaneelan T. Suicide rates: an overview [Internet]. Ottawa: Statistics Canada; 2016 [cited 2020 Aug 4]. Available from: https://www.statcan.gc.ca/pub/82-624-x/2012001/article/11696-eng.htm.
8. Bergman BP, Mackay DF, Smith DJ, et al. Suicide in Scottish military Veterans: a 30-year retrospective cohort study. Occup Med. 2017;67(5):350–5. https://doi.org/10.1093/occmed/kqx047. Medline:28486642
9. Kang HK, Bullman TA, Smolenski DJ, et al. Suicide risk among 1.3 million Veterans who were on active duty during the Iraq and Afghanistan wars. Annals Epi. 2015;25(2):96–100. https://doi.org/10.1016/j.annepidem.2014.11.020. Medline:25533155
10. Kaplan MS, Huguet N, McFarland BH, et al. Suicide among male Veterans: a prospective population-based study. J Epi Comm Health. 2007;61(7):619–24. https://doi.org/10.1136/jech.2006.054346. Medline:17568055
11. Miller M, Barber C, Azrael D, et al. Suicide among US Veterans: a prospective study of 500,000 middle-aged and elderly men. Am J Epi. 2009;170(4):494–500. https://doi.org/10.1093/aje/kwp164. Medline:19584133

12. Simkus K, VanTil L. 2018 Veteran suicide mortality study: identifying risk groups at release [Internet]. Charlottetown (PE): Veterans Affairs Canada, Research Directorate; 2018 [cited 2020 Aug 4]. Available from: http://publications.gc.ca/pub?id=9.865598&sl=0.
13. Rolland-Harris E, VanTil L, Zamorski M, et al. The Canadian Forces Cancer and Mortality Study II: a longitudinal record-linkage study protocol. Can Med Assoc J. 2018;6(4):E619–27. https://doi.org/10.9778/cmajo.20170125. Medline:30530722
14. Kapur N, While D, Blatchley N, et al. Suicide after leaving the UK Armed Forces: a cohort study. PLoS Med. 2009;6(3):e1000026. https://doi.org/10.1371/journal.pmed.1000026. Medline:19260757
15. Shen Y, Cunha JM, Williams TV. Time-varying associations of suicide with deployments, mental health conditions, and stressful life events among current and former US military personnel: a retrospective multivariate analysis. Lancet Psychiatry. 2016;3(11):1039–48. https://doi.org/10.1016/s2215-0366(16)30304-2.
16. Mahar AL, Aiken AB, Whitehead M, et al. Suicide in Canadian Veterans living in Ontario: a retrospective cohort study linking routinely collected data. BMJ Open. 2019;9(6):e027343. https://doi.org/10.1136/bmjopen-2018-027343. Medline:31160275
17. Australian Institute of Health and Welfare. Incidence of suicide among serving and ex-serving Australian Defence Force personnel 2001–2015: in brief summary report. Cat. No. PHE 213. Canberra: Australian Institute of Health and Welfare; 2017.
18. Reger MA, Smolenski DJ, Skopp NA, et al. Risk of suicide among US military service members following Operation Enduring Freedom or Operation Iraqi Freedom deployment and separation from the US military. JAMA Psychiatry. 2015;72(6):561–9. https://doi.org/10.1001/jamapsychiatry.2014.3195. Medline:25830941
19. VanTil L, Sweet J, Poirier A, et al. Well-being of Canadian Regular Force Veterans, findings from LASS 2016 survey [Internet]. Charlottetown (PE): Veterans Affairs Canada, Research Directorate; 2017 [cited 2020 Aug 4]. Available from: http://publications.gc.ca/pub?id=9.839366&sl=0.
20. Thériault FL, Gabler K, Naicker K. Health and lifestyle information survey of Canadian Armed Forces personnel 2013/2014: regular force report [Internet]. Ottawa: Department of National Defence; 2016 [cited 2020 Aug 4]. Available from: https://www.canada.ca/content/dam/dnd-mdn/documents/health/health-and-lifestyle-survey-2013-2014.pdf.
21. Rusu C, Zamorski MA, Boulos D, et al. Prevalence comparison of past-year mental disorders and suicidal behaviours in the Canadian Armed Forces and the Canadian general population. Can J Psychiatry. 2016;61(Supplement 1):46S–55S. https://doi.org/10.1177/0706743716628856. Medline:27270741
22. VanTil L, MacLean MB, Poirier A, et al. Veterans of the reserve force: life after service studies 2013 [Internet]. Charlottetown (PE): Veterans Affairs Canada, Research Directorate; 2016 [cited 2020 Aug 4]. Available from: http://publications.gc.ca/pub?id=9.826344&sl=0.
23. Thompson JM, Heber A, Carrese L, et al. Life course well-being framework for suicide prevention in Canadian Armed Forces Veterans. J Mil Veteran Fam Health. 2019;5(2):176–94. https://doi.org/10.3138/jmvfh.2018-0020

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Family members of Veterans with mental health problems: Seeking, finding, and accessing informal and formal supports during the military-to-civilian transition

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ABSTRACT

Introduction: For some Canadian Armed Forces Veterans who are released, the military-to-civilian transition (MCT) process may be complicated by significant mental health problems (e.g., posttraumatic stress disorder, depression, anxiety). Family members (i.e., spouses, adult children, parents) who serve as the primary caregivers for Veterans with mental health problems devote significant energy to seeking and finding social support as they navigate the MCT. The primary purposes of this qualitative study were to 1) hear from these family members and learn about the obstacles to and successes in accessing formal and informal social supports during the MCT and 2) understand how accessing such supports was affected by the Veteran's mental health problems. **Methods:** A sequential, multiple qualitative design was used, involving both in-depth individual interviews and focus groups with English- and French-speaking family members ($N = 36$) living in Eastern, Central, and Western Canada (i.e., individual, $n = 27$; focus groups, $n = 9$). Data coding was facilitated through the qualitative data analysis software MAXQDA, and data analysis was conducted using grounded theory strategies. **Results:** Amid numerous indicators of significant resolve and commitment to health, family members revealed significant issues (e.g., mental health stigma of the Veteran, caregiver burden and burnout) that contributed to notable barriers in accessing both informal (i.e., extended family, friends, online support groups) and formal (i.e., Operational Stress Injury Social Support, Military Family Resource Centres) support systems helpful in navigating the MCT. **Discussion:** Results are discussed in the context of how the Veteran's mental health compounded barriers for family members who sought to access informal and formal support services that would provide comfort, financial aid, respite, and counsel to the Veteran family in the MCT. Building on the resilience of military-connected families, gaps in the systems of formal and informal care are discussed in the context of how bold and creative changes (e.g., proactive signposting) might facilitate the MCT for Veterans with mental health problems.

Keywords: formal supports, informal support, military-connected families, military-to-civilian transition, Veteran mental health, Canadian Armed Forces, CAF

RÉSUMÉ

Introduction : Pour certain(e)s vétéran(e)s libérés des Forces armées canadiennes, le processus de transition de la vie militaire à la vie civile (TMC) peut être compliqué par d'importants troubles de santé mentale (p. ex., état de stress post-traumatique, dépression, anxiété). Les membres de la famille (conjoints ou conjointes, enfants adultes, parents), qui sont les principaux proches aidants des vétéran(e)s aux prises avec des troubles de santé mentale, consacrent beaucoup d'énergie à chercher et trouver des services de soutien social pendant qu'ils composent avec la TMC. La présente étude qualitative avait comme objectifs principaux : 1) d'écouter les membres de ces familles et de découvrir les obstacles et les réussites dans l'accès aux services de soutien social formels et informels pendant la TMC et 2) de comprendre les effets des troubles de santé mentale du vétéran sur la capacité d'accès à ces services de soutien social. **Méthodologie :** Les chercheur(e)s ont privilégié une méthodologie qualitative multiple et séquentielle faisant appel à la fois à des entrevues individuelles approfondies et à des groupes de travail formés de membres de la famille francophones ou anglophones (n = 36) qui habitaient dans les Maritimes, le centre du Canada ou l'Ouest canadien (27 personnes et neuf groupes

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de travail). Le codage des données a été facilité par le logiciel d'analyse qualitative MAXQDA, et les chercheurs ont analysé les données selon les stratégies de théorie ancrée. **Résultats :** Parmi les nombreux indicateurs de détermination et d'engagement envers la santé, les membres des familles ont fait ressortir des problèmes importants (p. ex., honte reliée aux troubles de santé mentale pour les vétéran(e)s, fardeau pour les proches aidants et épuisement) qui ont contribué aux obstacles importants à l'accès à des services de soutien informels (famille élargie, amis, groupes d'entraide en ligne) et formels (Soutien social blessures de stress opérationnel et Centres de ressources pour les familles des militaires) utiles pour faire face à la TMC. **Discussion :** Les résultats sont examinés dans le contexte de la façon dont la santé mentale du vétéran s'est aggravée par les barrières pour les membres de la famille qui cherchent à accéder à des services de soutien formels et informels qui leur apporteraient du réconfort, de l'aide financière, du répit et des conseils à la famille du vétéran en TMC. S'appuyant sur la résilience des familles liées aux militaires, les lacunes des services de soins formels et informels sont exposées en fonction des changements audacieux et créatifs (p. ex., indications proactives) qui pourraient faciliter la TMC des vétéran(e)s qui ont des troubles de santé mentale.

Mots-clés : soutien formel, soutien informel, familles liées à des militaires, transition de la vie militaire à la vie civile, santé mentale des vétérans/vétéranes, Forces armées canadiennes, FAC

LAY SUMMARY

Veterans and their families in the military-to-civilian transition (MCT) face a multitude of changes and challenges. Family members of those Veterans experiencing a significant mental health problem (e.g., posttraumatic stress disorder, depression, anxiety) may find that navigating the MCT is made more complex, especially as they seek to find social support during this transition. The present study set out to hear from family members and learn about their obstacles and successes in accessing formal and informal support during the MCT and how this was affected by the Veteran's mental health problems. Interviews and focus groups were completed with 36 English- and French-speaking Veteran family members across Canada. Family members shared how significant issues (e.g., mental health stigma, caregiver burden and burnout) were barriers to seeking and finding both informal (i.e., extended family, friends, online support) and formal (i.e., operational stress injury clinics, Military Family Resource Centres) support systems helpful in navigating the MCT. Despite setbacks and frustrations in accessing these supports, Veteran military families demonstrated resiliency and resolve as they pursued comfort, financial aid, respite, and counsel for themselves and for the Veteran with mental health problems during the MCT.

INTRODUCTION

The Canadian Armed Forces (CAF) includes more than 110,000 Regular and Reserve Force members with approximately 140,000 family dependents (i.e., spouses, children) residing across Canada and around the world.[1] These individuals will join the more than 600,000 CAF Veterans and their families living in Canada via the military-to-civilian transition (MCT) process.[2] Although there is no consensus on an operational definition of the MCT, it is recognized as a period of adaptation and adjustment to civilian life after military service,[3,4] with implications for Veterans and their families.

Pearson and colleagues reveal that 1 in 6 full-time Regular Force CAF members experiences an array of physical and mental health problems,[5] many of which are the result of operational stress injuries (OSIs), including posttraumatic stress disorder (PTSD), generalized anxiety disorder, and alcohol abuse and dependence. Results from both the 2010 and the 2013 Life After Service Surveys (LASS) indicate higher prevalence rates of both chronic health conditions and mental health problems among Veterans compared with serving members.[6]

Successful adjustment to civilian can both affect and be affected by family support. MacLean and colleagues found that 25% of recently released Regular Force Veterans reported a difficult adjustment to civilian life,[7] with higher rates of difficulty associated with low social support and low family income. The 2016 LASS survey found that 28% of Veterans reported that release had been difficult (i.e., very or moderately) for the partner or spouse, and 17% deemed the MCT to be difficult for their children.[8] Of note, these estimates come from the Veterans, not the family members, who may have responded differently.

Little research has investigated how Veterans' mental health can complicate the support seeking experiences of family members during the MCT, although recent studies have summarized the impact on family members in general.[9,10] Unique issues during the transition may affect the family, because it is typically family members who urge Veterans to seek assistance for health challenges.[7] Black and Papile found that 36% of those surveyed indicated their family,[11] or their relationship with their spouse, was the most important aspect of a successful transition. Hachey and colleagues also found that the

process of transitioning was easier when Veterans were satisfied with their family relationships.[12] Similarly, the odds of an easier adjustment were lower for Veterans who were dissatisfied with their family relationships.[12]

Given this background, this study explored the lived experiences of CAF military-connected families who recently experienced the MCT process while supporting a Veteran with a mental health problem. By investigating the social, relational, and psychological well-being of family members supporting Veterans with mental health problems, this article focuses on a single stated purpose: to identify the formal and informal supports accessed by the family during the MCT and their perceptions of how Veteran mental health problems present barriers to accessing these supports. The findings reveal the comprehensive and systemic factors that are affected by, and that affect, the Veteran's family as they process the MCT.

METHODS

In-depth qualitative interviews were conducted with participants from military-connected families, facilitating understandings of multiple standpoints and processes of meaning construction. Interview data were analyzed before the focus groups to identify areas for further exploration with new focus group participants and refine themes generated through the interviews while also widening the sample's range of geographic and socio-demographic representation. The focus groups provided the opportunity for dialectical exchanges, or comparing and contrasting of perspectives, and were designed to support the development of new understandings of experience. Use of multiple data collection strategies enhances the rigour of the findings.[13] Ethical clearance for this research was obtained from research ethics boards at Queen's University, Mount Saint Vincent University, and the University of Calgary.

Recruitment and eligibility

Family members of CAF Veterans with a mental health problem were recruited. CAF Veterans were defined as individuals who had previously served full time in the Regular Forces. Family members were defined as spouses or partners, siblings, parents, adult children, and individuals considered family who were not biological relatives. Mental health problems of the CAF Veteran were not restricted to those resulting from service, or beginning before release, and were operationalized as family member-reported diagnosed and undiagnosed issues that affect mood, thinking, and behaviour. Convenience sampling was used to select participants with heterogeneity in geography, rank, length of service, type or frequency of deployments, type of service (i.e., army, navy, air force), time since release, gender, and other factors, such as type of mental health condition. Participants were recruited through Military Family Resource Centres (MFRCs), Operational Stress Injury Support Services (OSISS) clinics, Veterans Affairs Canada (VAC), the Canadian Institute for Military and Veteran Health Research network, philanthropic organizations (e.g., The Royal Canadian Legion), and social media channels (e.g., Facebook, Twitter).

Procedure

Interviews and focus group guides were developed, piloted, and refined by the principal investigators. Consistent with the interpretive/constructivist framework, the guides structured the dialogue and allowed flexibility for participants to bring forth issues. Interpretive/constructivist research focuses on developing interpretations of lived experience from the perspectives of those who live it,[14] yielding the in-depth knowledge needed when little is known about the phenomenon under study. The dialectical exchanges between the researcher and the participants common to this method create newly formed perspectives as varying interpretations of these experiences are brought into view, revealing the details, complexities, and subjective meanings underpinning the experiences of family members accessing supports and, in some cases, the barriers impeding access. Both the focus groups and the interviews were conducted in such a way that both the researchers and the participants were active agents in the research process.

Researchers collected demographic information about each family participant, the Veteran, and the family structure (see the Appendix for the interview guide). Recorded and transcribed verbatim, all individual interviews and focus groups were conducted by telephone or in person, in English or French, and ranged from 75 to 120 minutes in length. Researchers maintained field notes to identify observations, thoughts, and reflections on underlying assumptions and expectations, understandings, misunderstandings, and analytical decisions, as well as contextual factors (e.g., participants' mood, vocal intonations).

Data analysis

Grounded theory was selected as the framework for analyzing data in this study because it offers a clear sequence of analytical procedures and specific techniques for

developing in-depth and integrated conclusions about experience and meaning central to this interpretive/constructivist research.[5–17] In each interview or focus group transcript, significant passages and powerful moments were identified within the interviews,[18] followed by open, axial, and selective coding.[19,20] Open coding involved the practice of breaking down, examining, and classifying data.[16,20] Axial coding proceeded by comparing and contrasting the codes generated through open coding, resulting in a classification tree.[16,20] Selective coding identified core themes or central issues around which all other themes were integrated.[16,20] Constant comparison of emerging themes was used throughout the analysis process until saturation was achieved,[17,21] with opposing interpretations resolved through team discussion.

Using an iterative approach, the coding tree was piloted across three researchers at two universities and refined to move toward consistency. Consensus meetings occurred between the two sites to ensure concordance in implementation and interpretation, and data coding was facilitated through the qualitative data analysis software MAXQDA (12.3.2 ed.; VERBI Software Consult Sozialforschung, Berlin).

RESULTS

Sample description

Twenty-seven family members of CAF Veterans living with a mental health problem were individually interviewed (21 in English, six in French); an additional nine family members (six English speaking, three French speaking) participated in the focus groups. Demographic information can be found in Table 1. Family members of Veterans reported PTSD as the most common mental health problem experienced by Veterans. Most mental health problems were reported as being formally diagnosed; however, clinical classification (e.g., according to the *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed.) was not completed to confirm diagnoses. Informal and formal support systems were described, along with barriers complicating access to those supports.

Table 1. Sample and Veteran demographic data

Sample	*n*[*]
Female spouse/common law	29
Male spouse	1
Parent(s)	3
Adult child	2
Sibling	1
Total	36[†]
Age, y	
Range	20–63
Mean	42.6
Length of relationship with Veteran, y	
Range	3–42
Mean	21.1
Veteran	
Age, y	
Range	32–80
Mean	45.5
Years of service	
Range	10–35
Mean	21.6
Service branch	
Navy	3
Army	11
Air Force	1
Combined service branch	5
Family did not disclose	16
No. of times deployed, range, mo	2–11
Deployment service length, range, mo	3–13
Reason for release	
Mental or physical problems	23
Voluntary	2
Mandatory (age >60 y)	2
Release date (2013 or later)	35
Release date (2009)	1

[*] Unless otherwise indicated.

[†] All but 3 participants (one child, sibling, and parent) lived with the Veteran and engaged regularly with the Veteran over the past 5y.

Informal support systems accessed by family members and perceived barriers

Informal supports

Family members identified a number of informal supports that provided them with the greatest assistance during the MCT, including social support received or sought from family and friends, social media (e.g., online supports through Facebook), community advocacy or philanthropic associations, and pets or animals. For example, some spouses described the importance of time with their children throughout the MCT. For

others, extended family was identified as an important informal support. One family noted the importance of visits to extended family during the MCT: "My parents are in the country, it is vast, there is space, fresh air. And on weekends, when we were just a couple, we always went down to [name of town], on weekends." Friends were identified as a source of support for spouses and children, providing temporary reprieve from home and caregiving responsibilities.

Pets and online support systems served as important avenues of informal support: "Well, we bought a dog. It is dumb eh? But my 12-year-old son has a bit of anxiety like his father, and the dog goes to bed with him at night and it brings a lot [of comfort]." Spouses developed new friendships with other military spouses through both online and in-person groups:

> I am in many groups. But not in person, because even in [city], there is not that. You have to go to [city], go to [city]. On Facebook we can meet up pretty well. I speak with another Veteran wife. I do not know her personally, we just speak on the Internet.

Barriers to informal support: Stigma and burden

Although civilian-based informal supports were often identified as important and effective sources of support, stigma or judgment about the Veteran's mental health, stemming from a limited understanding of the military lifestyle, rendered some inadequate or inaccessible. Some participants recounted how lack of knowledge about OSIs and their impacts may limit the capacity for perceived empathy extended to the Veteran and their family: "It's the loneliest thing, not having anyone to know what it's like. You can't just call someone up and — they just, they don't always get it, right?" Another noted, "My friends, just because they don't want to be around him … I'd say my civilian friends really don't understand him. They just don't understand." Although stigma regarding mental disorders is not unique to Veterans, how this stigma prohibits access to informal supports for family members during the MCT was a consistent theme.

These reactions may impede access to informal support systems, creating a reluctance to reach out. Family members suggested that they felt like a burden to their informal support systems, and some extended family members were reportedly disengaged, given the Veteran's mental health problems. An English-language focus group participant noted:

> I don't have any support. Like, last night I talked to my dad and said, "Can you call me?" And he's like, "Yeah, well, yes I can." He said, "I will tonight." I said, "I just need someone to talk to about what's going on." He didn't call. He didn't text. Um, we both don't have friends, because we pushed everybody away. Because it's a burden on other people.

In addition to the lack of emotional support, many spouses reported that the absence of logistical, day-to-day supports from family and friends compounded the stresses related to child care. Many spouses disclosed that leaving the Veteran at home with their children could be problematic because challenges in parenting often exceeded the Veteran's capacity to cope on their own.

Barriers to informal support: Confidentiality and privacy

Some family members were intent on finding anonymous avenues of support, which was particularly difficult to achieve in smaller or more geographically isolated communities. One spouse living in a rural setting said, "It's such a small community and the few people that — I think, I think it's harder for people like myself who feel like they want a little bit more anonymity, but to reach out. To have a space to do that."

Formal supports accessed by family members and perceived barriers

Formal supports

When asked to identify formal support systems they accessed as they navigated the MCT with a Veteran with mental health problems, family members described OSISS groups, OSI clinics, MFRCs, Couples Overcoming PTSD Everyday (COPE), and CanPraxis. OSI clinics provide outpatient assessment, treatment, and support to serving CAF members and Veterans, with family supports extended if indicated for the patient's health.[22] MFRCs are arms-length, independent organizations that provide a range of support services to CAF members and their families, with additional supports extended to families of those who have medically released.[23] COPE is a program sponsored by Wounded Warriors Canada that provides support to military and first responder couples via participation in a five-day relational development retreat, followed by ongoing coaching for up to six months.[24] CanPraxis is an equine-based treatment method based on meaning-centred counselling that uses horses to help soldiers recover from the effects of war and to regain their family relationships.[25]

Participants reported varying levels of success in gaining access to, and benefiting from, formal support programs. Regarding the OSISS program, peer support groups funded through VAC for family members of those living with an OSI, a family member from Eastern Canada stated, "OSISS has helped me so much. You know, education is power. So I took it upon myself to try and learn everything I could about PTSD." Citing less success, another family member from Central Canada commented that:

> I tried the OSISS support group, and then I went. And I didn't like it, because a lot of the women that were there were married or with the Veterans before they released and before diagnosis, so they knew [sic] a different aspect to what it was like.

Family members who lived near communities with an MFRC also found it to be helpful: "Oh, the MFRC here was a lot of help. Because [families] there would be living through the same thing, so talking with those people helped a lot." Those who seem to have benefited most from formal supports were those who actively sought out connection with available programs and found affinity with others who could identify with their family situation.

Barriers to formal social support: Navigating the military-to-civilian transition administrative process

Family members consistently reported that systemic barriers impeded access to formal support systems, a challenge exacerbated by the Veteran's mental health difficulties. As one participant noted, "You have somebody that has PTSD and can't do all that stuff … there's lots of people out there who have benefits that they don't get because they can't do the paperwork." Moreover, some participants indicated that they had few, if any, opportunities to learn about available supports, resources, and administrative processes or health care options for the Veteran after they leave the CAF: "and then there's nobody communicating with me to help him with that process." Families members were unclear on how to access services for themselves: "Nobody gave me a list of … places that I could go, support I could have."

Pushing to have the Veteran's mental health issues tied to service, and the bureaucracy associated with qualifying for and starting to receive benefits through VAC, were also significant sources of strain for some family members. These barriers created a sense of abandonment, betrayal, and a toxic environment within which to seek and receive needed supports and services, leaving the family with the burden of care. As one family member commented:

> They don't even acknowledge that her depression has to do, is related to her service. They, they, they won't even go so far as to recognize that her service exacerbated her depression and made it worse. And it did … just this downhill slide that no one will recognize. So you leave me to deal with the aftermath. And you leave me to try to be the glue that holds us together.

In several cases, as a result of conflict between the VAC case manager and the Veteran, the family member had to formally act as a communication liaison: "VAC is now to contact me, because every time VAC contacted him, it, like, it just sets him off for, like, two days." Family members identified significant administrative barriers embedded within the processes of existing formal support systems, even after eligibility for services was confirmed. The challenges of dealing with the paperwork were also noted by the parent of a Veteran who participated in one of the English-language focus groups:

> If you have a Member, um, who has, you know, PTSD and OSI, I mean, filling out a little form is enough, but when you've got pages and pages of forms and then you send them to them, and they lose them, and then you got to start all over again, um.

This perceived adversarial relationships between Veterans and VAC, along with concern about the power imbalance, left some feeling:

> vulnerable, totally and permanently incapacitated, and you have somebody with all the power who can control what you will and will not receive … there's no healing involved, right, because there's something else that will spring up that you'll have to fight.

Barriers to formal social support: Lack of awareness and increased isolation

Lack of awareness and increased isolation were also significant issues identified in accessing formal support services. There was a range of awareness among family members of programs such as OSISS or COPE. A family member living in Quebec commented on regional differences: "I think that's very present in English provinces, but I think it's not present here. I don't think so, anyway." Other family members living in Quebec were aware, for instance, of the OSISS groups, but distance precluded

participation. Some families living with a Veteran with mental health problems reported that they felt:

> quite alone. Nobody to reach out to, to the families, and that's just a big, big lack that is, you know, that I was dealing with, and nobody helped me in between the time [the CAF diagnosed him] and when he left.

Although supports and services were available to the Veteran, families were left on their own to find family-specific supports, which reinforced the isolation experienced by the family. On the whole, Veterans' families believed the formal support systems were obligated to recognize the impact of the Veteran's service on the family and to provide accordingly: "We gave up our daily lives of a normal life." Family members reported the need to feel equipped with knowledge and strategies to be able to support the Veteran's recovery, and some felt that they were left floundering:

> My frustration was just the fact that nobody was telling me anything. Like, here I am with him 24/7 and I've had, like, no contact with anybody saying, "This is what he should be trying to do," and "If this happens you should do this."

DISCUSSION

The results presented here summarize the experiences of accessing formal and informal supports of 36 family members of CAF Veterans living with mental health problems. These family members affirmed that navigating the MCT process alongside a Veteran with significant mental health problems is both daunting and complex. In attempting to access informal or formal supports, they experienced barriers of stigma and burden, confidentiality and privacy, exclusion from MCT administration processes, and lack of awareness and increased isolation, which, when added to the stress of the MCT itself, created a sense of hopelessness and helplessness.

Taken together, family members perceived lack of control over their life circumstances, with inconsistent access to informal and formal resources that are critical for successful adjustment to civilian life.[12] Family members described their experiences as disorienting, burdensome, and even dehumanizing, especially as the psychological symptoms and behaviours of the Veteran demanded more resources, care, and attention from those family members closest to that Veteran — supports that were inaccessible or unavailable to some. In the midst of their efforts to seek support from both formal and informal sources, many of the family members were providing care essential for managing the activities of daily living. Research shows that caregiver burden is heightened for family members whose assistance is required for such activities of daily living,[26] and the effects of this burden on the family member who is seeking support were evident in the tone and urgency of the responses collected in this study. This finding highlights the need to provide caregiving supports to families.

Family and friends constituted the main sources of informal support during the MCT. For some family members of Veterans, stigma and discomfort with discussing mental health issues impeded their capacity to access and benefit from social supports, specifically from family and friends. Although previous studies have highlighted the importance of "critical partners" (e.g., spouses, parents, siblings) in the care of Veterans,[27] it was evident from the family members' responses that psycho-education and mental health literacy training could enhance their capacity to provide safe, informed, and non-stigmatizing care.[28,29] Fear of being a burden and concerns about confidentiality complicated social interactions as well, and although informal peer-to-peer networks are springing up across the country (e.g., COPE via Wounded Warriors Canada), those who are experiencing ongoing isolation may require supports that are offered virtually, such as mobile apps (e.g., OSI Connect) or informal online chat groups (e.g., Facebook groups).

For some family members, access to formal supports, such as those provided by VAC and other military-centric organizations, was affected by social and geographic isolation, lack of awareness of information about interventions and supports, and the complexity of administrative processes. A previously cited study notes a lack of what is called proactive signposting, which engages key gatekeepers who "provide caregivers with adequate and accurate documentation of service providers [who] they can contact for support to minimize the risk to themselves and the client."[28(p.391)] Interprovincial variation in available programs and services, as well as the severity of Veterans' mental health problems, constituted further barriers to access for some. These barriers acted to both cause, and compound, gaps in service to Veterans and their family.

Limitations

Although the inclusion criteria used in recruitment for this study were intentionally broad, such that spouses, adult children, parents, siblings, and fictive kin were

eligible to participate, some voices were absent. In particular, only one male spouse participated in the study. Moreover, only intact families are represented in the sample. The impacts of Veterans' mental health problems on their families persist through the process of separation or divorce, particularly if children are involved. As a result, there are some gaps in the understanding of the full spectrum of details, complexities, and situated meanings characterizing the experiences of family members of Veterans with mental health problems throughout the MCT. In addition, several family members whose first language was French elected to participate in the research study in English, which complicates the meaningful division of the analysis across French-language and English-language interviews.

The study participants are supporting Veterans with mental health problems, most of which appear to be in the severe range. The degree to which these findings apply to those with mild to moderate health problems is unclear, and it is important to note that recruitment efforts and inclusion criteria did not require the Veteran's mental health problems to be in the severe range. The combination of the complex MCT and the severity of the mental health problems likely resulted in the messages from family members being communicated with greater urgency and fortitude. Moreover, the relationship between physical health problems and mental health problems experienced by the Veterans was not explicitly addressed in this study. Because this study was not designed to collect data on physical health, family members may be underestimating the role of chronic physical health problems and chronic pain in exacerbating the behaviours associated with the Veterans' mental health problems. As a result of these weaknesses, the recruitment of family members willing to share their experiences of living with a Veteran who had a mental health problem during the MCT likely attenuated the sample's heterogeneity.

Implications

The implications of this study are likely best summarized in this statement: military families are experiencing both small successes and formidable barriers in accessing evidence-based care systems that identify and address the unique needs of Veterans with mental health problems in the MCT. In supporting Veteran families during the MCT, especially those families whose Veterans have mental health problems, it is likely necessary for more time and resources to be invested in collecting data from sequential cohorts of Veteran families regarding their developmental, familial, and ecological strengths. Although pertaining to family members much younger than those in our sample, this echoes the recommendations of other recent meta-analysis (e.g., Lambert and colleagues[10]) and literature mapping (e.g., Rayce and colleagues[9]) studies that call for consideration of the contexts of how Veterans' mental health affects family members, including family variables (i.e., sex of parent, parent–child attachment, cultural background) and child variables (i.e., pre-existing psychological distress, peer relationships, school engagement).

The results of this study suggest that several practical changes might benefit Veteran families during the MCT, particularly families of Veterans who have a mental health problem. First, given the barriers experienced by families who sought formal support, it is apparent there would be value in enhancing mental health literacy training for frontline VAC staff. In particular, education on the additional stressors experienced by family members advocating on behalf of a Veteran with a mental health problem might allow for informed and compassionate communication between family members and frontline staff to develop.

In line with this, a second practical implication might be to provide psycho-educational training opportunities for family members to learn about the effects of trauma and toxic stress on Veterans' social, neurological, psychological, and physical functioning. Understanding how OSIs are carried into, and affect, family relationships, communication patterns, and coping capacities of Veteran families might assist family members to better understand what their immediate support needs are and also where to best seek support.

Finally, given that interviewees also noted accessibility to information as a barrier, Veteran families may benefit from online resources that would assist them in navigating the MCT process. In particular, such resources could include tailored links to formal (e.g., MFRCs) and informal (e.g., local peer-to-peer groups) support resources and summaries of research related to Veteran mental health problems and mental health disorders.

Conclusion

Amid the barriers experienced by family members supporting Veterans living with mental heath difficulties, there was also evidence of the resolve and commitment to supporting the Veteran's health and well-being that

have enabled the family system to adapt. Although it was apparent that family members' access to, and engagement with, both formal and informal support systems were compromised by the Veteran's mental health, the emotion conveyed in the words of family members as they described their MCT journey was indicative of the commitment and resilience undergirding these families. Although the ongoing and considerable health needs and issues of Veterans continue to absorb significant resources within the family system, gains can be made through policy and programming that simplify and diversify access to services and supports and that extend outreach and compassion to the families who support these Veterans in daily life and long-term recovery.

Future studies focusing on the presence and power of adaptation and coping, nurturing relationships via work and community connections, the role of religion and spirituality, and even inquiry into the importance of family rituals and routines (e.g., family meals) may be helpful to families in the midst of the MCT. Such data could be used to create family-specific resources that would serve to more intentionally include the family in the MCT process and in coming to understand how families as a whole experience change during MCT.

REFERENCES

1. Manser L. State of military families in Canada: issues facing regular force members and their families. Ottawa: Canadian Forces Morale and Welfare Services; 2018.
2. Statistics Directorate. Fourth quarter VAC fact sheet. Charlottetown, PEI: Veterans Affairs Canada; 2014.
3. Blackburn D. Out of uniform: psychosocial issues experienced and coping mechanisms used by Veterans during the military-to-civilian transition. J Mil Veteran Health. 2017;44(4):383–401. https://doi.org/10.3138/jmvfh.4160.
4. Shields DM, Kuhl D, Lutz K, et al. Mental health and well-being of military Veterans during military to civilian transition: review and analysis of the recent literature. Charlottetown (PEI): Veterans Affairs Canada; 2016.
5. Pearson C, Zamorski M, Janz T. Mental health of the Canadian Armed Forces [Internet]. Toronto: Statistics Canada; 2014 [cited 2018 Jan 21]. Available from: http://www.statcan.gc.ca/pub/82-624-x/2014001/article/14121-eng.htm.
6. Thompson JM, Van Til L, Poirier A, et al. Health and well-being of Canadian armed forces Veterans: findings from the 2013 life after service survey. Charlottetown (PEI): Veterans Affairs Canada; 2014.
7. MacLean MB, Van Til L, Thomson JM, et al. Postmilitary adjustment to civilian life: potential risks and protective factors. Phys Ther. 2014;94(8):1186–95. https://doi.org/10.2522/ptj.20120107. Medline:23766397
8. Schwartz KD. Review of the mental health support for Veteran families: a demographic profile using the 2016 life after service survey. Charlottetown (PEI): Veterans Affairs Canada; 2018.
9. Rayce SB, Andersen SB, Jorgenson A, et al. Mental health among children living with Veterans: a literature mapping. Scandinavian J Mil Stud. 2019;2(1):122–47. https://doi.org/10.31374/sjms.8.
10. Lambert JE, Holzer J, Hasbun A. Association between parents' PTSD severity and children's psychological distress: a meta-analysis. J Trauma Stress. 2014;27(1):9–17. https://doi.org/10.1002/jts.21891. Medline:24464491
11. Black TG, Papile C. Making it on civvy street: an online survey of Canadian Veterans in transition. Can J Couns Psychother. 2010;44(4):383–401.
12. Hachey KK, Sudom K, Sweet J, et al. Transitioning from military to civilian life: the role of mastery and social support. J Mil Veteran Fam Health. 2016;2(1):9–18. https://doi.org/10.3138/jmvfh.3379.
13. Haynes SN, Richard DCS, Kubany ES. Content validity in psychological assessment: a functional approach to concepts and methods. Psychol Assessment. 1995;7(3):238–47. https://doi.org/10.1037/1040-3590.7.3.238.
14. Schwandt TA. Constructivist, interpretivist approaches to human inquiry. In: Denzin NK, Lincoln YS, editors. Handbook of qualitative research. Thousand Oaks (CA): Sage; 1994.
15. Bryman A. Social research methods. 5th ed. London: Oxford University Press; 2016.
16. Strauss AL, Corbin JM. Basics of qualitative research: grounded theory procedures and techniques. Newbury Park (CA): Sage; 1990.
17. Creswell JW. Research design: qualitative and quantitative approaches. Thousand Oaks (CA): Sage; 1994.
18. Saldana J. The coding manual for qualitative research. 3rd ed. London: Sage; 2015.
19. Walker D, Myrick F. Grounded theory: an exploration of process and procedure. Qual Health Res. 2006;16(4):547–59. https://doi.org/10.1177/1049732305285972. Medline:16513996
20. LaRossa R. Grounded theory methods and qualitative family research. J Marriage Fam. 2005;67(4):837–57. https://doi.org/10.1111/j.1741-3737.2005.00179.x.
21. Glaser B, Strauss A. The discovery of grounded theory. London: Weidenfield & Nicolson; 1967.
22. Veterans Affairs Canada. OSI clinics [Internet]. Charlottetown (PEI): Veterans Affairs Canada; 2019 [cited 2019 May 2]. Available from: https://www.

veterans.gc.ca/eng/health-support/mental-health-and-wellness/assessment-treatment/osi-clinics.
23. Canadian Forces Morale & Welfare Services. Military family resource centres [Internet]. Ottawa: Canadian Forces Morale & Welfare Services; n.d. [cited 2020 Aug 24]. Available from: https://www.cafconnection.ca/National/Programs-Services/Deployment-Support/Deployment-Support-for-Families/Military-Family-Resource-Centres-(MFRC).aspx.
24. Wounded Warriors Canada. Couples overcoming PTSD everyday [Internet]. Vancouver: Wounded Warriors Canada; 2019 [cited 2020 Feb 6]. Available from: https://woundedwarriors.ca/our-programs/couples-overcoming-ptsd-everyday/.
25. CanPraxis. Equine-assisted therapy for operational stress injuries [Internet]. Ashburn (ON): CanPraxis; 2020 [cited 2020 Feb 6]. Available from: https://canpraxis.com.
26. Razani J, Kakos B, Orieta-Barbalace C, et al. Predicting caregiver burden from daily functional abilities of patients with mild dementia. J Am Geriatr Soc. 2007;55(9):1113–27. https://doi.org/10.1111/j.1532-5415.2007.01307.x. Medline:17767684
27. Hall C, Sigford B, Sayer N. Practice changes associated with the Department of Veterans Affairs' family care collaborative. J Gen Intern Med. 2010;25(1):18–26. https://doi.org/10.1007/s11606-009-1125-3. Medline:20077147
28. Verey A, Keeling M, Thandi G, et al. UK support services for families of wounded, injured or sick service personnel: the need for evaluation. Brit J Sport Med. 2016;162(5):388–93. https://doi.org/10.1136/jramc-2015-000483. Medline:26908508
29. Reavley NJ, Form AJ. The quality of mental disorder information websites: a review. Patient Educ Couns. 2011;85(2):16–25. https://doi.org/10.1016/j.pec.2010.10.015. Medline:21087837

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COMPETING INTERESTS

Kelly Dean Schwartz reports funding from Veterans Affairs Canada.

CONTRIBUTORS

All authors were integral in the study design, collection of data, interpretation of results, and drafting of the manuscript. All authors approved the final version submitted for publication.

ETHICS APPROVAL

The study protocol was approved by the research ethics boards at Queen's University, Kingston, Ontario, Canada; Mount Saint Vincent University, Halifax, Nova Scotia, Canada; and the University of Calgary, Calgary, Alberta, Canada.

INFORMED CONSENT

N/A

REGISTRY AND REGISTRATION NO. OF THE STUDY/TRIAL

N/A

ANIMAL STUDIES

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PEER REVIEW

This manuscript has been peer reviewed.

APPENDIX: INTERVIEW GUIDE

Introduction

Thank you for agreeing to participate in this study. Your input is extremely valuable to increasing our understanding of how Veteran families are dealing with a Veteran's mental health problems, especially during the military-to-civilian transition process.

Before we begin, do you have any questions about the introduction or consent form you signed?

Can we also confirm that you consent to this interview being recorded?

Just as a reminder, the purpose of this study is to better understand the impacts of Canadian Armed Forces (CAF) Veterans' mental health challenges on the family, factors that contribute to the mental health and well-being of CAF Veterans and their families, and your perception of the effectiveness of current support services during the military to civilian transition period. We are interested also in identifying whether any changes or additions can be made to enhance the capacity of the current support services available to assist Veterans with mental health challenges and their families during this transition.

In this study we define mental health in very broad terms. It can include a wide range of diagnosed and undiagnosed issues that affect mood, thinking, and behavior.

You can choose not to respond to any question or stop the interview at any time for any reason.

Interview question	Potential probes
General Information	
1. Would you like to select a pseudonym we will use for the interview, or would you like us to assign one?	How long have you lived with the Veteran? How strongly would you say you and the Veteran are/were engaged with one another on a daily basis? Probe for examples, e.g., meals, socially, physical and mental care.
2. What is your age? And the Veteran's age?	From this relationship? Previous relationships? How many?
3. What is your current relationship with the Veteran?	What were their ages when the Veteran released? How about ages during any deployments?
4. Are there any children living in the home?	In the last 5 years, how many months of the year would the family unit be living together?
5. When did the Veteran leave the military"?	How long did your family member serve in the military?
6. What has the Veteran been doing since release?	What was the nature of the Veteran's work in the military? Trade? Officer? Deployment? If deployed, how many times? Can you tell us about the nature of the deployment(s)?
	What prompted the decision to release/leave the military? Plan to retire? Health issues? Family needs?
	Did you go through the transition process with the Veteran?
	Work? Volunteering? Hobbies? Caregiving for other family members? Fitness? Managing health?
Objective 1: Identify the impacts of CAF Veterans' mental health problem(s) (including OSIs), on family members and on the functioning of the family unit during MCT.	
7. How did the Veteran's military service impact the household and family life?	What was fulfilling; what did you like? What were the challenges? Highlights/lowlights?
	Was there a medical release? For what kind of condition? Physical, mental?
8. Tell us about the Veteran's health. How does the health of the Veteran impact the family life? If his/her health has affected family life, tell us more about this.	Has there been a diagnosis of a mental health condition?
	How and when was the problem identified/first became apparent?
	Is he/she presently receiving treatment, e.g., therapy/counselling, consultation, medication?
9. What has changed since the mental health issues have been identified (including clinical diagnosis)?	Who is providing the mental health support — family physician, psychiatrist, psychologist, occupational therapist? Other? What has been the impact of the treatment?

(*Continued*)

(Continued)

Interview question	Potential probes
Objective 2: Describe the mental health and well-being of family members of CAF Veterans who have mental health problems.	
10. How, if at all, have the mental health issues in your Veteran family member impacted you? Your family? How would you describe this effect/these effects?	Determinants of well-being, e.g., employment effects, financial effects, impacts on health and disability, changes to social integration, impacts on housing, psychological effects. Are you experiencing any impacts? For example, hypervigilance, sleep disturbances, irritability, parenting, intimacy.
11. How, if at all, have you or other members of your family made adjustments to manage the impact of the Veteran's mental health?	For example, adjusting your behavior or expectations, using strategies like exercise to help calm or day planners to organize health appointments?
12. Tell me about the relationship between your family member's mental health and your/your family's health/well-being?	Are there are other mental health issues in the family and how those have been impacted by the Veteran's health?
Objective 3: Identify, from the family member's perspective, how family life is impacting and being impacted by the Veterans' well-being during MCT (there will be no contact with the Veterans themselves).	
13. Your Veteran/family member has been managing both mental health issues and the transition into civilian life. Tell us more about how that's been.	For example, child care or other daily responsibilities. Other determinants of well-being — employment effects, financial effects, impacts on health and disability, changes to social integration, impacts on housing, psychological effects
14. How have the mental health issues of the Veteran affected the transition to civilian life?	Has it affected the relationships with children? With parents? Siblings? With family? With friends?
15. Has your daily routine changed during or since your Veteran has transitioned to civilian life? In what way? Other changes?	Have your social relationships changed? Do you still have the same routine with friends and family? How has this affected your relationship with the Veteran?
16. What impact do you feel family life has had on your Veteran's mental health during the military to civilian transition?	How has it been a positive factor? A negative factor?
Objective 4: Identify interventions and supports accessed during the MCT and their success in addressing the needs of the family.	
17. What do you do to take care of yourself and your family through the transition process?	Physical, social, spiritual supports. Formal/informal? Hobbies? Career?
18. How do these things help you manage the transition experience? Your family member's mental health?	
19. Where do you find the greatest support during this transition period?	Family, friends, community, church/mosque/synagogue, military/Veteran family services What are the positive aspects of this support? What are the negative (if any) aspects of this support?
20. What does this support mean to you?	Are you familiar with the OSI clinics, or other programs offered through military/Veteran family services? If yes, what was your experience of those services? What were the key ingredients that were most helpful for you?
21. As your family has made the transition to civilian life, what have you learned about your support system(s)?	Why or why not?
22. Have you or would you seek support targeted to Veterans and/or their families? families?	

(*Continued*)

(Continued)

Interview question	Potential probes
Objective 5: Based on the findings, identify interventions and supports that could enhance the overall health and well-being of families during MCT and into the future.	
23. Given your experience, what services and programs would help you and other families supporting members/Veterans with a mental health issue through the transition from military to civilian life?	How did you learn about these? Enhanced communication channels, greater awareness of supports and services, changes to financial benefits, use of technology to promote access How would you like to get information about supports?
24. Is there anything you would change to existing programs to help make them better meet your needs now, or in the future?	
25. Is there anything else you think would be useful for us to know about mental health and transition that we haven't already covered?	

Note: CAF = Canadian Armed Forces; OSI = operational stress injury; MCT = military-to-civilian transition.

Alcohol use in Tobacco 21 (T21) states from 2016 to 2018: Differences by military service status

Justin T. McDaniel[a], David L. Albright[b], Dawn Null[a] and Shanna McIntosh[b]

ABSTRACT

Introduction: Given the greater likelihood of alcohol use among tobacco users, the authors sought to determine whether living in a Tobacco 21 (T21) state was associated with a decreased likelihood of alcohol use among military personnel and civilians aged 18-20 years. **Methods:** Data from the 2016-2018 Behavioral Risk Factor Surveillance System (BRFSS), an annual survey of the Centers for Disease Control and Prevention, were obtained for individuals aged 18-20 years (N = 11,827). The authors assessed whether a BRFSS respondent's state of residence included a T21 policy, a military exemption, or both at the time of interview by reviewing a published policy assessment tool. Individuals living in states with only a local T21 policy were excluded. A mixed logit model was estimated with "any alcohol use in the past 30 days" as the dependent variable. The primary independent variable was an interaction term for T21 state of residence and military service status. **Results**: Among civilians, the alcohol use rate was 34.04% in non-T21 states and 35.37% in T21 states. Among military service members, the alcohol use rate was 28.24% in non-T21 states and 19.81% in T21 states. After controlling for age, race, sex, income, mental distress, and smoking history, military service status moderated the relationship between living in a T21 state and alcohol use (adjusted OR = 0.81, 95% CI = 0.69, 0.95). **Discussion**: The implementation of a federal T21 policy may reduce alcohol use among minors, especially among those serving in the military.

Key words: alcohol, alcohol use, military, minimum legal age, policy, tobacco, T21, Tobacco 21, U.S. Department of Defense

RÉSUMÉ

Introduction : Puisqu'il est plus probable que les fumeurs consomment de l'alcool, les chercheur(e)s ont cherché à déterminer si le fait de vivre dans un État où l'âge légal du tabagisme est fixé à 21 ans (T21) est lié à une baisse de la probabilité de consommation d'alcool par le personnel militaire et les civils de 18 à 20 ans. **Méthodologie :** Les chercheurs ont recueilli les données du sondage annuel des *Centers for Disease Control and Prevention* de 2016 à 2018, le *Behavioral Risk Factor Surveillance System* (BRFSS), auprès de personnes de 18 à 20 ans (n = 11 827). Ils ont analysé l'outil d'évaluation des politiques pour évaluer si l'État de résidence des répondants au BRFSS était doté d'une politique de T21 ou d'une exemption militaire au moment de l'entrevue. Les personnes qui habitent dans les États dotés d'une politique locale de T21 étaient exclues. Ils ont estimé un modèle de répartition mixte dont la variable dépendante était « toute consommation d'alcool dans les 30 jours précédents ». La variable indépendante primaire était une interaction entre un État de résidence doté d'un T21 et le service militaire. **Résultats :** Chez les civils, le taux de consommation d'alcool s'élevait à 34,04 % dans les États sans politique de T21 et à 35,37 % dans les États dotés d'une politique de T21. Chez les membres de l'armée, le taux de consommation d'alcool s'élevait à 28,24 % dans les États sans politique de T21 et à 19,81 % dans les États dotés d'une politique de T21. Après voir tenu compte de l'âge, de la race, du sexe, du revenu, de la détresse mentale et des antécédents de tabagisme, le service militaire modérait la relation entre la résidence dans un État doté d'une politique de T21 et la consommation d'alcool (RR = 0,81, IC à 95 % : 0,69, 0,95). **Discussion :** La mise en œuvre d'une politique fédérale de T21 pourrait réduire la consommation d'alcool chez les mineur(e)s, particulièrement s'ils sont dans les Forces.

Mots-clés : âge légal minimal, alcool, militaire, politique, tabac, Département de la Défense américaine

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LAY SUMMARY

A national survey of U.S. military service members and civilians aged 18-20 years found that military service members were less likely than their civilian peers to use alcohol if they lived in a state with a Tobacco21 (T21) policy. Given that individuals who smoke are also more likely to use alcohol, the analysis shows that tobacco policies may also affect alcohol use behaviors for young adult military service members.

INTRODUCTION

On December 20, 2019, the president of the United States signed federal legislation that raised the minimum legal age for tobacco product sales from 18 years to 21 years, eliminating all state-specific implementation of the law.[1] Tobacco 21 (T21) policies have been shown to have a beneficial effect at the state and local levels on tobacco sales to, and consumption by, individuals aged younger than 21 years.[2–7] For instance, Glover-Kudon et al. reported that, after Hawaii's adoption of a T21 policy in January 2016, average monthly cigarette unit sales decreased by 4.4% over a period of six years (2012-2017).[5] Also, Zhang et al. showed the retailer violation rate for sales of electronic cigarettes (e-cigarettes) to underage individuals in Hawaii after its adoption of a T21 policy was 13.1% — a figure lower than the 20% federal Synar rate.[2] The Synar Amendment, signed into law on July 1992, allows for punitive action against states that fail to keep the noncompliance rate of tobacco sales to individuals older than the minimum age below 20%.[2] T21 policy compliance is correlated with forecasted reductions in chronic disease incidence and premature birth rates.[8]

Although the Institute of Medicine advises that raising the minimum legal age for purchase of tobacco products could affect the use of other substances, such as alcohol, and thereby augment the public health benefit of reducing tobacco use, the literature lacks an empirical analysis of the impact of T21 policies on alcohol use.[8] The association of alcohol and tobacco use is well established, especially among military service members and Veterans.[9,10] In particular, the National Institute on Alcohol Abuse and Alcoholism estimated that 90% of individuals with an alcohol use disorder also smoke.[9] Moreover, military service members or Veterans who use tobacco products are more likely to receive a higher score on the Alcohol Use Disorders Identification Test than non-Veteran tobacco users.[10] Therefore, it stands to reason that, if individuals aged younger than 21 years are no longer legally eligible to purchase tobacco products, and are less likely to smoke as a consequence, they may also be likely to reduce or quit consumption of alcohol. For example, Cavazos-Rehg et al. showed that smoking cessation was associated with decreased alcohol use.[11]

Before the passage of federal T21 legislation, six states (California, Arkansas, Virginia, Texas, Maryland, and Utah) passed exemptions to the minimum legal age requirement for active-duty military service members.[12] The rationale for implementing a T21 military exemption follows the philosophical reasoning cited in an article written by Morian and Malek:[13(p.1401)] "It is inconsistent to deny those aged 18-20 years the choice to use tobacco while simultaneously treating them as sufficiently mature, for example, to serve in the military." Experimental assessments of the impact of T21 exemptions on military service member smoking behavior have not been published to determine causation; however, the federal T21 law does not allow exemptions for the military.

Tobacco product use is more prevalent among military personnel (47.7%) than the general population (43.7%) who are aged younger than 21 years.[14] Moreover, self-reported use of any alcohol is higher among active-duty military personnel (55.5%) than among the general public aged younger than 21 years (49.5%).[15, 16] The demanding nature of basic training and subsequent deployment during military service are probable antecedents to military substance use but may reduce force readiness.[17] According to Harwood et al.,[18] the U.S. Department of Defense spends more than $1.12 billion each year for health care attributable to alcohol consumption. Therefore, policies that deter alcohol consumption among active-duty service members aged younger than 21 years are critical and deserve empirical investigation.

Although a T21 policy is now effective at the federal level in the United States, there is a need to contribute to the evidence base for such a policy, especially as it relates to military service members. Because some research has shown that military service members are more likely to comply with the law than civilians,[19,20] this study tests the following alternative hypothesis: the relationship between living in a T21 state and alcohol use is moderated by military service status among individuals aged 18-20 years.

METHODS

Data collection and study sample

Cross-sectional data from the 2016, 2017, and 2018 Behavioral Risk Factor Surveillance System (BRFSS) surveys were obtained and merged for this study.[21] The Centers for Disease Control and Prevention's BRFSS is an annual survey of adults conducted via landline or cellular telephones in all 50 states. Between 2016 and 2018, landline-based interviews generated an average response rate of 48.67%, and cellphone-based interviews resulted in an average response rate of 48%.[22–24] Each state adopted a disproportionate stratified sampling design to collect data from landlines, with state respondents divided into two groups: high density and medium density, where density is determined by the number of listed households in an area code. Simple random sampling was conducted to gather data via cellphones.[25]

Survey data from 1,373,755 respondents were collected between 2016 and 2018. Because of missing data on the measures described in the next section, and exclusion of respondents who, at the time of the BRFSS survey, were living in a state with local but not state-level T21 policies, the final analytic sample size for this study was 11,827. The following five states were excluded from the analysis: Illinois, Kansas, Missouri, New York, and Ohio.

Measures

Sociodemographic measures

Validity and reliability evidence for questions asked in the BRFSS survey is published elsewhere.[26] In this study, the authors obtained information about each person's age (18-20 y), race or ethnicity (dummy coding: white [reference category], black, and "other" race/ethnicity), and sex (male or female); military service status (civilian or military member) was assessed with the following question: "Have you ever served on active duty in the United States Armed Forces, either in the regular military or in a National Guard or military reserve unit (yes or no)?" Information about each respondent's annual income (dummy coding: <$15,000 [reference category], $15,000-$25,000, $25,000-$35,000, $35,000-$50,000, >$50,000) was also gathered.

Mental health

Because mental health conditions have been shown to be associated with alcohol use,[27,28] the following measure was included as a covariate in this study: "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?" Responses were grouped into the following dummy categories, as in previous studies[29,30] of the BRFSS mental distress measure: 0 days of mental distress in the past month (i.e., reference category), 1-13 days of mental distress in the past month, and 14 or more days of mental distress in the past month.

Cigarette use

Cigarette use history was determined by combining responses from two survey questions: "Have you smoked at least 100 cigarettes in your entire life?" and "Do you now smoke cigarettes every day, some days, or not at all?" On the basis of responses to these two questions, survey respondents were coded into two categories: not a current cigarette smoker (i.e., ever use but not current use) and currently a cigarette smoker (i.e., ever use and current use).

E-cigarette use

The following two questions were used to determine whether a respondent was using e-cigarettes at the time of data collection: "Have you ever used an e-cigarette or other electronic vaping product, even just one time, in your entire life?" and "Do you now use e-cigarettes or other electronic vaping products every day, some days, or not at all?" Respondents who answered "every day" or "some days" were coded as current e-cigarette users, and respondents who answered "not at all," or who had never used an e-cigarette, were coded as non-users.

Alcohol use

The dependent variable in this study, alcohol consumption, was measured with the following question: "During the past 30 days, how many days per week or per month did you have at least one drink of any alcoholic beverage such as beer, wine, a malt beverage or liquor?" Responses to this question were coded dichotomously: 1) 0 drinks of alcohol in the past 30 days or 2) more than 0 drinks of alcohol in the past 30 days. The outcome variable was coded in this way so as to discern whether an individual in the sample (i.e., aged <21 y) unlawfully consumed any alcohol.

T21 state of residence

The authors determined whether a respondent lived in a state with a T21 policy at the time of the interview by reviewing the T21 policy assessment tool created

by Dobbs et al.[31] Respondents living in a state with a T21 policy at the time of the BRFSS interview received a code of one on the T21 variable. To assess whether a respondent lived in a state with at least one local T21 policy, the authors reviewed the Tobacco21.org website and substantiated the website findings by examining city or county law documents posted on each city's or county's website (e.g., see the T21 law document for Tompkins County, NY).[32, 33] Individuals living in states with at least one local T21 policy, but no state-level T21 policy, were excluded from the final dataset, primarily because the 2016-2018 BRFSS survey datasets did not permit identification of sub-state area of residence. Respondents living in states with no state-level or local-level T21 policy were included as controls and received a code of zero on the T21 variable. Given that the state of California adopted a military exemption to its T21 policy, military service members living in California were coded as controls. Table 1 provides a summary of T21 policies in 50 states and the District of Columbia.

Data analysis

The authors included the BRFSS complex survey design weights, the methodology for which is described elsewhere,[34] in all analyses. First, given that the interest in this study was to determine the rate of alcohol use among military service members and civilians by residence in- or outside of a T21 state, survey-weighted estimates of alcohol use for each sub-population were developed. Second, factors associated with alcohol use were examined in a generalized linear mixed model with a logit link,[35] where alcohol use (yes = 1, no = 0) served as the dependent variable. The primary independent variable in this model was a two-way interaction term for T21 state and military service status. The main effects for this interaction were also included in the model. Each participant's state of residence was included as a random intercept in the model. The following variables were also included as control variables (i.e., all estimates were adjusted for these factors): sex, race, age, annual income, mental distress, cigarette use, and e-cigarette use.

RESULTS

The study sample included 927 (7.84%) participants living in T21 states and 402 military service members (3.40% of the sample). Twenty-two (2.37% of the T21 sub-sample) military service members reported living in a state with a T21 policy. Irrespective of residence in a T21 state and military service status, the rate of alcohol use from 2016 to 2018 among individuals aged 18-20 years was 34.84% (95% CI, 33.83-35.86). The rate of alcohol use in non-T21 states was 34.83% (95% CI, 33.78-35.89), and the rate of alcohol use in T21 states was 35.07% (95% CI, 31.49-38.82), irrespective of military service status. The rate of alcohol use among military service members was 27.93% (95% CI, 23.17-33.24), whereas among civilians it was 35.06 (95% CI, 34.03-36.10). Alcohol use rates among service members and civilians by state T21 policy are shown in Table 2. Alcohol use was highest among civilians in T21 states, followed by civilians in non-T21 states, service members in non-T21 states, and, last, service members in T21 states.

Results of the generalized linear mixed model for alcohol use are shown in Table 3. Main effects are provided in Model 1, and the interaction term for military service status and T21 state is provided in Model 2. Several control variables in the model were significantly associated with alcohol use. Specifically, results showed women were less likely than men, blacks and individuals of other races or ethnicities were less likely than whites, and younger individuals were less likely to report any alcohol use in the past 30 days. Individuals with an annual income between $15,000 and $50,000 were less likely than individuals with an annual income of less than $15,000 to report alcohol use; however, individuals with an annual income greater than $50,000 were more likely than individuals with an annual income of less than $15,000 to report alcohol use. Moreover, increasing severity of mental distress was significantly associated with alcohol use. The strongest predictor (adjusted OR [aOR] = 2.32) of alcohol use was current e-cigarette use, followed by current cigarette use (aOR = 2.28).

The main effect of T21 on alcohol use was not significant in Model 2 (aOR = 0.87; 95% CI, 0.73-1.03); however, the main effect of military service status on alcohol use was statistically significant (aOR = 0.69; 95% CI, 0.67-0.71). The interaction term for service member status and T21 was significant in Model 2 (aOR = 0.81; 95% CI, 0.69-0.95), indicating service members differed from civilians in terms of their likelihood of alcohol use in a T21 state. In particular, Cohen's h for the comparison of alcohol use among service members in non-T21 and T21 states (28.24% vs. 19.81%) was small (Cohen's h = 0.20). However, the effect size for the difference in civilian alcohol use in non-T21 and T21 states (34.04% vs. 35.37%) was smaller (Cohen's h = 0.01).

Table 1. Effective year of inceptive local, district, or local laws requiring the minimum age for purchase of tobacco products to be 21 years

State	2016*			2017*			2018*		
	State or district T21	Local T21	No T21	State or district T21	Local T21	No T21	State or district T21	Local T21	No T21
Alabama			X			X			X
Alaska			X			X		Aug 22	
Arizona		June 2			X			X	
Arkansas		Sept 1			X			X	
California	June 9†			X			X		
Colorado			X			X		Jan 18	
Connecticut			X			X			X
Delaware			X			X			X
District of Columbia			X	Feb 18			X		
Florida			X			X			X
Georgia			X			X			X
Hawaii	Jan 1			X			X		
Idaho			X			X			X
Illinois		Pre-2016			X			X	
Indiana			X			X			X
Iowa			X			X			X
Kansas		Pre-2016			X			X	
Kentucky			X			X			X
Louisiana			X			X			X
Maine		July 20			X		July 1		
Maryland			X			X			X
Massachusetts		Aug 1			X		Dec 31		
Michigan			X		1/1			X	
Minnesota			X		7/1			X	
Mississippi		Aug 1			X			X	
Missouri		Pre-2016			X			X	
Montana			X			X			X
Nebraska			X			X			X
Nevada			X			X			X
New Hampshire			X			X			X
New Jersey		Pre-2016		Nov 1			X		
New Mexico			X			X			X
New York		Pre-2016			X			X	
North Carolina			X			X			X
North Dakota			X			X			X
Ohio		Pre-2016			X			X	
Oklahoma			X			X			X
Oregon			X		Apr 14		Jan 1		
Pennsylvania			X			X			X

(*Continued*)

Table 1. (Continued)

State	2016*			2017*			2018*		
	State or district T21	Local T21	No T21	State or district T21	Local T21	No T21	State or district T21	Local T21	No T21
Rhode Island			X		Apr 1			X	
South Carolina			X			X			X
South Dakota			X			X			X
Tennessee			X			X			X
Texas			X			X		Oct 1	
Utah			X			X			X
Vermont			X			X			X
Virginia			X			X			X
Washington			X			X			X
West Virginia			X			X			X
Wisconsin			X			X			X
Wyoming			X			X			X

* *X*s are placed in a state's 2017 or 2018 cell if no changes were made from the previous year's inceptive T21 policy.

† Military exemption.

Table 2. Demographic, social, and behavioral characteristics of the study sample by residence in a T21 state and military service status (*N* = 11,827)

Variable	T21 states, *n* (%)*		Non-T21 states, *n* (%)*	
	Civilian (*n* = 905)	Military member (*n* = 22)	Civilian (*n* = 10,520)	Military member (*n* = 380)
Sex: Female	44 (43.82)	6 (27.78)	4,647 (46.34)	67 (20.83)
Race				
White	220 (28.09)	3 (14.07)	6,937 (66.68)	259 (66.49)
Black	54 (5.79)	0 (0.00)	985 (10.22)	30 (9.65)
Other	631 (66.13)	19 (85.93)	2,598 (23.11)	91 (23.86)
Age, y, Mean (SE)	18.99 (0.03)	19.24 (0.20)	18.95 (0.01)	19.24 (0.05)
Annual income, $				
<15,000	168 (16.87)	1 (2.73)	1,621 (14.38)	30 (6.86)
15,000–25,000	201 (21.08)	10 (42.16)	2,192 (19.84)	121 (28.80)
25,000–35,000	103 (10.79)	1 (4.37)	1,118 (9.88)	75 (19.84)
35,000–50,000	120 (12.37)	4 (19.60)	1,379 (13.09)	53 (14.42)
>50,000	313 (38.89)	6 (31.14)	4,210 (42.80)	101 (30.07)
Past month mental distress, days				
0	392 (42.51)	16 (75.44)	4,776 (45.61)	267 (68.24)
1–13	383 (42.92)	5 (21.43)	3,925 (37.38)	75 (24.03)
≥14	130 (14.58)	1 (3.13)	1,819 (17.01)	38 (7.73)
Cigarette use	62 (6.91)	3 (18.21)	1,096 (10.75)	47 (13.20)
E-cigarette use	125 (14.03)	2 (7.42)	1,491 (13.82)	67 (16.20)
Past month alcohol use	324 (35.37)	4 (19.81)	3,822 (35.04)	113 (28.24)

Note: Unweighted sample sizes are presented with weighted percentages or means. T21 = Tobacco 21.

* Unless otherwise indicated.

Table 3. Differences in likelihood of any alcohol use in the past 30 days by residence in a T21 state and military service status (*N* = 11,827)

Variable	Model 1		Model 2	
	aOR	95% CI	aOR	95% CI
Sex: Female (Ref.: Male)	0.89	0.88–0.90	0.89	0.88–0.90
Race (Ref.: White)				
Black	0.69	0.67–0.70	0.69	0.67–0.70
Other	0.76	0.75–0.77	0.76	0.75–0.77
Age	1.56	1.55–1.57	1.56	1.55–1.57
Income, $ (Ref.: <15,000)				
15,000–25,000	0.78	0.77–0.79	0.78	0.77–0.79
25,000–35,000	0.75	0.74–0.77	0.75	0.74–0.77
35,000–50,000	0.87	0.85–0.88	0.87	0.85–0.88
>50,000	1.21	1.20–1.23	1.21	1.20–1.23
Mental distress, days (Ref.: 0 days)				
1–13	1.67	1.65–1.68	1.67	1.64–1.68
≥14	1.88	1.85–1.91	1.88	1.86–1.91
E-cigarette use (Ref.: no e-cigarette use)	2.32	2.29–2.36	2.32	2.29–2.35
Cigarette use (Ref.: no cigarette use)	2.28	2.24–2.31	2.28	2.24–2.31
T21 state (Ref.: not a T21 use)	0.70	0.65–0.74	0.87	0.73–1.03
Military (Ref.: never served)	0.68	0.66–0.70	0.69	0.67–0.71
Military × T21			0.81	0.69–0.95
Random intercept variance (State)	0.17		0.17	

Note: aOR = adjusted odds ratio; T21 = Tobacco21.

DISCUSSION

Nationally representative data from 11,827 individuals were used to determine the moderating effect of military service status on the relationship between living in a T21 state and alcohol use among individuals aged 18-20 years. Given the strong association between tobacco use and alcohol use and, moreover, that tobacco-using military service members are more likely to use alcohol than non-Veterans,[9,10] the authors hypothesized that the relationship between living in a T21 state and alcohol use would be moderated by military service status. Analysis revealed a small but significant difference in alcohol use rates for T21 states and non-T21 states when military service status was considered — that is, alcohol use rates were lower for military service members living in T21 states (19.81%) than for military service members living in non-T21 states (28.24%).

Some evidence from previous research suggests that military service members and Veterans may be more likely than non-Veteran civilians to comply with laws in the United States.[18,19] Therefore, individuals who are in the military and aged younger than 21 years may be more likely to comply with laws on tobacco use and alcohol consumption than individuals with no military service history. The results of this study may corroborate those of the aforementioned studies, in that the strongest predictor of alcohol use in this model (i.e., e-cigarette use) was least prevalent among military service members living in T21 states (7.42%).

Nevertheless, this study, along with others,[3–8] provides evidence in support of the implementation of federal T21 legislation and its capability to reduce smoking prevalence among individuals in the military and the general population. Previous studies have shown that 95% of adult smokers begin smoking before age 21 years,[36] with 18-21 years being the age range in which most smokers transition to regular use.[37] Smoking rates are highest among young adults who do not attend college and higher overall among military men and women than their civilian counterparts.[38,39] Moreover, there is a strong relationship between tobacco and alcohol use among young adults.[40] In particular, heavy use of one

substance (e.g., tobacco) is predictive of heavy use of the other (e.g., alcohol).[40,41] Binge drinking and alcohol dependence among military personnel is most often observed in young men, non-commissioned individuals, and individuals in lower ranks.[42]

Smoking alone contributes to more than 480,000 annual deaths and reduces life expectancy by at least 10 years.[43] The Institute of Medicine strongly concludes that T21 legislation will have a "substantial positive impact on public health and save lives" and will likely prevent or delay tobacco use initiation.[44] Studies show drops in cigarette and cigar sales,[5] as well as a high-end awareness and support among retailers, thereby reducing illegal tobacco sales in states in which the T21 law has been enacted.[2] Moreover, the National Academy of Medicine suggests the T21 law has the potential to reduce smoking initiation by 15%-25% among those aged 15-20 years, resulting in a 10% decrease in smoking-related deaths (by the time today's teens are adults) and a decrease of more than 220,000 smoking-related cancers and respiratory illnesses in the coming years.[44]

The results of this study show promise for the reduction of smoking rates among military service members and are in congruence with those of previous studies indicating decreases in smoking rates in T21 states.[3–8] Analysis also indicates lower alcohol use rates for military service members living in T21 states. Contrary to popular belief, there is no military exemption in the recently enacted federal T21 law. Therefore, the T21 law could have a significant positive impact on young military service members in terms of reduction in both tobacco and alcohol use. Consequently, reducing smoking rates before military service may result in reduced harmful alcohol consumption and improved physical performance readiness and health[38] and, in the long term, mitigate potential associated comorbid outcomes such as cancer, cardiovascular disease, and pulmonary conditions.[45]

Although the results of this study are encouraging, there continues to be a need for community- and school-based programs to help prevent the initiation of tobacco use. Enforcement of T21 laws is also essential. Future research is warranted to investigate the impacts, if any, of the T21 laws on alcohol consumption among teens, young adults, and young military service members, as well as on e-cigarette use, because the T21 law does not include an e-cigarette flavor ban.

Several limitations accompanied the collection and analysis of data in this study. First, respondents from several states were excluded because of an inability to determine the sub-state residential location of individuals in states with only local, not state-level, T21 policies. Therefore, the results of this study may not be generalizable to the entire U.S. population. In particular, the authors excluded the following states from the analysis: Illinois, Kansas, Missouri, New York, and Ohio. Second, it is possible that results could have been contaminated by social desirability bias, given the nature of the issues (i.e., illegal alcohol and tobacco consumption) studied in this report. Third, this study was cross-sectional in nature; therefore, the authors were unable to determine causal relationships between variables.

Fourth, the confidence interval around the odds ratio for the interaction term in the logistic regression model was wider than for all other covariates. As such, there is a need for additional studies on this topic to more accurately understand the effect of living in a T21 state on alcohol use in the military. Fifth, the demographic composition of the military subsample in this study, particularly in terms of race and gender, was not representative of the broader military population.[46] Sixth, the measure of military service status in this study did not differentiate between active-duty and retired service members; however, because the authors delimited the sample to those aged 18-20 years, it was assumed individuals in this sub-sample were active-duty military members. Seventh, the measure of mental distress was a one-item measure and may not be as internally valid as other measures, such as the Patient Health Questionnaire-9.[47] Eighth, the authors categorized some of the continuous measures in this study for reasons explained earlier in the article. Such an analytic strategy is criticized by some because of information loss.[48]

In conclusion, this study used nationally representative data to examine the association between living in a T21 state and alcohol use among individuals aged 18-20 years, with a focus on military service members. Results of this study showed alcohol usage rates were lower among service members living in T21 states without a military exemption than among service members living in non-T21 states. As such, these results point to a beneficial public health spill-over effect for tobacco legislation, particularly among military personnel and, moreover, provide an evidence basis for the recently enacted federal T21 legislation.

REFERENCES

1. US Food and Drug Administration. Retail sales of tobacco products [Internet]. Silver Spring (MD): The Administration; 2019 [cited 2020 May 28]. Available from: https://www.fda.gov/tobacco-products/compliance-enforcement-training/retail-sales-tobacco-products.
2. Zhang X, Vuong TD, Anderson-Rodgers E, et al. Evaluation of California's Tobacco 21 law. Tob Control. 2018;27(6):656–62. https://doi.org/10.1136/tobaccocontrol-2017-054088. Medline:29440328
3. Ali FRM, Rice K, Fang X, et al. Tobacco 21 policies in California and Hawaii and sales of cigarette packs: a difference-in-differences analysis. Tob Control. 2019;29(5):588–92. https://doi.org/10.1136/tobaccocontrol-2019-055031. Medline:31645377
4. Scheider SK, Buka SL, Dash K, et al. Community reductions in youth smoking after raising the minimum tobacco sales age to 21. Tob Control. 2016;25(3):355–9. https://doi.org/10.1136/tobaccocontrol-2014-052207. Medline:26071428
5. Glover-Kudon R, Gammon DG, Rogers T, et al. Cigarette and cigar sales in Hawaii before and after implementation of a Tobacco 21 law. Tob Control. 2021;30(1):98–102 https://doi.org/10.1136/tobaccocontrol-2019-055248. Medline:31932332
6. Friedman AS, Buckell J, Sindelar JL. Tobacco-21 laws and young adult smoking: quasi-experimental evidence. Addiction. 2019;114(10):1816–23. https://doi.org/10.1111/add.14653. Medline:31342591
7. Ahmad S, Billimek J. Limiting youth access to tobacco: comparing the long term health impacts of increasing cigarette excise taxes and raising the legal smoking age to 21 in the United States. Health Policy. 2007;80(3):378–91. https://doi.org/10.1016/j.healthpol.2006.04.001. Medline:16698112
8. Bonnie RJ, Stratton K, Kwan LY, editors. Public health implications of raising the minimum age of legal access to tobacco products. Washington (DC): National Academies Press; 2015.
9. National Institute on Alcohol Abuse and Alcoholism. Alcohol and tobacco. Alcohol Alert No. 39. Rockville (MD): The Institute; 1998.
10. Albright DL, Holmes L, Lawson M, et al. Veteran-nonveteran differences in alcohol and drug misuse by tobacco use status in Alabama SBIRT. J Soc Work Pract Addict. 2020;20(1):46–58. https://doi.org/10.1080/1533256x.2020.1705109.
11. Cavazos-Rehg PA, Breslau N, Hatsukami D, et al. Smoking cessation is associated with lower rates of mood/anxiety and alcohol use disorders. Psychol Med. 2014;44(12):2523–35. https://doi.org/10.1017/s0033291713003206. Medline:25055171
12. Dobbs PD, Chadwick G, Ungar KW, et al. Development of a tobacco 21 policy assessment tool and state-level analysis in the USA, 2015–2019. Tob Control. 2019;29(5):487–95. https://doi.org/10.1136/tobaccocontrol-2019-055102. Medline:31611425
13. Morian SR, Malek J. Minimum age of sale for tobacco products and electronic cigarettes: ethical acceptability of US "Tobacco 21 laws." Am J Public Health. 2017;107(9):1401–5. https://doi.org/10.2105/ajph.2017.303900. Medline:28727531
14. Cooper M, Yaqub M, Hinds JT, et al. A longitudinal analysis of tobacco use in younger and older US Veterans. Prevent Med Rep. 2019;16:100990. https://doi.org/10.1016/j.pmedr.2019.100990. Medline:31890466
15. Mattiko MJ, Olmsted KLR, Brown JM, et al. Alcohol use and negative consequences among active duty military personnel. Addict Behav. 2011;36(6):608–14. https://doi.org/10.1016/j.addbeh.2011.01.023. Medline:21376475
16. Richter L, Pugh BS, Peters EA, et al. Underage drinking: prevalence and correlates of risky drinking measures among youth aged 12–20. Am J Drug Alcohol Abuse. 2016;42(4):385–94. https://doi.org/10.3109/00952990.2015.1102923. Medline:26682472
17. Hermes ED, Wells TS, Smith B, et al. Smokeless tobacco use related to military deployment, cigarettes and mental health symptoms in a large, prospective cohort study among US service members. Addiction. 2012;107(2):983–94. https://doi.org/10.1111/j.1360-0443.2011.03737.x. Medline:22126651
18. Harwood HJ, Zhang Y, Dall TM, et al. Economic implications of reduced binge drinking among the military health system's TRICARE Prime plan beneficiaries. Mil Med. 2009;174(7):728–36. https://doi.org/10.7205/milmed-d-03-9008. Medline:19685845
19. Mumola CJ. Veterans in prison or jail. Bureau of Justice Statistics Special Report NCJ 178888. Washington (DC): US Department of Justice, Office of Justice Programs,; 2000.
20. Noonan ME, Mumola C. Veterans in state and federal prison, 2004. Bureau of Justice Statistics Special Report NCJ 217199. Washington (DC): U.S. Department of Justice, Office of Justice Programs; 2007.
21. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System: survey data and documentation [Internet]. Atlanta (GA): The Centers; 2020 [cited 2020 May 28]. Available from: https://www.cdc.gov/brfss/data_documentation/index.htm.
22. Centers for Disease Control and Prevention. 2016 summary data quality report [Internet]. Atlanta (GA):

The Centers; 2020 [cited 2020 May 28]. Available from: https://www.cdc.gov/brfss/annual_data/2016/pdf/2016-sdqr-508.pdf.
23. Centers for Disease Control and Prevention. 2017 summary data quality report [Internet]. Atlanta (GA): The Centers; 2020 [cited 2020 May 28]. Available from: https://www.cdc.gov/brfss/annual_data/2017/pdf/2017-sdqr-508.pdf.
24. Centers for Disease Control and Prevention. 2018 summary data quality report [Internet]. Atlanta (GA): The Centers; 2020 [cited 2020 May 28]. Available from: https://www.cdc.gov/brfss/annual_data/2018/pdf/2018-sdqr-508.pdf.
25. Centers for Disease Control and Prevention. Overview: BRFSS 2018 [Internet]. Atlanta (GA): The Centers; 2020 [cited 2020 May 28]. Available from: https://www.cdc.gov/brfss/annual_data/2018/pdf/overview-2018-508.pdf.
26. Centers for Disease Control and Prevention. BRFSS data quality, validity, and reliability: BRFSS data quality and national estimates [Internet]. Atlanta (GA): The Centers; 2020 [cited 2020 May 28]. Available from: https://www.cdc.gov/brfss/publications/data_qvr.htm.
27. McDaniel JT, Davis J, Anton PM, et al. Physical activity and mental distress among Veteran cancer survivors with heart disease and diabetes. J Mil Vet Family Health. 2019;5(2):67–74. https://doi.org/10.3138/jmvfh.2018-0010.
28. Danzo S, Connell AM, Stormshak EA. Associations between alcohol-use and depression symptoms in adolescence: examining gender differences and pathways over time. J Adolesc. 2017;56:64–74. https://doi.org/10.1016/j.adolescence.2017.01.007. Medline:28167374
29. McDaniel JT, Albright DL, Patrick SL, et al. Physical activity and mental health among Veteran lung and colorectal cancer survivors: results from the Behavioral Risk Factor Surveillance system. Mil Beh Health. 2019;7(2):238–44. https://doi.org/10.1080/21635781.2019.1580640.
30. McDaniel JT, Mayer AB, McDermott RJ, et al. Service member and Veteran mental distress rates and military-civilian residential segregation in South Carolina counties. Housing Society. 2019;46(3):157–69. https://doi.org/10.1080/08882746.2019.1668224.
31. Dobbs PD, Chadwick G, Ungar KW, et al. Development of a tobacco 21 policy assessment tool and state-level analysis in the USA, 2015–2019. Tob Control. 2019;29(5):487–95. https://doi.org/10.1136/tobaccocontrol-2019-055102. Medline:31611425
32. Tobacco21. US communities with Tobacco21 ordinances as of June 30, 2018 [Internet]. Tobacco21; 2019 [cited 2019 Oct 1]. Available from: https://tobacco21.org/wp-content/uploads/2018/06/T21-cities-as-of-June-30-2018-1.pdf.
33. Tompkins County Legislature. Adoption of local law no. b of 2017: a local law raising the legal age to 21 for tobacco sale and purchase [Internet]. Ithaca (NY): The Legislature; 2019 [cited 2019 Nov 7]. Available from: http://tompkinscountyny.gov/files2/wellness/tobaccofree/pos/T21_LegPktVote_2017-05-02.pdf.
34. Centers for Disease Control and Prevention. Complex sampling weights and preparing 2018 BRFSS module data for analysis [Internet]. Atlanta (GA): The Centers; 2020 [cited 2019 Oct 15]. Available from: https://www.cdc.gov/brfss/annual_data/2018/pdf/Complex-Smple-Weights-Prep-Module-Data-Analysis-2018-508.pdf.
35. Skrondal A, Rabe-Hesketh S. Prediction in multilevel generalized linear models. J R Stat Soc A Stat. 2009;172(3):659–87. https://doi.org/10.1111/j.1467-985x.2009.00587.x.
36. US Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality. National Survey on Drug Use and Health, 2014. Ann Arbor (MI): Inter-University Consortium for Political and Social Research; 2016.
37. Substance Abuse and Mental Health Services Administration. National Survey on Drug Use and Health [Internet]. Rockville (MD): The Administration; 2016 [cited 2020 May 28]. Available from: https://www.datafiles.samhsa.gov/study-series/national-survey-drug-use-and-health-nsduh-nid13517.
38. Lenk K, Rode P, Fabian L, et al. Cigarette use among young adults: comparisons between two-year college students, four-year college students, and those not in college. J Am Coll Health. 2012;60(4):303–8. https://doi.org/10.1080/07448481.2011.607481. Medline:22559089
39. Committee on Smoking Cessation in Military and Veteran Populations. Combating tobacco use in military and veteran populations. Washington (DC): National Academies Press; 2009.
40. Jiang N, Lee YO, Ling PM. Association between tobacco and alcohol use among young adult bar patrons: a cross-sectional study in three cities. BMC Public Health. 2014;14(1):500. https://doi.org/10.1186/1471-2458-14-500. Medline:24886521
41. Hurley LL, Taylor RE, Tizabi Y. Positive and negative effects of alcohol and nicotine and their interactions: a mechanistic review. Neurotox Res. 2012;21(1):57–69. https://doi.org/10.1007/s12640-011-9275-6. Medline:21932109
42. Waller M, McGuire ACL, Dobson AJ. Alcohol use in the military: associations with health and wellbeing.

Subst Abuse Treat Prev Policy. 2015;10(1):27. https://doi.org/10.1186/s13011-015-0023-4. Medline:26216215

43. Centers for Disease Control and Prevention. Tobacco-related mortality: smoking and tobacco use 2018 [Internet]. Atlanta (GA): The Centers; 2020 [cited 2020 Feb 20]. Available from: https://www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/tobacco_related_mortality/index.htm.
44. Institute of Medicine. Public health implications of raising the minimum age of legal access to tobacco products. Washington (DC): National Academies Press; 2015.
45. Rojewski AM, Baldassarri S, Cooperman NA, et al.; Comorbidities Workgroup of the Society for Research on Nicotine and Tobacco Treatment Network. Exploring issues of comorbid conditions in people who smoke. Nicotine Tob Res. 2016;18(8):1684–96.
46. MacLean A. A few good men and women: gender, race, and status in the wartime volunteer military. Pop Res Policy Rev. 2018;37(4):591–613. https://doi.org/10.1007/s11113-018-9479-z.
47. Kroenke K, Spitzer RL. The PHQ-9: a new depression diagnostic and severity measure. Psych Ann. 2002;32(9):509–15. https://doi.org/10.3928/0048-5713-20020901-06.
48. Giannoni A, Baruah R, Leong T, et al. Do optimal prognostic thresholds in continuous physiological variables really exist? Analysis of origin of apparent thresholds, with systematic review for peak oxygen consumption, ejection fraction, and BNP. PLoS One. 2014;9(1):e81699. https://doi.org/10.1371/journal.pone.0081699. Medline:24475020

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A knowledge translation intervention to promote evidence-based practices in ankle sprain management among Canadian Armed Forces physiotherapists: Six-month results

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ABSTRACT

Introduction: Lateral ankle sprain (LAS) is a common musculoskeletal injury among Canadian Armed Forces (CAF) members that challenges their physical readiness. The operational impact of LAS on the CAF may be minimized through evidence-based practice (EBP). This research project delivered a knowledge translation (KT) intervention tailored for CAF physiotherapists to improve their knowledge and performance of EBP in LAS management. **Methods:** All CAF physiotherapists (n = 67) were sent an invitation to complete an online questionnaire investigating their self-reported knowledge and performance of interventions and outcomes recommended in the management of LAS. One three-hour, active, multi-component KT intervention, including summarized research, point-of-care practice tools, and peer interaction, was then facilitated over a distance learning platform. The primary outcome was the median change reported on the online questionnaire before and six months after the KT intervention. **Results:** The response rate to the online questionnaire at six months was 64.2% (n = 43). Respondents reported improvements in their knowledge and performance of recommended rehabilitation interventions and outcome measures between baseline and six months. Some discrepancies between respondents' knowledge and performance of recommended outcome measures remained at six months. Unfamiliarity, use of competing outcome measures, or restraints in clinical settings explained these discrepancies, which may require changes at the clinical setting or organization level. **Discussion:** CAF physiotherapists improved their self-reported knowledge and performance of rehabilitation interventions and outcome measures recommended in LAS management six months after participation in an active, multi-component KT intervention delivered through distance learning. Further adoption of EBP may require changes at the clinical setting or organization level. These results should inform KT interventions directed at improving EBP by CAF physiotherapists and, conceivably, other CAF Health Services Centre providers.

Key words: ankle sprain, assessment, CAF, Canadian Armed Forces, evidence-based practice, health services, knowledge translation, LAS, musculoskeletal, physiotherapy, rehabilitation, treatment

RÉSUMÉ

Introduction : Les entorses latérales de la cheville (ELC) sont des blessures musculosquelettiques courantes chez les membres des Forces armées canadiennes (FAC), qui nuisent à leur aptitude physique. Il est possible de limiter les conséquences opérationnelles des ELC sur les FAC grâce à des pratiques fondées sur des données probantes (PDB). Le présent projet de recherche faisait appel à une intervention d'application du savoir (AS) adaptée aux physiothérapeutes des FAC afin de mieux faire connaître les PDB dans la prise en charge des ELC et d'en améliorer l'exécution. **Méthodologie :** Tous les physiothérapeutes des FAC ont été invité(e)s à remplir un questionnaire en ligne sur leurs connaissances et leur exécution autoévaluées des interventions et des résultats cliniques recommandés dans la prise en charge des ELC. Les concepteurs ont ensuite organisé une intervention d'AS active et polyvalente de trois heures sur une plateforme d'apprentissage à distance, incluant des résumés de recherche, des outils de pratique au point de service et une interaction entre collègues. Le résultat primaire était le changement médian déclaré dans le questionnaire en ligne avant l'intervention d'AS et six mois plus tard. **Résultats :** Le taux de réponse au questionnaire en ligne au bout de six mois s'élevait à 64,1 % (n = 43/67). Les répondant(e)s ont déclaré avoir accru leurs connaissances et leur exécution des interventions de

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réadaptation recommandées et des mesures de résultats entre le début de l'étude et six mois plus tard. Certains écarts ont été constatés entre les connaissances des répondants et l'exécution des mesures de résultats recommandées au bout de six mois. La méconnaissance, l'utilisation de mesures concurrentes ou les contraintes des milieux cliniques expliquaient ces écarts, qui peuvent exiger des changements aux milieux cliniques ou organisationnels. **Discussion :** Les physiothérapeutes des FAC ont accru leurs connaissances et leur exécution autodéclarées des interventions de réadaptation et des mesures de résultats recommandées pour la prise en charge des ELC six mois après leur participation à une intervention d'AS active et polyvalente donnée à distance. Pour adopter les PDB encore davantage, il faudra peut-être modifier le milieu clinique ou organisationnel. Ces résultats devraient éclairer les interventions d'AS visant à améliorer les PDB des physiothérapeutes des FAC et probablement celles d'autres prestataires de services de santé des FAC.

Mots-clés : application du savoir, ELA, entorse de la cheville, évaluation, FAC, Forces armées canadiennes, musculosquelettique, pratique fondée sur des données probantes, physiothérapie, réadaptation, services de santé, traitement

LAY SUMMARY

Physiotherapists employed in Canadian Armed Forces Health Services Centres maintained or improved their awareness and use of recommended assessments and treatments of ankle sprains six months after participating in a distance learning presentation. Further improvements may require administrative support locally, nationally, or both.

INTRODUCTION

Lateral ankle sprain (LAS) is among the most common musculoskeletal injuries sustained by soldiers, burdening the military with lost personnel hours, disrupted duties, and high rehabilitation workloads.[1] A substantial number of Canadian Armed Forces (CAF) members with LAS report persistent complaints, activity limitations, and recurrences that affect their physical readiness to complete duties and contribute to premature military release.[2,3] Should the consequences of LAS not be resolved through evidence-based practice (EBP), they may threaten the operational readiness of the CAF.

EBP in rehabilitation should be informed by EBP in knowledge translation (KT). In their systematic review of KT strategies used among allied health professionals, Scott et al. reported that education was the most commonly cited KT intervention.[4] However, Scott et al. cautioned against education-only KT interventions, proposing that behaviour change among health professionals is complex, and although education may improve knowledge, it alone may not change clinical practice. In their systematic review of KT interventions used among rehabilitation professionals, Jones et al. reported that active, multi-component KT interventions (i.e., educational meetings, summarized materials) were the most effective at improving physiotherapists' knowledge and practice.[5] Moreover, Hudon et al. proposed the value of conceptual frameworks to guide the implementation of KT interventions,[6] and the knowledge-to-action framework addressed the most barriers to EBP implementation reported by physiotherapists.[7]

CAF physiotherapists have reported some discrepancies from EBP in their management of LAS, including the frequent use of electrotherapy modalities, a limited prescription of balance and strengthening interventions, and limited use of balance and functional performance outcome measures.[8] They have also reported their preferred KT interventions as including summarized research, opportunities for peer interaction, and delivery through distance learning. Therefore, the purpose of this research project was to use the knowledge-to-action framework to guide an active, multi-component KT intervention tailored for CAF physiotherapists to improve their knowledge and use of rehabilitation interventions and outcome measures recommended by EBP in management of LAS.

METHODS

Approval for this study was provided by the Queen's University Health Sciences Research Ethics Board (REH653-16) and the CAF Surgeon General Health Research Program (2016-02-024-0004). The full methodology of this study and its three-month results have been previously published,[9] so only the salient points are summarized here.

All civilian and military physiotherapists employed in CAF Health Services Centres across Canada (CAF physiotherapists) were sent an email invitation to complete a baseline questionnaire. The questionnaire was an adapted version of the Self-Assessment of Knowledge and Frequency of Performance Survey that was designed to measure self-reported changes in knowledge and performance of EBPs by physiotherapists using a five-point

Likert scale (for Knowledge, 1 = unfamiliar, 2 = familiar, 3 = sufficient knowledge to perform, 4 = sufficient knowledge to teach informally, 5 = sufficient knowledge to teach formally; for Performance, 1 = never, 2 = rarely [1%-25%], 3 = sometimes [26%-50%], 4 = frequently [51%-75%], 5 = very frequently [76%-100%]).[10]

An active, multi-component distance learning presentation was developed that summarized the National Athletic Training Association's (NATA's) position statement on the conservative management and prevention of ankle sprains among athletes,[11] using a multimedia description of the position statement's recommended rehabilitation interventions and outcome measures and their operationalization for the CAF into point-of-care practice tools; a facilitated discussion of common barriers to and facilitators of implementation; and mitigating goal-setting strategies. The distance learning presentation was then uploaded to an electronic file-sharing platform to make it accessible to all CAF physiotherapists across Canada.

CAF physiotherapy team leaders were prompted to retrieve the distance learning presentation and share it with their teams in one three-hour session. Team leaders were asked to facilitate opportunities for peer interaction by intermittently pausing the presentation to encourage peer practice of the interventions, administer the outcome measures and facilitate discussion regarding perceived barriers, and use the mitigating goal-setting strategies relevant to their clinical setting. Team leaders were prompted to review these goals with their team once a month for three months. To contribute to the methodological quality of reporting of KT interventions, an implementation strategy was outlined according to the recommendations of the Workgroup for Intervention Development and Evaluation Research (online Supplemental Table 1).[12]

The questionnaire was re-administered at three months and six months after participation in the distance learning presentation to determine any self-reported change in knowledge and performance of EBPs.[9] Because of the ordinal nature of the data, the authors calculated the median scores for knowledge and performance and explored any differences between military or civilian CAF physiotherapist responses using Fisher's exact test (FET).

RESULTS

Figure 1 shows a flow diagram of the response rate. Data for 92 CAF physiotherapists were retrieved from the most current CAF physiotherapy personnel list. Eighty-nine respondents were deemed eligible, and 67 consented to participate by completing the survey at baseline, resulting in a response rate of 75.3%. Of those 67, 43 responded to the survey at six months, resulting in a response rate of 64.2%. The characteristics of respondents are shown in Table 1. Of the 43 respondents, 21 (48.8%) were military physiotherapists and 22 (51.2%) were civilian physiotherapists.

Overall, respondents reported a minor change in median score from 4 to 5 (out of 5) for knowledge and performance of one of the summarized components of

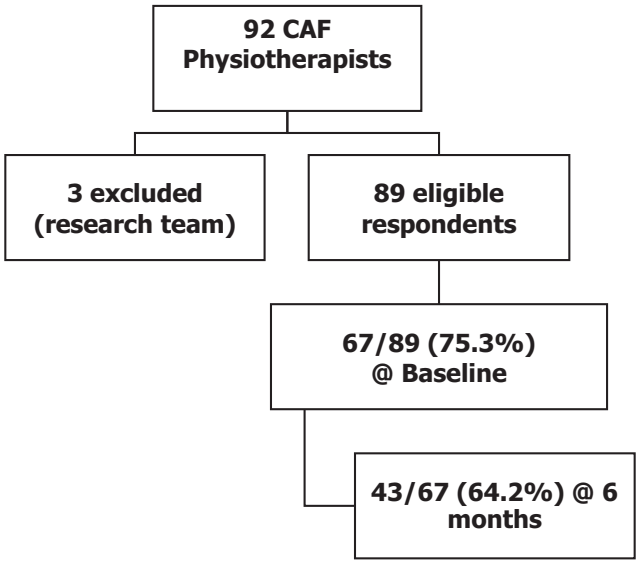

Figure 1. Survey response rate flow diagram

Notes: CAF = Canadian Armed Forces.

Table 1. Respondent characteristics

Respondent characteristics	*n* (%)	
	Baseline (*n* = 67)	6 mo (*n* = 43)
Age, y		
25–34	20 (29.9)	12 (27.9)
35–44	31 (46.3)	22 (51.2)
45–54	12 (17.9)	9 (20.9)
≥55	4 (6.0)	0 (0)
Gender		
Female	42 (62.7)	23 (53.5)
Male	25 (37.3)	20 (46.5)
Employment		
Military	29 (43.3)	21 (48.8)
Civilian	38 (56.7)	22 (51.2)

the NATA position statement, and they reported maintaining a median score of 5 for knowledge and performance of the remainder of the components, as well as for recommended interventions between baseline and six months (Table 2 and Table 3). When respondents were sorted into cohorts of military or civilian CAF physiotherapists, no significant differences were reported in their knowledge or performance ($p \geq 1.00$; FET).

Between baseline and six months, respondents reported improvements from 2 to 5 for knowledge and from 1 to 5 for performance of the Foot and Ankle Abilities Measure (FAAM) and from 3 to 4 for knowledge and from 2 to 4 for performance of both the Star Excursion Balance Test (SEBT) and the hop test (Figure 2).[13–15] In contrast, although respondents reported a consistent score of 4 in knowledge of the Patient Specific Functional Scale (PSFS) at baseline and six months, they reported only a minimal improvement in score from 2 to 3 for its performance.[16] When respondents were sorted into cohorts of military or civilian CAF physiotherapists, no significant differences were reported in their knowledge or performance ($p \geq 1.00$; FET).

Those respondents who reported performing the recommended outcome measures less than frequently (≤3) were invited to comment further. The most frequent comments explaining limited performance conveyed the habitual use of another outcome measure determined by the setting or standardized rehabilitation program (PSFS, $n = 6$; FAAM, $n = 6$; SEBT, $n = 4$; hop test, $n = 4$) or by setting restraints or challenges (SEBT, $n = 2$; hop test, $n = 2$). The most frequently reported standardized rehabilitation program was the Rehabilitation 4 Performance program ($n = 6$), and the most frequently reported habitual outcome measures were the Lower Extremity Functional Scale (LEFS) or the Foot and Ankle Disability Index (FADI; $n = 6$).[13] One respondent reported using the PSFS with other populations but had not considered using it with CAF members with LAS. Two respondents reported the flooring in their clinical setting presented a safety hazard for the hop test.

Between baseline and six months, respondents reported a change in median score from 4 to 5 in knowledge and from 2 or 3 to 4 in performance for supporting clinical colleagues to administer the recommended outcome measures or rehabilitation interventions (Table 4).

Respondents reported an improvement from 1 to 3 or 4 in knowledge, but a limited change from 1 to 2

Table 2. Median scores for knowledge and performance of summarized components of the NATA position statement

Summarized components of the NATA position statement	Baseline		6 mo	
	Knowledge	Performance	Knowledge	Performance
Prescribe functional treatment	5	5	5	5
Prescribe cold, compression, and elevation	5	5	5	5
Prescribe brace and ≥3 mo rehabilitation	4	4	5	5
Prescribe early comprehensive rehabilitation*	5	5	5	5

Note: Scores could range from 1 to 5. NATA = National Athletic Training Association.

* Comprehensive rehabilitation was defined as early progressive balance, mobility, and strength exercises during each phase of rehabilitation; acute, subacute, and rehabilitative.

Table 3. Median scores for knowledge and performance of recommended interventions

Recommended interventions	Baseline		6 mo	
	Knowledge	Performance	Knowledge	Performance
Avoid electrotherapy	5	5	5	5
Comprehensive rehabilitation*				
Acute phase	5	5	5	5
Sub-acute phase	5	5	5	5
Rehabilitative phase	5	5	5	5

Note: Scores could range from 1 to 5.

* Comprehensive rehabilitation was defined as early progressive balance, mobility, and strength exercises during each phase of rehabilitation; acute, subacute, and rehabilitative.

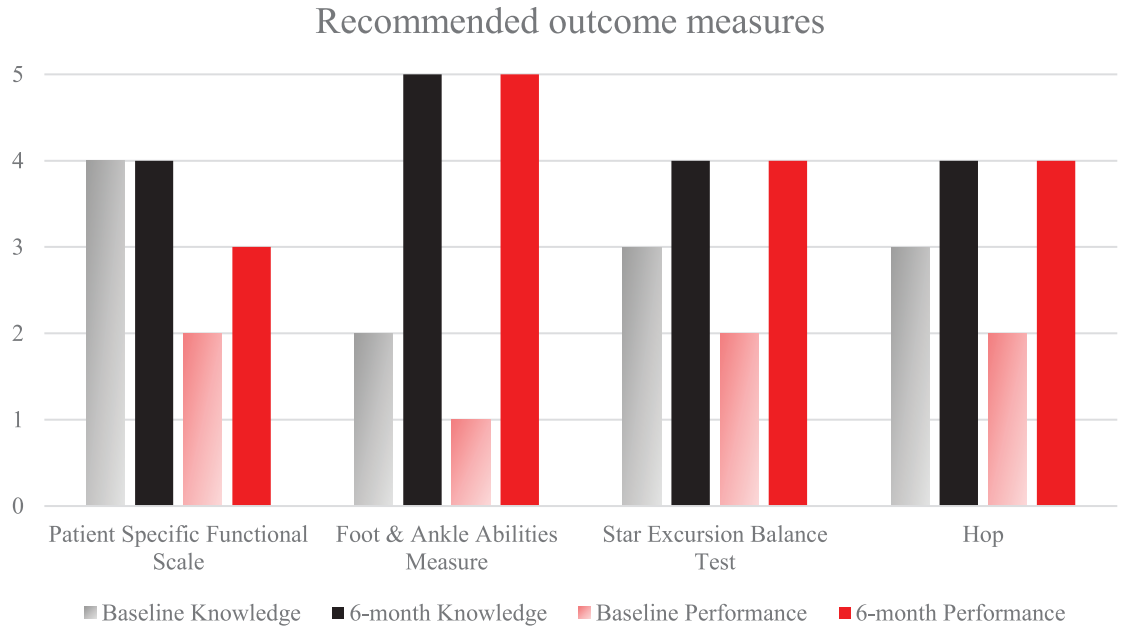

Figure 2. Median scores on recommended outcome measures for performance (red) and knowledge (black)
Notes: Scores could range from 1 to 5.

Table 4. Median scores on knowledge and performance for supporting clinical colleagues

Supporting clinical colleagues	Baseline		6 mo	
	Knowledge	Performance	Knowledge	Performance
Outcome measures	4	2	5	5
Rehabilitation interventions	4	3	5	5

Note: Scores could range from 1 to 5.

Table 5. Median scores on knowledge and performance for point-of-care practice tools

Point-of-care practice tools	Baseline		6 mo	
	Knowledge	Performance	Knowledge	Performance
Outcome measures reporting form	1	1	4	2
Comprehensive rehabilitation program	1	1	3	3

Note: Scores could range from 1 to 5.

or 3 in performance, for the point-of-care practice tools between baseline and six months (Table 5). The most frequent comment explaining limited use conveyed unfamiliarity with the tool ($n = 3$) or the habitual use of a standardized rehabilitation program ($n = 3$).

When asked whether participating in the distance learning presentation led to a change in their knowledge and performance of EBP in LAS management, 65% and 56% of respondents, respectively, reported yes. When asked which component of the distance learning presentation most influenced their knowledge and performance, respondents reported summarized research, followed by peer interaction opportunities, for both. All participants reported interest in participating in similar KT interventions to develop their use of EBP.

DISCUSSION

Although this study reported a loss of respondents between baseline and six months, the response rate of 64% remains comparable to the 60% response rate found in similar studies.[17] The authors attempted to minimize the risk of non-response by keeping the duration of the

questionnaire short (~10 min), providing it in both official languages (English and French), and requesting that team leaders provide respondents work time to complete it. The loss of more civilian, versus military, respondents introduces concern over sampling bias; however, the similar absolute number of civilian and military respondents, and the lack of significant differences between their reported rehabilitation interventions, minimize this concern.

When compared with the previous three-month results,[9] respondents maintained a median score of 5 on knowledge and performance of the summarized components of the NATA position statement and the recommended rehabilitation interventions. Interestingly, and without deliberate KT interventions, respondents reported either maintaining or improving their knowledge and performance of the recommended outcome measures between three and six months. Respondents reported continued improvements in knowledge and performance of the FAAM, from a median score of 4 at three months to 5 at six months. Some respondents reported the habitual use of other self-reported outcome measures, including the LEFS or the FADI. The LEFS is a Likert-scale instrument that assesses activity limitations of general lower-extremity musculoskeletal conditions, whereas the FADI is a Likert-scale instrument, divided into activities of daily living and sport activities, that assesses activity limitations of regional foot and ankle conditions.[13] Although each of these patient-reported outcome measures is considered appropriate for individuals who have sustained LAS, the FAAM has properties that make it more appropriate for CAF members.

When general patient-reported outcome measures, such as the LEFS, are used in athletic populations, ceiling effects, or scores at the high end of normal function, decrease the measure's sensitivity to determine activity limitations or responsiveness to interventions. For example, a ceiling effect was reported in a study of CAF members with LAS for whom LEFS scores had improved to the point where further change could not be measured, whereas improvements could still be determined using the FADI sport scores.[8] Because the FADI was revised by its authors in 2005 and renamed the FAAM, the FAAM has been recommended as the most appropriate patient-reported outcome measure to assess the activity limitations of CAF members with LAS.[8]

Respondents maintained their knowledge and performance of the PSFS between three and six months. As a measure of perceived functional capacity for patient-selected activity limitations, the PSFS has been recommended to measure the unique occupational and recreational needs of importance to CAF members.[9] One respondent's comment that the PSFS was believed to be only for specialized populations suggests that further adoption may require clarification. Some respondents reported that the selection of outcome measures was predetermined as part of a standardized rehabilitation program unique to their clinical setting. It was hoped that this implementation barrier would be revealed during the team leader-facilitated discussion of perceived barriers and mitigating goal-setting strategies. This finding suggests that an implementation strategy at the level of the clinical setting or organization may be necessary.

It is crucial to recall that effective KT interventions may not only require a change in clinician behaviour but may also require changes at the clinical setting or organization level.[4,5] In CAF physiotherapy, an implementation strategy at the level of the clinical setting may include integration of the PSFS into the outcome measures recorded during a standardized rehabilitation program, whereas an implementation strategy at the organization level may include integration of the PSFS into the outcome measures section of standardized patient assessment forms. The introduction of standardized rehabilitation programs and standardized digital documentation into electronic medical records may provide CAF physiotherapists with opportunities to engineer change at the clinical setting or organization level.

Respondents maintained a median score of 4 for both knowledge and performance of the objective outcomes SEBT and hop testing between three and six months. Although differing physical occupational requirements of the varied trades of CAF members would adequately explain selective use of hop testing, the report of safety concerns regarding appropriate flooring offers a valid justification for limited hop testing. The perceived risk of carrying out this outcome measure effectively restricted the respondent from implementing it in the clinical setting. Mitigating this safety risk may be out of the respondent's capability because it would require administrative action and resource allocation from organizational decision makers to resurface or replace flooring.

Respondents reported continued improvement in knowledge from 4 to 5 and in performance from 3 or

4 to 5 in supporting clinical colleagues to use recommended interventions and outcome measures between three and six months. This continued improvement suggests that respondents may have required additional time to develop sufficient confidence in their clinical colleagues' (i.e., physiotherapy support personnel, CAF medical technicians) proficiency. KT interventions that purposely focus on developing the proficiency of clinical colleagues may be an opportunity to accelerate EBP.

Overall, respondents did not appear to find the point-of-care practice tools of clinical utility, reporting a change from 2 or 3 to 3 or 4 in knowledge and performance between three and six months. The intention of these tools is to present EBP in a clinically usable format that could be easily applied at the point of care to directly support clinical decision making.[7] The habitual use of standardized rehabilitation programs that include standardized outcome measures offers some explanation for this finding. However, when one considers the considerable change in the reported use of the other recommended outcome measures, it may be that respondents did not perceive a need for practice tools to successfully implement EBP.

Respondents reported maintained or continued improvements in their knowledge, performance, or both between three and six months, despite the lack of deliberate KT interventions. All participants reported interest in participating in similar KT interventions to develop their use of EBP, which was gratifying because this active, multi-component KT intervention was tailored to their reported preferences.[8] Respondents consistently reported that summarized research was the KT intervention that most influenced their familiarity and performance at both three and six months, which initially prompted the suggestion that summarized research alone may have led to similar results.[9] However, at six months respondents reported that peer interaction opportunities were the next most influential KT intervention after summarized research. The largely standardized and hierarchical nature of the CAF provides a compelling argument for peer interaction's influence on clinical behaviour. The behaviour-changing techniques promoted in this KT intervention, and their proposed causal processes, offer an alternative explanation and are fully outlined in the online supplement. Given the low resource demands and positive results of this KT intervention, the implementation strategy used in this study should be considered to promote EPB for other musculoskeletal injuries managed by CAF physiotherapists and, conceivably, other CAF health professionals.

Limitations

The authors previously reported and addressed limitations to this project, including the risk of reporting and recall bias, lack of a control group, and a limited follow-up duration of three months.[9] They acknowledge not directly measuring tangible change in patient outcomes. A concurrent chart audit of CAF members with LAS being managed by CAF physiotherapists before and after the KT intervention may have permitted such an evaluation. Given that, at this time, CAF physiotherapy clinical documentation remains paper based and CAF physiotherapists are geographically divided across Canada, this design was considered logistically unrealistic. The current evolution of CAF physiotherapy toward digital documentation in the electronic medical record may provide a future opportunity to concurrently investigate the effectiveness of KT interventions on EBP and patient outcomes.

Conclusion

This study demonstrated that, six months after participation in an active, multi-component KT intervention, CAF physiotherapists reported improvements in self-reported knowledge and performance of rehabilitation interventions and outcome measures recommended by EBP in LAS management. These results add to the KT literature by reporting maintained or continued improvements in knowledge and performance for most recommended outcomes, despite a lack of deliberate intervention between three and six months. The authors acknowledge that further adoption may require changes at the clinical setting or organization level,[4, 5] and they propose some suggestions at those levels for consideration by CAF physiotherapy, including integration of recommended outcome measures into standardized rehabilitation programs, standardized assessment forms, or both. Moreover, it should be acknowledged that the knowledge-to-action framework encourages the regular monitoring of outcomes so as to continuously reveal any implementation barriers and address them with mitigating KT interventions as required.[7] As CAF physiotherapy evolves toward digital documentation, EBP may be operationalized to facilitate aggregate data collection and may thereby be used to evaluate patient outcomes, treatment efficacy, and cost effectiveness.

REFERENCES

1. Cameron KL, Owens BD, DeBarardino TM, et al. Incidence of ankle sprains among active duty members of the United States Armed Services from 1998 through 2006. J Athl Train. 2010;45(1):29–38.
2. Hébert, LJ. Are musculoskeletal injuries a hidden threat to the Canadian Armed Forces? J Mil Veteran Fam Health. 2016;2(1):2–4. https://doi.org/10.3138/jmvfh.0021.
3. Perron M, Hébert LJ, Moffet H, et al. L'entorse latérale de la cheville: une condition banalisée qui entraine des séquelles fonctionelles mais pour laquelle le physiothérapeute peut faire la difference [Lateral ankle sprains: a trivial condition causing functional limitations that physiotherapy can improve] [Internet]. Physio-Québec. 2008 [cited 2018 Mar 7];33(2):5–10. Available from: https://oppq.qc.ca/wp-content/uploads/physio_quebec_mai_08.pdf.
4. Scott SD, Albrecht L, O'Leary K, et al. Systematic review of knowledge translation strategies in the allied health professions. Impl Sci. 2012;7:70–87.
5. Jones CA, Roop SC, Pohar SL, et al. Translating knowledge in rehabilitation: systematic review. Phys Ther. 2015;95(4):663–77.
6. Hudon A, Gervais M-J, Hunt M. The contribution of conceptual frameworks to knowledge translation interventions in physical therapy. Phys Ther. 2015;95(4):630–9.
7. Graham ID, Logan J, Harrison BM, et al. Lost in knowledge translation: time for a map? J Contin Educ Health Prof. 2006;26(1):13–24. https://doi.org/10.1002/chp.47. Medline:16557505
8. Robitaille E, Agur A, Hébert LJ, et al. The optimization of the management of lateral ankle sprains by Canadian Armed Forces physiotherapists [Internet]. Surgeon General Health Research Program report number SGR-2015-003. Ottawa: Department of National Defence; 2015 [cited 2018 Mar 7]. Available from: https://sghrp.ca/reports/open-report.php?id=144.
9. Robitaille E, MacRae M, Rowe P, et al. A knowledge translation implementation strategy to promote evidence-based practices in the management of lateral ankle sprains by Canadian Armed Forces physiotherapists. J Mil Veteran Fam Health. 2019;5(2):50–9. https://doi.org/10.3138/jmvfh.2018-0041.
10. Schreiber J, Perry S, Downey M, et al. Implementation of an innovative continuing education program focused on translation of knowledge into clinical practice. J Phys Ther Educ. 2013;27(3):63–71. https://doi.org/10.1097/00001416-201307000-00009.
11. Kaminski TW, Hertel J, Amendola N, et al. National Athletic Training Association position statement: conservative management and prevention of ankle sprains in athletes. J Athl Train. 2013;48(4):528–45. https://doi.org/10.4085/1062-6050-48.4.02. Medline:23855363
12. Albrecht L, Archibald M, Arseneau D, et al. Development of a checklist to assess the quality of reporting of knowledge translation interventions using the Workgroup for Intervention Development and Evaluation Research (WIDER) recommendations. Impl Sci. 2013;8:52–6. https://doi.org/10.1186/1748-5908-8-52.
13. Martin RL, Irrgang J. A survey of self-reported outcome instruments for the foot and ankle. J Orthop Sports Phys Ther. 2007;37(2):72–84.
14. Hertel J. Functional instability following lateral ankle sprain. Sports Med. 2000;29(5):361–7. https://doi.org/10.2165/00007256-200029050-00005. Medline:10840868
15. Caffrey E, Docherty CL, Schrader J, et al. The ability of 4 single-limb hopping tests to detect functional performance deficits in individuals with functional ankle instability. J Orthop Sports Phys Ther. 2009;39(11):799–806. https://doi.org/10.2519/jospt.2009.3042. Medline:19881005
16. Horn KK, Jennings S, Richardson R, et al. The Patient-Specific Functional Scale: psychometrics, clinimetrics, and application as a clinical outcome measure. J Orthop Sports Phys Ther. 2012;42(1):30–42. https://doi.org/10.2519/jospt.2012.3727. Medline:22031594
17. Leemrijse CJ, Plas GS, Hofhuis H, et al. Compliance with the guidelines for acute ankle sprain for physiotherapists is moderate in the Netherlands: an observational study. Aust J of Physiother. 2006;52(4):293–9. https://doi.org/10.1016/s0004-9514(06)70010-1. Medline:17132125

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COMPETING INTERESTS

The authors have nothing to disclose.

CONTRIBUTORS

All authors conceived, designed, researched, and drafted the manuscript and approved the final version submitted for publication.

ETHICS APPROVAL

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REVIEW

Quantifying physiological responses during simulated tasks among Canadian firefighters: A systematic review and meta-analysis

Goris Nazari[a], Steve Lu[b] and Joy C. MacDermid[a]

ABSTRACT

Introduction: Firefighting involves a high level of physical exertion with tremendous physiological demands on the cardiorespiratory system. It is necessary to quantify levels of physical work exertion in firefighting to set the physical fitness standards that firefighters need to meet to improve their performance and task efficiency and possibly decrease injury risks. Therefore, the aim of this review was to provide a pooled estimate of the physiological demands of simulated firefighting tasks. **Methods:** The authors searched MEDLINE, EMBASE, PubMed, and Web of Science from April 1999 until April 2019. Prospective or retrospective cross-sectional cohort studies of career and professional firefighters or healthy participants in Canada were identified and critically appraised. Physiological demands included percentages of maximum heart rate (%HR_{max}) and maximal oxygen consumption (%VO_{2max}). The authors extracted the following data: author, year, country, study population, sample size, physiological variables, study type, and description of the simulated firefighting task or tasks undertaken. The STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines were used to assess the strengths and weaknesses of the included studies. **Results:** Ten eligible studies were included with a total of 492 participants. The pooled estimates for %HR_{max} were 86.0% (six studies, 296 participants; 95% CI, 82.0-90.0). Subgroup analysis by sex indicated random pooled estimates of 86.0% for men (three studies, 75 male participants; 95% CI, 79.0-92.0) and 87.0% for women (three studies, 49 female participants; 95% CI, 79.0-94.0). Regarding %VO_{2max} (ml/kg/min) demands during the simulated firefighting tasks, a random pooled estimate of 65.0% (four studies, 210 participants; 95% CI, 59.0-71.0) was reported. **Discussion:** Simulated firefighting tasks are physiologically demanding. The development of firefighter-specific strength and conditioning programs, with regular monitoring, is warranted.

Key words: Canada, conditioning, firefighters, heart rate, physical work exertion, physiological responses, simulated firefighting tasks, strength

RÉSUMÉ

Introduction : La lutte contre l'incendie exige un grand effort physique et un énorme effort physiologique sur le système respiratoire. Il faut quantifier le niveau d'effort physique nécessaire pour la lutte contre l'incendie afin d'établir les normes d'aptitudes physiques dont ont besoin les pompiers pour améliorer leur rendement, l'efficacité à leur tâche et peut-être réduire le risque de blessures. Ainsi, la présente analyse vise à fournir une estimation globale de l'effort physiologique nécessaire pendant la simulation des tâches de lutte contre l'incendie. **Méthodologie :** Les auteur(e)s ont cherché dans les bases de données MEDLINE, EMBASE, PubMed et Web of Science entre avril 1999 et 2019. Ils en ont extrait les études de cohorte transversales prospectives ou rétrospectives des pompiers professionnels ou des participants en bonne santé du Canada et en ont fait l'analyse critique. L'effort physiologique incluait le pourcentage de fréquence cardiaque (%FC_{max}) et la consommation maximale d'oxygène (%VO_{2max}). Les auteurs ont recueilli les données (auteur, année, population à l'étude, taille de l'échantillon, variables physiologiques, type d'étude et description de la simulation des tâches de lutte contre l'incendie). Ils ont utilisé les études STROBE (*Strengthening the Reporting of Observational studies*, ou renforcer la déclaration des études d'observation) pour évaluer les forces et les faiblesses des études. **Résultats :** Dix études admissibles ont été incluses, pour un total de 492 participants. Les estimations regroupées de %FC_{max} s'élevaient à 86,0 % (six études, 296 participants; IC à 95 %, 82,0 à 90,0). L'analyse

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de sous-groupe selon le sexe indiquait une estimation groupée aléatoire de 86,00 % (trois études, 75 participants de sexe masculin; IC à 95 %, 79,0 à 92,0) et une estimation de 87,00 % (trois études, 49 femmes participantes; IC à 95 %, 79,0 à 94,0). Pour ce qui est du %VO_{2max} (mL/kg à la minute) pendant la simulation des tâches de lutte contre l'incendie, l'estimation groupée aléatoire était de 65,0 % (quatre études, 210 participants; IC à 95 %, 59,0 à 71,0). **Discussion :** La simulation des tâches de lutte contre l'incendie est exigeante sur le plan physiologique. Le développement de la force et des programmes de force et de conditionnement propres aux pompiers, suivi régulièrement, s'impose.

Mots-clés : Canada, conditionnement, effort physique, force, fréquence cardiaque, pompiers, réponses physiologiques, simulations de tâches de lutte contre les incendies

LAY SUMMARY

Firefighting involves a high level of physical exertion with tremendous demands on the heart and body. It is necessary to quantify levels of physical work exertion in firefighting to set physical fitness standards firefighters need to meet to improve performance, efficiency, and possibly decrease injury risks. Researchers need to focus on and develop exercise programs that are specific to firefighters so that they can be prepared and able to do their work safely.

INTRODUCTION

It has been estimated that, during a 10-year period between 1995 and 2004, cardiovascular disease (CVD) accounted for 45% of all U.S. firefighter duty-related fatalities.[1–3] In addition, Fahy et al. indicated that, in the past five years, approximately 42% of on-duty mortality was due to sudden cardiac death.[4] The rate of 45% among firefighters represents an overwhelmingly higher proportion of on-duty mortality rate due to CVD than that reported among on-duty police officers (22%) or on-call emergency medical service workers (11%).[5–6] This is due to a combination of factors unique to firefighting that includes elevated sympathetic nervous system activation, high levels of physical work exertion, heat stress and dehydration, and environmental (smoke) exposures, further mediated by individual characteristics: health status (i.e., cardiovascular risk factors such as smoking, obesity, and hypertension) and physical fitness (i.e., minimum aerobic fitness level of 42 ml/kg/min).[7]

Firefighting involves high levels of physical work exertion with tremendous demands on the cardiorespiratory system.[8–9] Therefore, it is necessary to quantify levels of physical work exertion for firefighting to set physical fitness standards that firefighters need to possess to improve performance and task efficiency and possibly decrease the risk of injury.[8–9] However, it is difficult to quantify the actual levels of physical work exertion and demands among firefighters during real fire emergency situations. Therefore, researchers have attempted to estimate such levels of physical work demands by conducting simulated firefighting exercises or tasks.[9–18] Simulated firefighting tasks are similar to regular on-duty tasks performed by firefighters in a controlled environment at a safe and efficient pace.[9–18] Certain simulated firefighting tasks are also included in the Candidate Physical Ability Test or have been developed through discussions and consultation with firefighters, commanders, or district chiefs. Numerous individual studies have attempted to estimate the overall levels of physiological response — often represented as percentage of maximum heart rate (%HR_{max}) or maximal oxygen consumption (VO_{2max}) during vigorous exercise in a given period — during various simulated firefighting tasks or sets of tasks.[9–18] It is also widely acknowledged that different tasks require varying physiological demands.[8–9] Providing an overall summary — pooled estimates — and examining the degree to which simulated firefighting tasks affect firefighters' physiology may assist in providing physical fitness recommendations and requirements for the duration of firefighters' careers. Moreover, it would facilitate the design and implementation of appropriate aerobic conditioning programs to further enhance firefighters' health status and physical fitness. Such programs would ultimately improve performance and task efficiency and keep firefighters safe. Therefore, the authors conducted a systematic review and meta-analysis of cross-sectional observational studies and attempted to:

1) highlight physiological demands during various simulated firefighting tasks,
2) provide a pooled estimate of the physiological demands (%HRmax, %VO_{2max}, and peak oxygen consumption [%VO_{2Peak}]) during simulated firefighting tasks
3) assess the strengths and weaknesses of the included observational studies using STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines.

METHODS

The authors followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[19] In addition, the STROBE guidelines were used to assess strengths and weaknesses of the included observational studies (protocol registration no. PROSPERO CRD 42019133622).

Eligibility criteria

Studies were included in the systematic review if they met the following criteria:

- *Design:* Prospective or retrospective cross-sectional cohort study
- *Participants:* Career or professional Canadian firefighters or healthy participants
- *Outcomes:* Heart rate (beat per minute [bpm]), $\%HR_{max}$, volume of gaseous exchange (VO_2 [ml/min], VO_{2Peak} [ml/kg/min], $\%VO_{2max}$)
- *Simulated firefighting tasks:* Tasks similar to regular on-duty tasks performed by firefighters; tasks included in the Candidate Physical Ability Test or the Canadian Forces Firefighter Physical Fitness Maintenance Evaluation; or tasks developed through discussion and consultation with firefighters and firefighter captains, commanders, or district chiefs.

Conference papers, abstracts, and posters were excluded.

Information sources

Two authors (SL and GN) performed systematic electronic searches to identify relevant randomized prospective or retrospective cross-sectional studies in MEDLINE, EMBASE, PubMed, and Web of Science from April 1999 until April 2019. Several different combinations of keywords were used, such as *firefighters, firemen, live fire drills, firefighting training exercise, firefighting training, live fire training, simulated firefighting work, physiological response,* and *heart rate*. These two authors also carried out a manual search of the references of all studies included.

Study selection

Two independent reviewers (SL and GN) carried out the systematic electronic searches in each database, and then categorized and removed duplicate studies. Next, the reviewers performed independent screening of the titles and abstracts and retrieved, in full text, any study marked "include" or "uncertain." Finally, these reviewers performed independent full-text reviews to determine final study eligibility.

Data collection process

Two independent researchers (GN and SL) extracted the data from the eligible articles. Data extracted were the author, year, study population, country, sample size, physiological variables quantified, study type, and description of the simulated firefighting task or tasks undertaken. When insufficient data were presented, GN contacted the authors by email and requested further data.

Assessment of the studies' strengths and weaknesses

Two independent reviewers (JC and GN) examined the quality of reporting of observational studies using the STROBE statement.[20] The STROBE statement consists of a checklist of 22 items that relate to the title and abstract (indication of appropriate title and abstract), introduction (adequate rationale and specific objectives), methods (study design, description of the settings, participants, variables, data sources, sample size calculation, source of bias, and statistical analysis), results (description of participants, data, outcomes, and main findings), and discussion (key results, limitations, interpretation, generalizability, and funding) sections of articles.[20]

Subgroup analysis and exploration of heterogeneity

In the presence of heterogeneity, the authors planned to perform subgroup analyses (a priori) based on sex (men vs. women) and different simulated firefighting tasks. An I^2 estimate of at least 50% was used to interpret evidence of a substantial problem with heterogeneity.[21]

Synthesis of results

A qualitative synthesis was performed to report study findings. The authors summarized the main results of the included articles on the basis of the physiological demands quantified and simulated firefighting tasks performed. The authors performed 13 meta-analyses of studies to pool estimates of the physiological demands (%HRmax, $\%VO_{2max}$, and $\%VO_{2Peak}$) during simulated firefighting tasks (these estimates were also determined by sex). Study-specific estimates were pooled using a random-effects model. The percentage (random effect) and 95% CIs were summarized in forest plots. Software programs (MedCalc [Version 16.2.1, MedCalc, Ostend, Belgium] and StatsDirect [Version 3, StatsDirect Ltd., Merseyside, United Kingdom]) were used to facilitate all statistical analyses.

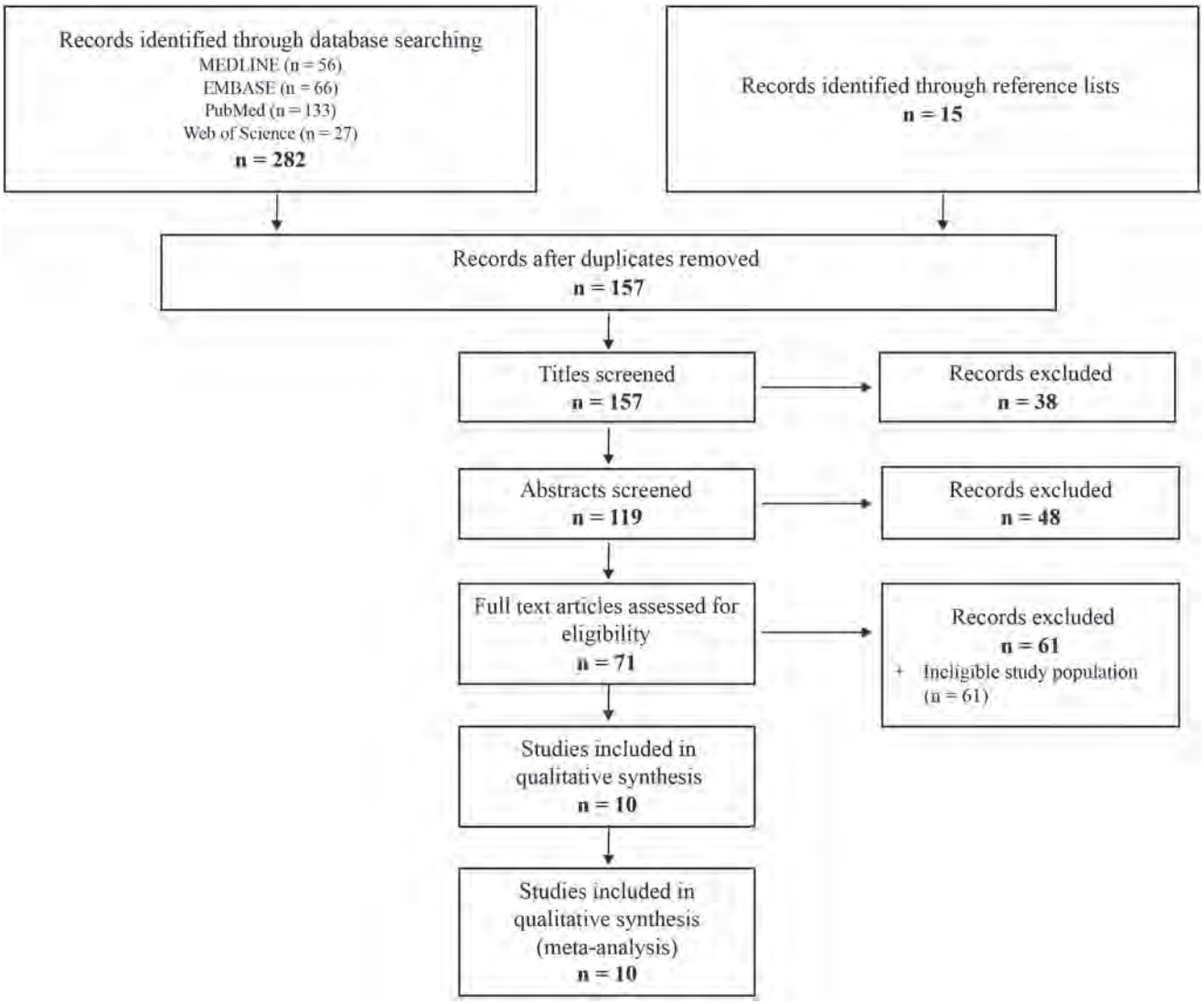

Figure 1. Selection of Studies for Inclusion in the Systematic Review.

RESULTS

Study selection

Initially, the electronic search yielded 297 publications. After removing duplicates, 157 studies remained and were screened using title and abstract information, leaving 71 studies designated for full-text review. A total of 61 articles were excluded because of ineligible study populations (i.e., they included U.S., European, and Australian firefighters). Ten studies were eligible to proceed to data extraction and meta-analysis. The flow of studies through the selection process is presented in Figure 1.

Study characteristics

The 10 eligible, cross-sectional, prospective cohort studies were conducted between 2000 and 2018 and included 492 participants. Study size ranged from 17 to 148 participants. Studies were conducted in various provinces across Canada. A summary description of all included articles is presented in Table 1.

Assessment of the strengths and weaknesses of studies

The strengths and weaknesses of each study (i.e., the reporting items of individual cross-sectional studies) were assessed using the STROBE guidelines (Table 2). The most commonly missed items noted were 1) failure to indicate the study's design with a commonly used term in the title or the abstract, 2) inadequate presentation of the key elements of study design early in the article, 3) lack of clarity or effort to address potential sources of bias, and 4) lack of sample size calculation or justification.

Table 1. Select characteristics of studies reporting on the physiological responses during simulated firefighting tasks

Study	Population	Sample size	Physiological responses	Study type	Simulated firefighting task details
Williams-Bell et al.[11] Professional firefighters, City of Toronto Fire Services Toronto, Ontario, Canada	33 men, 3 women (mean age 40.7 y [SD 6.6], with a mean 12.0 y [SD 8.5] of service)	*N* = 36	VO_2 (ml/min) VO_{2max} (ml/kg/min) $\%VO_{2max}$ $\%HR_{max}$ HR bpm	Prospective cohort	Firefighters wore full PPE (bunker pants and jacket, flash hood, gloves, helmet, and boots) that weighed approximately 9.2 kg and an integrated Cosmed K4b2-SCBA system (weight 9.5 kg). Before each task, firefighters stood for 2 min while breathing room air through the SCBA face mask to collect pre-exercise data. The tasks were completed at a self-selected pace with 2 hr separation between the high-rise stair climb and fifth-floor search and rescue tasks. *High-Rise Stair Climb Task* "The high-rise stair climb scenario was implemented to determine the total number of flights of stairs firefighters were capable of climbing, while carrying an additional 18 kg high-rise pack (consisting of two 38 mm hose bundles). Vertical ascent was terminated when firefighters had consumed 55% of the air in their cylinder allowing 20% for exit before their low air alarm sounded, or on reaching the top (23rd) floor. At the point of 55% depletion, the subjects were requested to drop the high-rise pack and descend the stairs in order to achieve a safe exit." *Fifth-Floor Search and Rescue Task* "1. Ascend five stories while carrying an additional 18 kg high-rise pack. Five stories were chosen as this is normally the maximum number of floors climbed without the use of an elevator in a high-rise structure, 2. On arriving at the fifth floor, the firefighter dropped the high-rise pack and crawled on hands and knees in order to advance an un-charged 38 mm hose line a distance of 18.3 m. At intervals throughout the hose advance each firefighter completed three separate room searches (average area 15.6 m^2) that simulated a scan for a victim, 3. After the search, the firefighter used a sledge hammer to hit a forcible entry simulator in order to breach a door (simulator set to a resistance between 700 and 800 psi [4826–5516 kN/m2], requiring at least four solid strikes), 4. Enter the room and rescue a 75 kg mannequin a distance of 23 m back to the stairwell, 5. Descend five stories in order to achieve a safe exit."
Williams-Bell et al.[10] Professional firefighters, City of Toronto Fire Services Toronto, Ontario, Canada	33 men, 3 women (Mean age 41.5 y [SD 6.5] with a mean 12.0 y [SD 8.5] of service)	*N* = 36	VO_2 (ml/min) VO_{2Peak} (ml/kg/min) $\%VO_{2max}$ VCO_2 (ml/min) $\%HR_{max}$ HR bpm	Prospective cohort	Firefighters wore full PPE (bunker pants and jacket, flash hood, gloves, helmet, and boots) that weighed approximately 9.2 kg and integrated Cosmed K4b2-SCBA system (weight 8.4 kg). Before each task firefighters stood for 2 min while breathing room air through the SCBA face mask to collect pre-exercise data. Two firefighters (A and B) were randomly paired and completely instrumented. The tasks were completed at a self-selected pace. *Simulated Subway Task* "1. 1-Floor Descent: Descend 1 story (11.6 m) while carrying an additional 22 kg high-rise pack (consisting of a hose nozzle and 2 lengths of 44 mm hose) over their shoulder, 2. Approach Walk: Walk 183 m into the station and along the length of one subway tunnel. Pick up the specialized subway access ladder hanging track side and walk an additional 101 m toward a subway car,

(Continued)

Table 1. (Continued)

Study	Population	Sample size	Physiological responses	Study type	Simulated firefighting task details
					3. Ladder Setup: Drop and leave the 22 kg high-rise pack and attach the ladder to mount the subway car, 4. Car Search: Perform a 55 m search for a victim through 2 subway cars, 5. Guide–Rescue: Firefighter A rescues the 75 kg mannequin a distance of 27.5 m through the first subway car, while firefighter B acts as a guide to avoid potential obstacles. Subsequently, firefighter B rescues the victim through the second subway car, while firefighter A acts as a guide. The firefighter drags the mannequin using the 2 shoulder straps attached to the harness, which are indicative of the technique that would be used to rescue a fallen firefighter, 6. Retreat Walk: Descend the subway car and walk 284 m back to the base of the stairwell, 7. 1-Floor Ascent: Ascend 1 story to safely exit the fire scene."
Petersen[15] Healthy volunteers Canada	15 men, 2 women (mean age 27.7 y [SD 8.09]; mean height 179.1 cm [SD 7.03]; mean body mass 78.7 kg [SD 10.8])	*N* = 17	%HR_{max} HR bpm	Prospective cohort	Firefighters performed the SFWC while wearing full firefighting turnout gear and SCBA, at a self-selected pace. *SFWC* "1. *Stair climb event*: From the starting point on the field-house floor, subjects lifted and carried a high-rise hose-pack (18.2 kg) up the stairs to the top of the spectator seating area (vertical rise of 14.5 m). The pack was placed on a mark on the floor and then the subject walked quickly to the next event which was approximately 30 m away and up another set of stairs with vertical rise of 1.5 m, 2. *Rope pull event*: A roll of 65 mm hose in a net bag (total weight 25 kg) was raised and lowered a vertical distance of 16.7 m using 16 mm nylon rope and a hose roller. Subjects then returned to the high-rise pack, picked it up and descended back to the field-house floor, 3. *Victim drag event*: Subjects lifted and dragged (while walking backwards) a rescue mannikin (82 kg) along a straight line for a distance of 15 m, 4. *Forcible entry event*: In a forcible entry simulation, subjects used a 'dead-blow' sledge-hammer to move a steel box (weighing 75 kg) along a metal track for a distance of approximately 1.5 m, 5. *Hose drag event*: Three lengths of 65 mm hose and nozzle were dragged 60 m to the finish line."
Nazari[9] Firefighters Hamilton, Ontario, Canada	46 men, 3 women (mean age 33.66 y [SD 9.19]; mean height 181 cm [SD 0.08]; mean body mass 90.35 kg [SD 13.22])	*N* = 49	HR bpm %HR_{max} (age predicted) RR	Prospective cohort	Firefighters performed the simulated tasks in full PPE (22.7 kg) and SCBA (18.1 kg), at a pace used at a fire scene. *Hose Drag Task* "A designated start/finish line was established from which each task was initiated and terminated. The hose drag task required firefighters to begin in standing, at the designated start/finish position. When instructed to begin, the firefighters bent to floor level and lifted the nozzle (6.10 kg.) of an uncharged firefighting hose (30m). The firefighters were given standardized instructions to pull the uncharged fire hose a distance of 18m to a pylon. Once at the pylon, the firefighters maneuvered the hose around the pylon at 90 degrees and pulled the hose to an end marker (12m from the pylon). The firefighters then repeated the task while returning the nozzle to the start/finish line. Firefighters were timed while performing the task using a stopwatch.

(*Continued*)

Table 1. (Continued)

Study	Population	Sample size	Physiological responses	Study type	Simulated firefighting task details
					Stair Climb with a High-Rise Pack Task "Firefighters retrieved and lifted a high-rise pack (18.1 kg) from floor level to their preferred shoulder. The high-rise pack was contained with a green strap and included two links of hose and a nozzle. Once the firefighters stabilized the high-rise pack on their preferred shoulder, they ascend and descend stairs to the 4th floor of the training facility (112 total steps). Firefighters were again timed while performing the task using a stopwatch."
Nazari[9] Firefighters Hamilton, Ontario, Canada	46 men, 3 women (mean age 33.66 y [SD 9.19]; mean height 181 cm [SD 0.08]; mean body mass 90.35 kg [SD 13.22])	*N* = 49	HR bpm %HR_{max} (age predicted) RR	Prospective cohort	Firefighters performed the simulated tasks in full PPE (22.7 kg) and SCBA (18.1 kg), at a pace used at a fire scene. *Hose Drag Task* "A designated start/finish line was established from which each task was initiated and terminated. The hose drag task required firefighters to begin in standing, at the designated start/finish position. When instructed to begin, the firefighters bent to floor level and lifted the nozzle (6.10 kg.) of an uncharged firefighting hose (30m). The firefighters were given standardized instructions to pull the uncharged fire hose a distance of 18m to a pylon. Once at the pylon, the firefighters maneuvered the hose around the pylon at 90 degrees and pulled the hose to an end marker (12m from the pylon). The firefighters then repeated the task while returning the nozzle to the start/finish line. Firefighters were timed while performing the task using a stopwatch. *Stair Climb with a High-Rise Pack Task* "Firefighters retrieved and lifted a high-rise pack (18.1 kg) from floor level to their preferred shoulder. The high-rise pack was contained with a green strap and included two links of hose and a nozzle. Once the firefighters stabilized the high-rise pack on their preferred shoulder, they ascend and descend stairs to the 4th floor of the training facility (112 total steps). Firefighters were again timed while performing the task using a stopwatch."
Sinden[14] Firefighters Southwestern Ontario, Canada	143 men, 5 women (mean age 41.9 y [SD 9.6]; mean height 170.9 cm [SD 2.9]; mean body mass kg 92.0 [SD 28.6])	*N* = 148	HR bpm %HR_{max} (age predicted)	Prospective cohort	Firefighters performed the tasks in full bunker gear (22.7 kg) plus SCBA (18.1 kg.), at a pace used at a fire scene. *Hose Drag Task* "A designated start/finish line was established from which the task was initiated and terminated. Firefighters initiated the task in standing at a designated start/finish position. When instructed to begin, the firefighters bent to floor level and lifted the nozzle (6.1 kg.) of an uncharged firefighting hose (30 m). The firefighters were given standardized instructions to pull the uncharged fire hose a distance of 18 m to a pylon. Once at the pylon, the firefighters maneuvered the hose around the pylon and pulled the hose to an end marker positioned 12m from the pylon. The firefighters then reversed the task components to return the nozzle to the start/finish line. Participants were timed while performing the task."

(*Continued*)

Table 1. (Continued)

Study	Population	Sample size	Physiological responses	Study type	Simulated firefighting task details
Petersen & Dreger[13] Healthy volunteers with regular physical activity patterns Canada	13 men (mean age 25.6 y [SD 3.9]; mean height 179.4 cm [SD 6.2]; mean body mass kg 86.2 [SD 8.7]; mean mass in PPE 110.1 kg [SD 8.4]), 12 women (mean age 23.9 y [SD 3.4; mean height 169.8 cm [SD 6.4]; mean body mass 67.7 kg [SD 6.1]; mean mass in PPE 91.2 kg [SD 6.7])	*N* = 25	VO_2 (ml/min) VO_2 (ml/kg/min) $\%VO_{2max}$ $\%HR_{max}$ HR bpm	Prospective cohort	Participants were in NFPA Standard 1500 duty coat, firefighting pants, helmet, anti-flash hood, leather work gloves or firefighting gloves, rubber firefighting boots and a Scott 4.5 harness with 60-min Scott Air-Pac fibre composite air cylinder. "Scenarios One and Two were developed (Fire-Rescue Tasks) that each included: • 8 blacked out rooms filled with non-toxic smoke on two levels • staircase between levels • two fire props • two hose-lines (charged 38 mm hose) • two victims (70 kg "Rescue Randy" mannequins) to be found and removed to triage area 15 m from point of entry" *Scenario 1* "When completing Scenario One, the fire-rescue team entered on the ground floor and finished their search on the upper level. This scenario ended when the second victim was evacuated *down* the stairs to the triage area." *Scenario 2* When completing Scenario Two, the fire-rescue team entered on the upper floor and finished their search on the lower level. This scenario ended when the second victim was evacuated *up* the stairs to the triage area. In each case, the triage area was located 15 m from the point of entry into the search area."
Williams-Bell[16] Healthy, physically active subjects Canada	34 men (mean age 24.3–20.5 y [SD 5.6–2.1]; mean height 180–173.5 cm [SD 6.9–10.6]; mean body mass 81.8–77.0 kg [SD 12.2–17.0]), 23 women (mean age 24.2–22.1 [SD 3.3–1.9]; mean height 167.8–166.0 cm [SD 4.9–4.1]; mean body mass 64.7–61.3 kg [SD 10.4–10.8])	*N* = 57	VO_2 (ml/min) VO_2 (ml/kg/min) $\%VO_{2\,max}$ VCO_2 (ml/min) $\%HR_{max}$ HR bpm	Prospective cohort	*CPAT* "The CPAT was conducted in accordance with the actual administration of the test for firefighter candidate recruits with the exception of wearing the Cosmed K4b2 throughout the test. Participants wore a 22.68-kg vest to simulate the weight of the [SCBA] and firefighter protective clothing ensemble as well as safety gloves and protective hard helmet. The CPAT protocol consists of eight events in a continuous circuit with a 22.9-m walk between each of the events." *Stair Climb* "Subjects wore two additional shoulder weights (5.67 kg each) to simulate the weight of a high-rise pack and climbed on the step mill (Stair Master, Stepmill 7000 PT, StairMaster Sports, Kirkland, WA) for 3 min at a stepping rate of 60 steps per min." *Hose Drag* "Subjects dragged a 44-mm hose equipped with a 3-kg automatic nozzle at a distance of 22.86 m to a pre-positioned drum then made a 90° turn and dragged the hose to an additional 7.62 m. The subject then dropped to one knee and pulled the hose for 15.24 m." *Equipment Carry* "Subjects removed two saws (14.5 and 12.7 kg, respectively), one at a time, from a tool cabinet and placed them on the floor. They picked up both saws and walked 22.86 m around a prepositioned drum and back to the starting point. At the tool cabinet, subjects placed the saws on the ground and then put them one at a time back into the cabinet."

(*Continued*)

Table 1. (Continued)

Study	Population	Sample size	Physiological responses	Study type	Simulated firefighting task details
					Ladder Raise and Extension "Subjects grabbed a 7.32-m ladder by the top rung and walked it up, using each rung on the ladder, until it was placed against the wall. Subjects then proceeded to a secured ladder and extended it 7.32 m to its stopper before lowering it in a controlled manner back to the ground." *Forcible Entry* "Subjects picked up a 4.54-kg sledgehammer and struck the forcible entry device until a buzzer was activated. The forcible entry device simulated hitting a door and had a resistance between 700 and 800 psi (4826–5516 kNImj2) requiring approximately four to five solid hits by most men. After activating the buzzer, subjects placed the sledgehammer on the ground." *Search* "Subjects crawled on their hands and knees through a blackout tunnel for a total length of 19.51 m with two 90º right turns. Subjects had to maneuver over, under, and around obstacles before reaching the exit of the maze." *Rescue* "Subjects had to grasp a 74.84-kg manikin by the shoulder harness, using one or both hands, and drag it 10.67 m around a pre-positioned drum and back to an additional 10.67 m to the finish line." *Ceiling Breach and Pull* "Subjects picked up a pike pole then used it to push the door of the ceiling completely open three times followed by hooking an adjacent ceiling device and pulling down completely five times. Subjects completed four sets of three pushes and five pulls with the time stopped upon completion of this event."
Dreger & Petersen[12] Firefighters and non-firefighters volunteered as subjects Canada	30 men (mean age 29.0 y [SD 6.8]; mean height 181.9 cm [SD 5.8]; mean body mass 84.6 kg [SD 6.6]; mean mass in PPE 107.1 kg [SD 6.7]), 23 women (mean age 25.8 y [SD 5.6]; mean height 169.0 cm [SD 6.4]; mean body mass 68.2 kg [SD 7.6]; mean mass in PPE 91.9 kg [SD 7.5])	*N* = 53	VO_{2max} VO_{2Peak} (ml/kg/min) $\%VO_{2Peak}$ $\%HR_{max}$ HR bpm	Prospective cohort	Firefighters and other participants were dressed in NFPA Standard 1500 duty coat, firefighting pants, helmet, anti-flash hood, leather work gloves, rubber firefighting boots, and a Scott 4.5 harness and a full 60-min Scott Air-Pac fibre composite air cylinder. *Canadian Forces/Department of National Defense Fire Fit Test:* *Hose Carry* "The subject carried one section (15.24 m) of rolled 65 mm rubber jacketed hose (Red Chief; Angus Fire, Thame, Oxfordshire, UK) weighing 16.5 kg in one hand a distance of 15.24 m, then returned the same distance carrying the hose in the other hand. The subject set down the rolled hose and walked 15.24 m to the next event." *Ladder Carry and Raise* "The subject lifted and carried a 3.6 m aluminum roof ladder (13.6 kg) a distance of 15.24 m and raised it against a brick wall. The subject then walked 15.24 m to the next event."

(*Continued*)

Table 1. (Continued)

Study	Population	Sample size	Physiological responses	Study type	Simulated firefighting task details
					Hose Drag "The subject gripped a hose nozzle (Pistol Grip; Elkhart Brass Mfg. Co. Inc., Elkhart, IN) over the shoulder and dragged two charged lengths (30.48 m in total) of 38 mm hose (Red Chief; Angus Fire, Thame, Oxfordshire, UK) a distance of 30.48 m. The force required to move the hose bundle was approximately 260 N. The subject then walked 15.24 m to the next event." *Ladder Climb 1* "Using a 7.2 m ladder (Duo-safety Ladder Corp., Oshkosh, WIS), the subject climbed 10 rungs (3.45 m) up and down, 3 times. The subject then walked 30.48 m to the next event." *Rope Pull* "While standing in a stationary position, the subject pulled a 16 mm nylon rope (static) attached to a bundle of hose (one 30.48 m length of 100 mm hose and one 15.24 m length of 65 mm; Red Chief; Angus Fire, Thame, Oxfordshire, UK) 15.24 m using a hand-over-hand movement. The subject then walked 15.24 m and repeated the pull. The force required to move the hose bundle was approximately 200 N. The subject then walked 15.24 m to the next event." *Forcible Entry* "Using a 4.5 kg steel-head sledge hammer (DF0832C; Garant, Saint-Francois, QUE) the subject hammered a 71 cm diameter rubber tire filled with sandbags (total weight 102.5 kg) a distance of 30.5 cm across a 76.2 cm high wooden picnic table. The tabletop was reinforced with 19 mm (¾") 'good-one-side' plywood. The subject then walked 15.24 m to the next event." *Victim Rescue* "The subject dragged a 68.2 kg mannequin (Rescue Randy 1434; Simulaids Inc., Woodstock, NY) a total distance of 30.48 m (15.24 one way, around a pylon and then back 15.24 m). The subject then walked 15.24 m to the next event." *Ladder Climb 2* "Using a 7.2 m ladder (Duo-safety Ladder Corp., Oshkosh, WIS), the subject climbed 10 rungs (3.45 m) up and down, 2 times. The subject then walked 30.48 m to the next event." *Ladder Lower and Carry* "The subject lowered and carried (15.24 m) a 3.6 m aluminum roof ladder (13.6 kg). The subject then walked 15.24 m to the next event." *Spreader Tool Carry* "The subject picked up and carried a 36.4 kg spreader tool (Hurst 32B; Hale Products Inc., Conshohocken, PA) 15.24 m and then returned 15.24 m."

(*Continued*)

Table 1. (Continued)

Study	Population	Sample size	Physiological responses	Study type	Simulated firefighting task details
Boyd[17] Healthy physically active participants Canada	31 men (mean age 23.5 y [SD 3.3]; mean height 180 cm [SD 6.6]; mean body mass 80.4 kg [SD 12.4]), 20 women (mean age 22.5 y [SD 2.9]; mean height 170 cm [SD 6.2]; mean body mass 68.3 kg [SD 10.4])	*N* = 51	%HR_{max} (age predicted) HR bpm	Prospective cohort	Participants were fitted with the protective clothing ensemble (mean mass 23.0 kg [SD 1.8]), and with the SCBA. *FF PFME* *One-Arm Hose Carry* "Using a rope handle, the firefighter carries, in 1 hand, one 15.24-m (50-foot) section of rolled 65-mm rubber jacketed hose weighing 16.5 kg for a distance of 15.24 m, then returns the same distance carrying the hose in the other hand. The subject sets down the rolled hose and walks 15.24 m to the next event." *Ladder Carry and Raise* "The firefighter lifts and carries a 3.6-m aluminum roof ladder (13.6 kg) a distance of 15.24 m and raises it to a secure position against a wall. The subject walks 15.24 m to the next event." *Charged Hose Drag* "The firefighter lifts and places over the preferred shoulder a hose nozzle then proceeds to drag 2 charged lengths (30.48 m or 100 feet in total) of 44-mm hose a distance of 30.48 m. The subject walks 15.24 m to the next event." *Ladder Climb 1* "Using a 7.2-m ladder the firefighter climbs 10 rungs (3.45 m) up and down, 3 times. The subject walks 30.48 m to the next event." *Weighted Sled Pull* "Standing in a stationary position, the firefighter pulls a 16-mm static nylon rope attached to a weighted sled for 15.24 m using a hand-over-hand movement. The subject then walks 15.24 m to the starting position of the sled and repeats the pull. The subject walks 15.24 m to the next event." *Forcible Entry* "Using a 4.5-kg steel-head sledge hammer, the firefighter hits a target on a mechanical apparatus until a buzzer sounds. The subject walks 15.24 m to the next event." *Victim Rescue* "Walking backward, the firefighter drags a 80-kg mannequin a total distance of 26 m (13 m 1 way, around a pylon and then back 13 m). The subject walks 15.24 m to the next event." *Ladder Climb 2* "Using a 7.2-m ladder, the firefighter climbs 10 rungs (3.45 m) up and down, 2 times. The subject walks 30.48 m to the next event." *Ladder Lower and Carry* "The firefighter lowers and carries a 3.6-m aluminum roof ladder (13.6 kg) for 15.24 m. The subject walks 15.24 m to the next event."

(*Continued*)

Table 1. (Continued)

Study	Population	Sample size	Physiological responses	Study type	Simulated firefighting task details
					Equipment Carry "The firefighter picks up and carries a tricep bar with weight plates and collars (total weight 36.4 kg) for 15.24 m and then returns 15.24 m. The test ends when the firefighter finishes the carry (lowering the weight is not part of the test)."
Harvey[18] Healthy physically active participants Canada	12 men (height 183.5 cm; body mass 88.5 kg), 8 women (height 173.5 cm; body mass 73.5 kg), age 23.0 y	*N* = 20	VO_2 (ml/kg/min) $\%VO_{2max}$ HR bpm	Prospective cohort	Participants wore the portable gas collection system (instead of SCBA), ankle weights (2.2 kg), and a weighted vest (18 kg) and were instructed to complete the circuit as quickly as possible. *Firefighting Simulation Circuit* *Hose Carry* "Subjects carried a bucket equivalent to one section of rolled 65 mm hose weighing 16.5 kg in one hand a distance of 15.24 m, and returned the same distance, carrying the bucket in the other hand." *Ladder Raise* "Subjects picked up a ladder (mass 13.6 kg) from the floor, carried it a distance of 15.24 m and raised it against a brick wall." *Hose Drag* "Subjects dragged a weighted sled (280 N force required) using a length of hose to simulate dragging a water filled 65 mm hose a distance of 30.48 m." *Ladder Climb 1* "In place of climbing 10 rungs up and down a 7.2 m ladder 3 times, our subjects climbed 4 times up and down 7 rungs." *High-Volume Hose Pull* "Subjects pulled a 30.48 m section of 100 mm hose (180 N force required) a total distance of 30.48 m." *Forcible Entry* "Subjects moved a rubber tire weighing 192.5 kg a distance of 30.5 cm across a table 76.2 cm high, by hitting it with a 4.5 kg sledge hammer." *Victim Drag* "Subjects dragged a 'Rescue Randy' mannequin weighing 68.2 kg a total distance of 30.48 m." *Ladder Climb 2* "In place of climbing up and down 10 rungs of the ladder twice, our subjects climbed three times up and down seven rungs." *Ladder Lower* "Subjects lowered the ladder from where it was previously erected, and carried it a distance of 15.24 m." *Tool Carry* "Subjects carried a 36.4 kg barbell (simulating the mass of a spreader tool) a distance of 30.48 m."

Notes: VO_2 = oxygen consumption; VO_{2max} = maximal oxygen consumption; $\%VO_{2max}$ = percentage of maximal oxygen consumption; $\%HR_{max}$ = percentage of maximum heart rate; HR bpm = heart rate beats per minute; PPE = personal protective equipment; SCBA = self-contained breathing apparatus; VCO_2 = volume of carbon dioxide; SFWC = simulated firefighting work circuit; RR = respiration rate; NFPA = National Fire Protection Association; CPAT = Candidate Physical Ability Test; VO_{2Peak} = peak oxygen consumption; $\%VO_{2Peak}$ = percentage of peak oxygen consumption; FF PFME = Canadian Forces Firefighter Physical Fitness Maintenance Evaluation.

Outcomes: physiological measures

Overall, 10 cross-sectional cohort studies were included in the review. The physiological measure, HR_{max} using maximal exercise testing, was quantified in seven studies, HR_{max} using age-predicted formula was quantified in three studies, VO_{2max} (ml/kg/min) was quantified in five studies, VO_{2Peak} (ml/kg/min) was quantified in two studies, and VO_2 (ml/min) was quantified in four studies.

Physiological demands of simulated firefighting tasks

Williams-Bell[11] investigated the physiological demands (VO_2, VO_{2max}, HR_{max}) among 36 professional firefighters during high-rise stair climb and fifth-floor search and rescue tasks, in full personal protective equipment (PPE) and self-contained breathing apparatus (SCBA) system, while carrying an additional 18-kg high-rise pack.[11] During the stair climb (ascent portion), heart rate was 91% of HR_{max}, and throughout the descent portion, it was 85% of HR_{max}. During the fifth-floor search and rescue task, it was 87% of HR_{max}.[11] The VO_2 (ml/kg/min) demands were 75% of VO_{2max} in the ascent portion of the stair climb and 54% of VO_{2max} in the descent portion, and they were 66% of VO_{2max} during the fifth-floor search and rescue task. The VO_2 (ml/min) demands were 71% of VO_{2max} in the ascent portion of the stair climb, 55.5% of VO_{2max} in the descent portion, and 67.5% of VO_{2max} during the fifth-floor search and rescue task.[11]

Williams-Bell[10] assessed the physiological demands (VO_{2Peak}, HR_{max}) among 36 professional firefighters during a simulated subway task, in full PPE and SCBA system, while carrying an additional 22-kg high-rise pack.[10] Heart rate was 75% of HR_{max}, and VO_2 (ml/kg/min) demands were 48% of VO_{2Peak}.[10]

Petersen[15] examined the physiological demands (HR_{max}) among 17 healthy volunteers during a simulated firefighting work circuit in full firefighting turnout gear and SCBA.[15] Heart rate was 90% of HR_{max}.[15]

Dreger and Petersen[12] investigated the physiological demands (VO_{2max}, HR_{max}) among 53 professional firefighters and healthy volunteers during the Canadian Forces/Department of National Defense (CF–DND) Fire Fit Test.[12] During the CF–DND fire fit test, heart rate was 90% of HR_{max}, and VO_{2Peak} (ml/kg/min) demands were 86% of VO_{2Peak}.[12]

Petersen and Dreger[13] assessed the physiological demands (VO_{2max}, VO_2, HR_{max}) among 25 healthy volunteers during two simulated fire and rescue tasks.[13] During the two simulated fire and rescue tasks, heart rate was 79% of HR_{max}, VO_2 (ml/kg/min) demands were 60% of VO_{2max}, and VO_2 (ml/min) demands were also 60% of VO_{2max}.[13]

Williams-Bell[16] examined the physiological demands (VO_{2max}, VO_2, HR_{max}) among 57 healthy volunteers during the Candidate Physical Ability Test (CPAT).[16] During the CPAT, heart rate was 90% of HR_{max}, VO_2 (ml/kg/min) demands were 72% of VO_{2max}, and VO_2 (ml/min) demands were also 72% of VO_{2max}.[16]

Nazari[9] investigated the physiological demands (age-predicted HR_{max}) among 49 professional firefighters during hose drag and stair climb with high-rise pack tasks, dressed in full PPE and SCBA.[9] During the hose drag task, heart rate was 88% of age-predicted HR_{max}; throughout the stair climb with a high-rise pack task, it was 89% of age-predicted HR_{max}.[9]

Sinden[14] assessed the physiological demands (age-predicted HR_{max}) among 148 professional firefighters during a hose drag task.[14] During the hose drag task, heart rate was 56% of age-predicted HR_{max}.[14]

Boyd[17] examined the physiological demands (age-predicted HR_{max}) among 51 healthy participants during the CF Firefighter Physical Fitness Maintenance Evaluation (FF PFME). During the FF PFME, heart rate was 91% of age-predicted HR_{max}.[17]

Harvey[18] investigated the physiological demands (VO_{2max}) among 20 healthy participants during a firefighting simulation circuit with portable gas collection system, ankle weights, and a weighted vest.[18] During the firefighting simulation circuit, the VO_2 (ml/kg/min) demands were 66% of VO_{2max}.[18]

Meta-analyses of physiological measures

HR_{max}

When focused on $\%HR_{max}$ (by maximal exercise testing) demands during the simulated firefighting tasks, the random pooled estimate was 86.0% (six studies, 296 participants; 95% CI, 82.0-90.0; I^2 = 80.0 %; Table 3).[10–13,15–16] Subgroup analysis by sex indicated a random pooled estimate of 86.0% for men (three studies, 75 male participants; 95% CI, 79.0-92.0; I^2 = 80.0 %)[12,13,16] and a random pooled estimate of 87.0% for women (three studies, 49 female participants; 95% CI, 79.0-94.0; I^2 = 86.0%).[12,13,16] In terms of the (age-predicted) percentage of HR_{max} demands during the simulated firefighting tasks, the random pooled estimate was 82.0% (three studies, 297 participants;

Table 2. STROBE statement checklist

Items	Item no.	Recommendation	Individual studies									
			Williams-Bell[11]	Williams-Bell[10]	Dreger & Petersen[12]	Petersen & Dreger[13]	Sinden[14]	Nazari[9]	Petersen[15]	Williams-Bell[16]	Boyd[17]	Harvey[18]
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	×	×	×	×	×	×	×	×	×	×
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Introduction												
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Objectives	3	State specific objectives, including any prespecified hypotheses	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Methods												
Study design	4	Present key elements of study design early in the paper	×	×	×	×	✓	×	✓	×	×	×
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bias	9	Describe any efforts to address potential sources of bias	×	×	×	×	×	×	×	×	×	×
Study size	10	Explain how the study size was arrived at	×	×	×	×	×	×	×	×	✓	×
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		(b) Describe any methods used to examine subgroups and interactions	×	×	✓	✓	×	×	×	✓	×	✓
		(c) Explain how missing data were addressed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		(d) If applicable, describe analytical methods taking account of sampling strategy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		(e) Describe any sensitivity analyses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(*Continued*)

Table 2. (Continued)

Items	Item no.	Recommendation	Individual studies									
			Williams-Bell[11]	Williams-Bell[10]	Dreger & Petersen[12]	Petersen & Dreger[13]	Sinden[14]	Nazari[9]	Petersen[15]	Williams-Bell[16]	Boyd[17]	Harvey[18]
Results												
Participants	13	(a) Report numbers of individuals at each stage of study — eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		(b) Give reasons for non-participation at each stage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		(c) Consider use of a flow diagram	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Descriptive data	14	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		(b) Indicate number of participants with missing data for each variable of interest	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Outcome data	15	Report numbers of outcome events or summary measures	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		(b) Report category boundaries when continuous variables were categorized	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Other analyses	17	Report other analyses done — eg analyses of subgroups and interactions, and sensitivity analyses	×	×	✓	✓	×	×	×	✓	×	✓
Discussion												
Key results	18	Summarise key results with reference to study objectives	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	✓	✓	✓	×	✓	✓	×	✓	✓	✓
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	✓	✓	✓	×	✓	✓	×	✓	✓	✓
Generalisability	21	Discuss the generalisability (external validity) of the study results	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

(*Continued*)

Table 2. (Continued)

Items	Item no.	Recommendation	Individual studies									
			Williams-Bell[11]	Williams-Bell[10]	Dreger & Petersen[12]	Petersen & Dreger[13]	Sinden[14]	Nazari[9]	Petersen[15]	Williams-Bell[16]	Boyd[17]	Harvey[18]
Other information												
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	✓	✓	✓	✓	✓	✓	×	✓	✓	✓

Note: × = not addressed; ✓ = addressed; N/A = not applicable

Table 3. Meta-analyses of percentage of maximum heart rate by maximal testing during simulated firefighting tasks

Study	Firefighting Tasks	Sample	HR	HR_{max}	% HR_{max}	95% CI
All participants (*N* = 296)						
Williams-Bell[11]	High-rise stair climb — Ascent	36	167	183	91.00	86.00–95.00
Williams-Bell[11]	High-rise stair climb — Descent	36	156	183	85.00	79.00–90.00
Williams-Bell[11]	Fifth-floor search and rescue	36	160	183	87.00	82.00–92.00
Williams-Bell[10]	Subway scenario	36	138	184	75.00	68.00–81.00
Petersen & Dreger[13]	Two fire-rescue scenarios	25	154	194	79.00	73.00–85.00
Dreger & Petersen[12]	Canadian Forces/DND FFT	53	170	188	90.00	85.00–94.00
Petersen[15]	SFWC	17	173	192	90.00	85.00–94.00
Williams-Bell[16]	Candidate Physical Ability Test	57	170	188	90.00	85.00–94.00
Random-effects model, heterogeneity I^2 = 80.0%					86.00	82.00–90.00
Subgroup analysis by sex: men (*n* = 75)						
Petersen & Dreger[13]	Two fire-rescue scenarios	13	154	194	79.40	73.00–85.00
Dreger & Petersen[12]	Canadian Forces/DND FFT	30	169	189	89.30	84.00–93.00
Williams-Bell[16]	Candidate Physical Ability Test	32	169	188	90.00	85.00–94.00
Random-effects model, heterogeneity I^2 = 80.0%					86.00	79.00–92.00
Subgroup analysis by sex: women (*n* = 49)						
Petersen & Dreger[13]	Two fire-rescue scenarios	12	155	196	79.00	73.00–85.00
Dreger & Petersen[12]	CF–DND FFT	23	171	187	91.00	86.00–95.00
Williams-Bell[16]	Candidate Physical Ability Test	14	171	188	91.00	86.00–95.00
Random-effects model, heterogeneity I^2 = 86.0%					87.00	79.00–94.00

Notes: HR = heart rate; HR_{max} = maximum heart rate; %HR_{max} = percentage of maximum heart rate; CF–DND FFT = Canadian Forces/Department of National Defense Fire Fit Test; SFWC = simulated firefighting work circuit.

95% CI, 66.0–94.0; I^2 = 96.0%).[9,14,17] The authors were unable to perform subgroup analysis by sex because of the lack of reported information.

VO_{2max}, VO_{2Peak}, and VO_2

Regarding the %VO_{2max} (ml/kg/min) demands during the simulated firefighting tasks, a random pooled estimate of 65.0% (four studies, 210 participants; 95% CI, 59.0-71.0; I^2 = 22.0%; Table 4) was reported.[10,11,13,16,18] Subgroup analysis by sex indicated a random pooled estimate of 68.00% for men (three studies, 57 male participants; 95% CI, 56.0-75.0; I^2 = 0.0%),[13,16,18] and a random pooled estimate of 64.00% for women (three studies, 34 female participants; 95% CI, 56.50-72.00; I^2 = 0.0%).[13,16,18] In terms of the percentage of VO_{2Peak} (ml/kg/min) demands during the simulated firefighting

Table 4. Meta-analyses of percentage of VO_{2max} (ml/kg/min) during simulated firefighting tasks

Study	Firefighting Tasks	Sample	VO_2	VO_{2max}	% VO_{2max}	95% CI
All participants (N = 210)						
Williams-Bell[11]	High-rise stair climb — ascend	36	38.30	51.40	75.00	51.00–98.00
Williams-Bell[11]	High-rise stair climb — descent	36	27.60	51.40	54.00	34.00–74.00
Williams-Bell[11]	Fifth-floor search & rescue	36	34.10	51.40	66.00	44.00–89.00
Petersen & Dreger[13]	Two fire-rescue	25	26.60	44.50	60.00	37.00–82.00
Williams-Bell[16]	Candidate Physical Ability Test	57	37.55	52.45	72.00	49.00–94.00
Harvey[18]	Firefighting Simulation Circuit	20	31.80	48.12	66.00	43.00–89.00
Random-effects model, heterogeneity I^2 = 22.00%					65.00	59.00–71.00
Subgroup analysis by sex: men (n = 57)						
Petersen & Dreger[13]	Two fire-rescue	13	27.10	44.20	61.30	45.50–75.60
Williams-Bell[16]	Candidate Physical Ability Test	32	38.70	53.00	73.00	59.10–84.30
Harvey[18]	Firefighting Simulation Circuit	12	34.20	50.30	68.00	53.30–80.40
Random-effects model, heterogeneity I^2 = 0.00%					68.00	56.00–75.00
Subgroup analysis by sex: women (n = 34)						
Petersen & Dreger[13]	Two fire-rescue	12	26.1	44.7	58.40	42.70–72.90
Williams-Bell[16]	Candidate Physical Ability Test	14	36.6	51.9	70.50	56.20–82.40
Harvey[18]	Firefighting Simulation Circuit	8	29.2	45.57	64.10	48.50–77.70
Random-effects model, heterogeneity I^2 = 0.00%					64.00	56.50–72.00

Note: VO_2 = oxygen consumption; VO_{2max} = maximal oxygen consumption; %VO_{2max} = percentage of maximal oxygen consumption.

tasks, the random pooled estimate of 72.0% (three studies, 114 participants; 95% CI, 47.0-91.0; I^2 = 89.0%; Table 5) was reported.[10,12,13] Subgroup analysis by sex indicated a random pooled estimate of 83.0% for men (two studies, 43 male participants; 95% CI, 74.4-89.5; I^2 = 0.0%),[12–13] and a random pooled estimate of 80.00% for women (two studies, 35 female participants; 95% CI, 71.0-87.0; I^2 = 0.0%).[12–13] When focused on the percentage of VO_2 (ml/min) demands during the simulated firefighting tasks, the random pooled estimate was 65.0% (three studies, 190 participants; 95% CI, 59.0-71.0; I^2 = 99.0%; Table 6).[11,13,16] Subgroup analysis by sex indicated a random pooled estimate of 68.0% for men (two studies, 45 male participants; 95% CI, 57.0-78; I^2 = 99.0%)[13,16] and a random pooled estimate of 65.0% for women (two studies, 26 female participants; 95% CI, 53.0-76.0; I^2 = 99.0%).[13,16]

DISCUSSION

This systematic review and meta-analyses found high VO_2 and HR physiological demands during simulated firefighting tasks among both male and female participants. These findings represent the first synthesis of the evidence and emphasize the importance of developing firefighter-specific conditioning and injury prevention programs.

It is generally accepted that firefighters are fitter than the general population.[9] Moreover, to enhance

Table 5. Meta-analyses of percentage of VO_{2Peak} (ml/kg/min) during simulated firefighting tasks

Study	Firefighting tasks	Sample	VO_2	VO_{2Peak}	% VO_{2Peak}	95% CI
All participants (*N* = 114)						
Williams-Bell[10]	Subway scenario (simulated)	36	24.30	51.10	48.00	33.40–62.00
Dreger & Petersen[12]	Canadian Forces/DND FFT	53	39.20	45.50	86.00	72.70–95.00
Petersen & Dreger[13]	Two fire-rescue scenarios	25	34.70	43.60	79.60	64.70–90.00
Random-effects model, heterogeneity I^2 = 89.0%					72.00	47.00–91.00
Subgroup analysis by sex: men (*n* = 43)						
Dreger & Petersen[12]	CF–DND FFT	30	42.40	49.20	86.20	73.00–94.40
Petersen & Dreger[13]	Two fire-rescue scenarios	13	35.30	44.20	80.00	65.10–90.40
Random-effects model, heterogeneity I^2 = 0.0%					83.00	74.40–89.50
Subgroup analysis by sex: women (*n* = 35)						
Dreger & Petersen[12]	CF–DND FFT	23	34.80	41.70	83.50	68.70–93.00
Petersen & Dreger[13]	Two fire-rescue scenarios	12	34.20	44.40	77.10	62.10–88.40
Random-effects model, heterogeneity I^2 = 0.0%					80.00	71.00–87.00

Note: VO_2 = oxygen consumption; VO_{2max} = maximal oxygen consumption; $\%VO_{2max}$ = percentage of maximal oxygen consumption; CF–DND FFT = Canadian Forces/Department of National Defense Fire Fit Test.

Table 6. Meta-analyses of percentage of VO_2 (ml/min) during simulated firefighting tasks

Study	Firefighting tasks	Sample	VO_2	VO_2	% VO_2	95% CI
All participants (*N* = 190)						
Williams-Bell[11]	High-rise stair climb — ascent	36	3,165	4,470	71.00	69.50–72.10
Williams-Bell[11]	High-rise stair climb — descent	36	2,482	4,470	55.50	54.10–57.0
Williams-Bell[11]	Fifth floor search & rescue	36	3,015	4,470	67.50	66.10–69.0
Petersen & Dreger[13]	Two fire-rescue	25	2,040	3,400	60.00	58.30–61.70
Williams-Bell[16]	Candidate Physical Ability Test	57	2,743	3,806	72.00	70.60–73.50
Random-effects model, heterogeneity I^2 = 99.0%					65.00	59.00–71.00
Subgroup analysis by sex: men (*n* = 45)						
Petersen & Dreger[13]	Two fire-rescue	13	2,310	3,720	62.10	60.50–63.70
Williams-Bell[16]	Candidate Physical Ability Test	32	3,128	4,282	73.10	71.70–74.40
Random-effects model, heterogeneity I^2 = 99.0%					68.00	57.00–78.00
Subgroup analysis by sex: women (*n* = 26)						
Petersen & Dreger[13]	Two fire-rescue		1,770			57.10–61.00
Williams-Bell[16]	Candidate Physical Ability Test		2,357			69.20–72.30
Random-effects model, heterogeneity I^2 = 99.0%						53.00–76.00

Note: VO_2 = oxygen consumption; VO_{2max} = maximal oxygen consumption; $\%VO_{2max}$ = percentage of maximal oxygen consumption.

task performance, efficiency, and safety, firefighters are required to possess and demonstrate high levels of physical fitness on entering the fire service. In this review, three studies included all-firefighter participants and indicated VO_2 levels that ranged from 45.50 to 51.40 ml/kg/min.[10–12] These levels were high and indicated that the majority of firefighters possessed the minimum firefighter-required aerobic fitness level of 42 ml/kg/min.[7] Therefore, the notion that firefighters are fitter (possess a higher level of aerobic capacity) than the general population was supported by this study when compared with the reported VO_{2max} levels of 39.10 ml/kg/min (men) and 35 ml/kg/min (women) reference scores for general populations.[22, 23] The Canadian firefighters' VO_2 levels also corresponded well with those from previous studies assessing U.S. firefighters' level of aerobic capacity. Studies by Davis and colleagues, Donovan and colleagues, and Poplin and colleagues indicated mean VO_{2max} levels that ranged from 47.00 ml/kg/min to 49.60 ml/kg/min among U.S. firefighters.[22, 24,25] In addition, European firefighters (in the United Kingdom, Belgium, and Italy) also indicated similar VO_{2max} levels, ranging from 46.50 ml/kg/min to 55.00 ml/kg/min.[26–28] It is also important to note that five of 10 studies included in the review recruited healthy, physically active participants. Therefore, caution should be used when interpreting the results of this review.

Sex is believed to have an effect on physical fitness levels. Female firefighters' cardiovascular, muscle strength, and endurance levels consistently vary when contrasted with those of their male counterparts.[29] Therefore, in this review, the authors planned a priori to conduct subgroup analyses by sex (men and women) to provide further data. However, only half of the studies (five of 10) recruited all-firefighter participants. Also, only four of 10 further stratified and reported physiological measures by sex. This review indicates that physiological demands ($\%HR_{max}$) during simulated tasks might be similar between men and women. Moreover, in the subgroup analyses, two studies (Dreger & Petersen and Williams-Bell)[12,16] included eight and 10 subtasks that constituted the simulated task. However, the Petersen and Dreger study involved only two subtasks.[13] Therefore, it is possible that such variation in the tasks contributed to the high heterogeneity levels.

It has been reported that high cardiorespiratory fitness levels (VO_{2max}) are associated with lower risks of all-cause CVD and cancer mortality without considering muscle strength.[30] Therefore, the authors explored the participants' cardiorespiratory fitness levels and assessed the VO_{2max} and VO_{2Peak} demands during simulated firefighting tasks. Pooled estimates of 65.0%[10,11,13,16,18] and 72%[13,16,18] were reported for VO_{2max} and VO_{2Peak} levels, respectively. Heterogeneity was high and was reduced by subgroup analyses. Among men, VO_{2max} and VO_{2Peak} demands during simulated firefighting tasks were slightly higher than those among women — 68% versus 64% (VO_{2max} demands) and 83% versus 80% (VO_{2Peak} demands), respectively.[11,13,16,18] In these studies, men also had slightly higher VO_{2max} levels that ranged from 44.20 to 53.00, compared with 44.7 to 51.9 among women.[11,13,16,18] The mean difference in VO_{2max} levels between men and women was 1.77 ml/kg/min.[13,16,18] It is important to highlight that, because of a lack of data reporting, the authors did not pool studies to provide an estimate of upper and lower body strength levels among firefighters. Lower or poor muscular strength has also been shown to be a major marker of mortality and adverse health outcomes.[30]

Moreover, improving both cardiorespiratory and muscle strength levels, as opposed to either of the two alone, has shown to be highly effective in reducing all-cause and cardiovascular mortality risk.[30] Therefore, considering the results from this review that firefighting tasks are physiologically demanding, and the emerging evidence emphasising the importance of improving both cardiorespiratory fitness and muscle strength levels as the most suitable and effective behavioural strategy to lower all-cause and cardiovascular mortality risk, developing firefighter-specific strength and conditioning programs with regular monitoring is warranted for firefighters' health and well-being.

The strength of this review is that the authors systematically identified and appraised the available cross-sectional observational studies, highlighted the physiological demands during various simulated firefighting tasks, and provided a pooled estimate of the physiological demands. One of the main limitations of this systematic review was that the authors pooled studies that used controlled training environments to represent real-life situations, referred to as simulated firefighting tasks. Evidence indicates that simulated firefighting tasks are comparable to real-life situations; however, such tasks lack psychological impact, including genuine risk to life and task uncertainty.[10] Moreover, caution must be used when interpreting the results of this review because of 1) the inclusion of a limited number of studies (N = 10; 492 participants/

firefighters) and 2) high heterogeneity in the analyses. High heterogeneity was explained or reduced in some of the subgroup analyses. However, subgroup analyses are inherently underpowered.

Conclusion

This systematic review provides evidence on the magnitude of physiological demands during simulated firefighting tasks, indicating that such tasks require near-maximal heart rates among both men and women. Moreover, simulated tasks required two-thirds of the VO_{2max} level. These findings provide additional evidence highlighting that firefighting tasks are physiologically demanding and place an emphasis on developing firefighter-specific strength and conditioning programs with regular monitoring.

REFERENCES

1. Public Health Agency of Canada. 2009 tracking heart disease and stroke in Canada. Ottawa: Public Health Agency of Canada; 2009.
2. Soteriades ES, Smith DL, Tsismenakis AJ, et al. Cardiovascular disease in US firefighters: a systematic review. Cardiol Rev. 2011;19(4):202–15. https://doi.org/10.1097/crd.0b013e318215c105. Medline:21646874
3. Fahy RF. US firefighter fatalities due to sudden cardiac death, 1995–2004. Nat Fire Pro Assoc J. 2005;99:44–7.
4. Fahy R, Leblanc P, Molis J. Fire fighter fatalities in the United States-2013. Quincy (MA): NFPA Fire Analysis and Research; 2014.
5. Hunter AL, Mills NL, Newby DE. Combustion-derived air pollution and cardiovascular disease. Br J Hosp Med. 2012;73(9):492–7. https://doi.org/10.12968/hmed.2012.73.9.492. Medline:23124400
6. Donaldson K, Hunter AL, Poland C, et al. Mechanisms of action of combustion-derived nanoparticles. In: Purser DA, Maynard RL, Wakefield JC, editors. Toxicology, survival and health hazards of combustion products. London: Royal Society of Chemistry; 2015. p. 412–5.
7. Smith DL, Barr DA, Kales SN. Extreme sacrifice: sudden cardiac death in the US fire service. Extrem Physiol Med. 2013;2(1):6. https://doi.org/10.1186/2046-7648-2-6. Medline:23849605
8. Nazari G, MacDermid JC, Sinden KE, et al. Comparison of Canadian firefighters and healthy controls based on submaximal fitness testing and strength considering age and gender. Int J Occup Saf Ergon. 2017;25(1):1–7. https://doi.org/10.1080/10803548.2017.1372086. Medline:28877646
9. Nazari G, MacDermid JC, Sinden KE, et al. The relationship between physical fitness and simulated firefighting task performance. Rehabil Res Pract. 2018;3234176. https://doi.org/10.1155/2018/3234176. Medline:29850253
10. Williams-Bell FM, Boisseau G, McGill J, et al. Air management and physiological responses during simulated firefighting tasks in a high-rise structure. Appl Ergon. 2010;41(2):251–9. https://doi.org/10.1016/j.apergo.2009.07.009. Medline:19683700
11. Williams-Bell FM, Boisseau G, McGill J, et al. Physiological responses and air consumption during simulated firefighting tasks in a subway system. Appl Physiol Nutr Metab. 2010;35(5):671–8. https://doi.org/10.1139/h10-061. Medline:20962923
12. Dreger RW, Petersen SR. Oxygen cost of the CF-DND fire fit test in males and females. Appl Physiol Nutr Metab. 2007;32(3):454–62. https://doi.org/10.1139/h07-020. Medline:17510680
13. Dreger R, Peterson S. Development of the aerobic fitness test and standard [Internet]. Ottawa: Canadian Forces Morale and Welfare Services; 2004 [cited 2019 Jun 17]. Available from: https://www.cfmws.com/en/AboutUs/PSP/DFIT/Documents/Publications%20and%20Reports/FF%20Physical%20Fitness%20Selection%20Standard.pdf.
14. Sinden KE. Identifying determinants of firefighter work health and task performance: implications for injury management [dissertation] [Internet]. Hamilton (ON): McMaster University; 2014 [cited 2019 Jun 17]. Available from: http://hdl.handle.net/11375/15948.
15. Petersen SR, Dreger RW, Williams BE, et al. The effects of hyperoxia on performance during simulated firefighting work. Ergonomics. 2000;43(2):210–22. https://doi.org/10.1080/001401300184567. Medline:10675059
16. Williams-Bell FM, Villar R, Sharratt MT, et al. Physiological demands of the firefighter candidate physical ability test. Med Sci Sports Exerc. 2009;41(3):653–62. https://doi.org/10.1249/mss.0b013e31818ad117. Medline:19204584
17. Boyd L, Rogers T, Docherty D, et al. Variability in performance on a work simulation test of physical fitness for firefighters. Appl Physiol Nutr Metab. 2015;40(4):364–70. https://doi.org/10.1139/apnm-2014-0281. Medline:25781347
18. Harvey DG, Kraemer JL, Sharratt MT, et al. Respiratory gas exchange and physiological demands during a fire fighter evaluation circuit in men and women. Eur J Appl Physiol. 2008;103(1):89–98. https://doi.org/10.1007/s00421-008-0673-2. Medline:18204853
19. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-

analyses of studies that evaluate healthcare interventions: explanation and elaboration. BMJ 2009;339:b2700. https://doi.org/10.1136/bmj.b2700.
20. Vandenbroucke JP, von Elm E, Altman DG, et al. STROBE initiative: strengthening the reporting of observational studies in epidemiology (STROBE): explanation and elaboration. Int J Surg. 2014;12(12): 1500–24. https://doi.org/10.1016/j.ijsu.2014.07.014
21. Higgins JPT, Green S, editors. Cochrane handbook for systematic reviews of interventions [Internet]. Version 5.1.0. London: Cochrane Collaboration; 2011 [cited year mon day]. Available from: handbook.cochrane.org.
22. Davis SC, Jankovitz KZ, Rei S. Physical fitness and cardiac risk factors of professional firefighters across the career span. Res Q Exerc Sport. 2002;73(3):363–70. https://doi.org/10.1080/02701367.2002.10609033. Medline:12230346
23. Heyword VH. Advanced fitness assessment and exercise prescription. 6th ed. Champaign (IL): Human Kinetics; 2010.
24. Poplin GS, Roe JD, Peate W, et al. The association of aerobic fitness with injuries in the fire service. Am J Epidemiol. 2013;179(2):149–55. https://doi.org/10.1093/aje/kwt213. Medline:24186973
25. Donovan R, Nelson T, Peel J, et al. Cardiorespiratory fitness and the metabolic syndrome in firefighters. Occup Med. 2009;59(7):487–92. https://doi.org/10.1093/occmed/kqp095. Medline:19578075
26. Kiss P, De Meester M, Maes C, et al. Cardiorespiratory fitness in a representative sample of Belgian firefighters. Occup Med. 2014;64(8):589–94. https://doi.org/10.1093/occmed/kqu138. Medline:25237075
27. Perroni F, Cignitti L, Cortis C, et al. Physical fitness profile of professional Italian firefighters: difference among age groups. Appl Ergon. 2014;45(3):456–61. https://doi.org/10.1016/j.apergo.2013.06.005. Medline:23849328
28. Wynn P, Hawdon P. Cardiorespiratory fitness selection standard and occupational outcomes in trainee firefighters. Occup Med. 2012;62(2):123–8. https://doi.org/10.1093/occmed/kqr206. Medline:22199364
29. Sinden K, MacDermid J, Buckman S, et al. A qualitative study on the experiences of female firefighters. Work. 2013;45(1):97–105. https://doi.org/10.3233/wor-121549.
30. Kim Y, White T, Wijndaele K, et al. The combination of cardiorespiratory fitness and muscle strength, and mortality risk. Eur J Epidemiol. 2018;33(10):953–64. https://doi.org/10.1007/s10654-018-0384-x.

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COMPETING INTERESTS

The authors have nothing to disclose.

CONTRIBUTORS

Goris Nazari conceived and designed the study and acquired and analyzed data and was heavily involved the writing of the manuscript. Steve Lu was partially involved in study design and involved in interpretation of the data, provided important intellectual content, and approved the final version submitted for publication. Joy MacDermid was partially involved in study design and data analysis and revised the article for important intellectual content and approved the final version submitted for publication.

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PEER REVIEW

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REVIEW

Best practices in serving college student Veterans: A scoping review

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ABSTRACT

Introduction: Student Veterans are enrolling in college at increasingly rapid rates after separating from the military. Institutions of higher education are urged to evaluate and redesign programs targeted to support Veterans' unique attributes, because they differ from civilian students in many aspects. The aim of the current scoping review is to provide a comprehensive examination of the existing literature regarding best practices in serving U.S. student Veterans in higher education and to provide suggestions for the implementation, assessment, and institutionalization of best practices. **Methods**: The methodology for the current scoping review, based on the framework by Arksey and O'Malley, included a structured and iterative design to allow accuracy and replication of the review process. The authors conducted a scoping review of existing scholarly and grey literature on programs provided by U.S. colleges and universities to support student Veterans and enhance their retention, persistence, and success in higher education. **Results:** The current study addresses three specific areas: the extent to which U.S. colleges and universities are providing targeted support for their student Veteran population, the types of programs and services that colleges and universities are providing to students who have served in the U.S. military, and the current data that exist regarding the effectiveness of the programs and services offered by colleges and universities. **Discussion:** Current findings of existing programs and services are examined and categorized under the 8 Keys to Veterans' Success. Suggested implications and future directions, as they relate to best practices for student Veteran programming in higher education, are discussed.

Key words: college, higher education, military students, student Veterans, university, Veterans, United States

RÉSUMÉ

Introduction : Les vétéran(e)s reprennent de plus en plus leurs études à leur sortie des Forces. Les établissements de formation supérieure sont vivement encouragés à évaluer et à remanier les programmes pour soutenir les particularités des vétéran(e)s qui, à de nombreux égards, diffèrent de celles des étudiants civils. La présente analyse exploratoire vise à obtenir un examen complet des pratiques exemplaires des publications sur les services aux vétéran(e)s américains en formation supérieure et à présenter des suggestions sur la mise en œuvre, l'évaluation et l'institutionnalisation des pratiques exemplaires. **Méthodologie :** L'analyse exploratoire, inspirée de la structure d'Arksey et O'Malley, reposait sur une méthodologie structurée et itérative pour assurer l'exactitude et la reproductibilité du processus. Les auteur(e)s ont procédé à une analyse exploratoire des publications universitaires et parallèles sur les programmes offerts par les collèges et les universités américains pour soutenir les vétéran(e)s aux études et accroître leur rétention, leur persistance et leur réussite. **Résultats :** La présente étude traite de trois secteurs précis : l'importance du soutien ciblé des collèges et université des États-Unis à la population de vétéran(e)s aux études, le type de programmes et de services que les collèges et universités offrent aux étudiants qui ont servi dans l'armée américaine et les données sur l'efficacité des programmes et services offerts par les collèges et universités. **Discussion :** Les observations des programmes et services en place sont examinées et classées en vertu des *8 Keys to Veterans' Success*. S'appuyant sur les pratiques exemplaires du programme des vétéran(e)s aux études en supérieures, les conséquences et les orientations possibles sont exposées.

Mots-clés : collège, étudiants, vétéranes, étudiantes militaires, formation supérieure, université, vétérans, vétéran(e)s aux études États-Unis

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LAY SUMMARY

Student Veterans are enrolling in college at increasingly rapid rates after separating from the military. Colleges and universities are urged to evaluate and redesign programs targeted to specifically support Veterans. The aim of the current review is to provide a comprehensive examination of the existing literature regarding best practices in serving U.S. student Veterans in higher education. Concrete suggestions related to the implementation, assessment, and institutionalization of best practices are provided.

INTRODUCTION

Since October 2001, more than 2.5 million U.S. troops have deployed as part of the Global War on Terror (GWOT), which includes Operation Iraqi Freedom, Operation Enduring Freedom, and Operation New Dawn,[1] and 43% of service members have deployed multiple times.[2] It is estimated that, by 2020, a full 3.3 million U.S. service members who participated in GWOT conflicts will have separated.[1] Projections further suggest that, by 2045, the United States will be home to 4,180,360 post-9/11 Veterans.[3] As troops withdraw from conflicts in the Middle East, thousands of Veterans are returning to civilian society and commencing or resuming higher education. To support Veterans transitioning to civilian life, the Post-9/11 GI Bill was established to provide recently separated Veterans with support to cover academic expenses related to tuition, books, and housing, as well as a monthly stipend. Indeed, U.S. institutions of higher education are confronting the largest growth of student Veterans since the Second World War,[4] as well as the largest populations of reservist and National Guard members activated for overseas deployments since 2001.[5]

It is important to note that student Veterans differ from traditional students in significant ways. The 2016 Student Veterans of America Census Survey reports that more than 63% of college student Veterans are aged 25-39 years, and more than 44% have a dependent spouse or child.[6] More than 50% of U.S. college student Veterans have a mental or physical disability,[6] complicating their successful adjustment to student life in the civilian world. Veterans are more likely to experience a range of psychological and relational difficulties that compromise educational and occupational achievement, including depression, anxiety, substance abuse, and partner violence.[7–9] Moreover, the nature of the conflicts in Afghanistan and Iraq pose unique risk factors that increase the likelihood of trauma and related effects.[10] The U.S. government reports that 32% of recently separated Veterans have been diagnosed with musculoskeletal injuries, and approximately 12% have been diagnosed with posttraumatic stress disorder (PTSD).[1] More than 383,000 cases of traumatic brain injury (TBI) have been diagnosed in Veterans since 2000.[11] Indeed, TBI and mild TBI are considered the signature injuries of the GWOT conflict, creating difficulties in focus, concentration, and memory for affected student Veterans.[12]

Compared with their traditional student peers, Veterans' educational progress is more likely to be affected by non-academic factors. For example, Klaw and colleagues found that approximately one-third of student Veterans experienced loneliness, low social support, and psychological distress.[8] In terms of context, findings suggest that many student Veterans experience significant financial stress during college.[13,14] With regard to integration into higher education, the National Survey for Student Engagement found that student Veterans experienced significantly less satisfaction with their student-faculty interactions, fewer opportunities for integrative learning, and less campus support than non-Veteran peers.[15]

For students on active duty and those serving in the National Guard or the military reserves, getting activated for duty can significantly disrupt academic progress.[13, 16, 17] O'Rourke's 2013 study of more than 1,100 student Veterans attending community colleges found that Veterans' persistence in higher education was associated with several domains, including satisfaction with navigating the campus, positive student-faculty interactions, confidence in the affordability of education, fewer hours of employment, fewer family-related responsibilities, and greater encouragement from family and friends.[13] In terms of psychological factors, stress had the most negative impact on intent to persist in college.[13] As a result of the influx of GWOT Veterans, most colleges and universities in the United States have developed programs to serve Veteran and military students.[17] Data, however, are scant with regard to the effectiveness of these efforts and their long-term impact.

METHODS

The methodology for the current scoping review was based on the framework established by Arksey and O'Malley, a structured, iterative design that allows for accuracy and replication of the review process.[18] This scoping review was undertaken to review existing

literature on programs in U.S. colleges and universities to support student Veterans and enhance their retention, persistence, and success in higher education. Three specific questions were posed to frame the current project:

1) To what extent are U.S. colleges and universities providing targeted support for their student Veteran population?
2) What types of programs and services are colleges and universities providing to students who have served in the U.S. military?
3) What data exists regarding the effectiveness of the programs and services offered by colleges and universities with regard to student Veterans' satisfaction with college, their persistence in education, and their academic success?

To comprehensively review available literature regarding best practices in serving U.S. student Veterans, several search methods were utilized: online database searches were conducted to garner primary and secondary research; reference lists in relevant articles were used to identify primary sources and related literature; statistics were derived from online federal websites and platforms; and websites of national and local Veteran-serving organizations known to the authors were explored. Inclusion and exclusion decisions were based on whether the services were developed in response to the influx of GWOT Veterans and whether programs aimed to increase military students' integration or had documented potential as emerging practices. These criteria allowed the first two authors to reach complete agreement regarding literature to review. Thus, to identify best practices in meeting the needs of student Veterans, only literature published between 2005 and 2019 was reviewed (see Figure 1). The following databases were used for the literature search: Academic Search

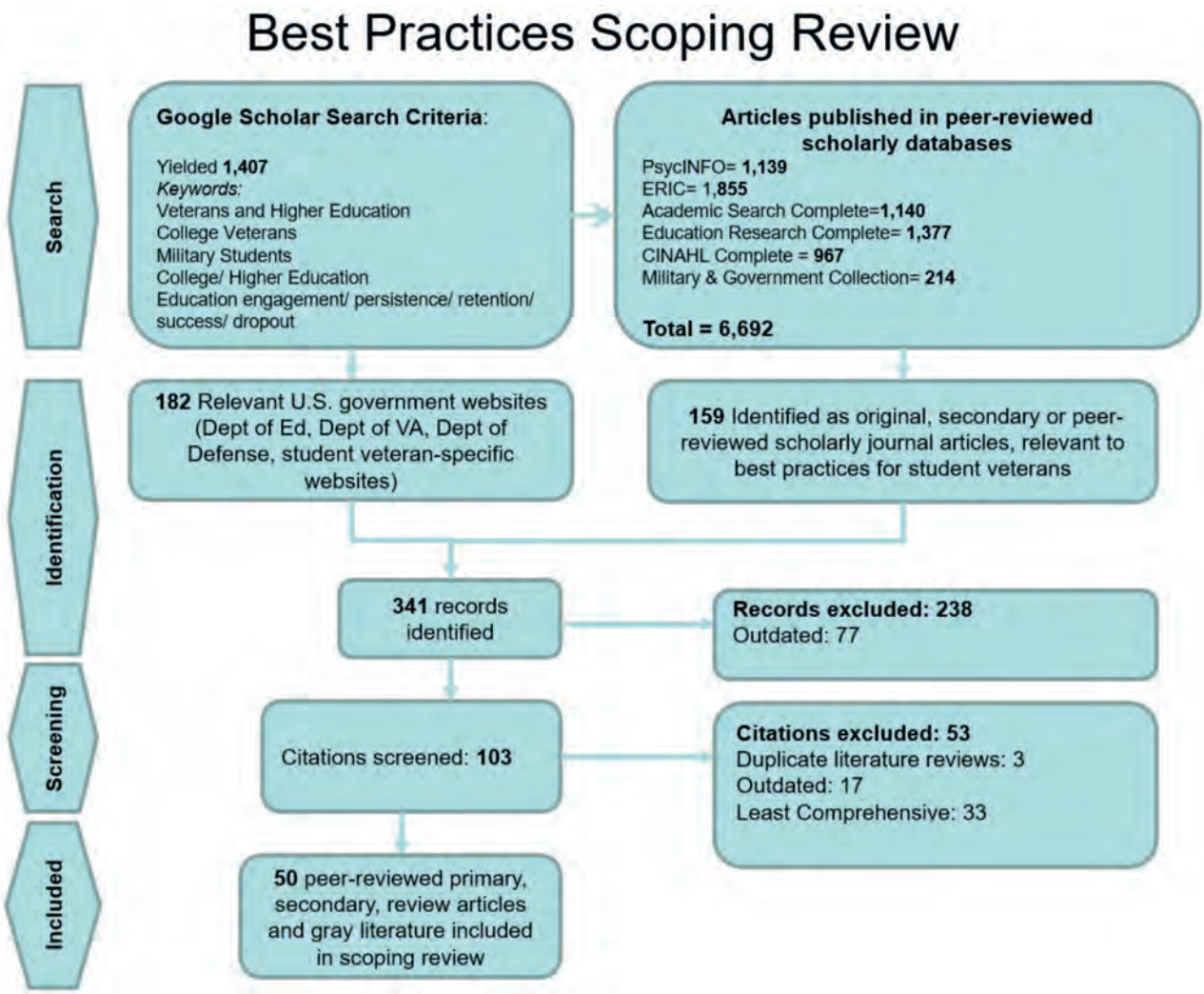

Figure 1: Scoping review process

Complete, CINAHL Complete, Education Research Complete, ERIC, Military & Government Collection, PsycINFO, and ProQuest. Grey literature authored by a credible source (i.e., the government) was included. Fifty studies from the initial 6,692 reviewed studies were determined to meet the criteria and were included in the final analysis for the scoping review.

This scoping review of existing programs and services for college student Veterans is framed by federal standards for serving student Veterans in higher education. More specifically, a collaborative initiative involving the U.S. Departments of Education, Veterans Affairs (VA), and Defense introduced the 8 Keys to Veterans' Success as "steps that postsecondary institutions can take to assist Veterans and Service members in transitioning to higher education, completing their college degrees, and obtaining career-ready skills."[19] Thus, in this review, existing programs and services are examined and categorized under the 8 Keys. Currently, 2,299 universities and colleges have affirmed support of the 8 Keys to Veterans' Success, thereby committing to developing and establishing campus initiatives that support student Veterans.[19]

RESULTS

Key 1: Create a culture of trust and connectedness across the campus community to promote well-being and success for Veterans

Of the nearly 700 institutions of higher education that were surveyed in 2012, 62% already had programs and services in place for students who served in the armed forces, and 16% were in the process of designing such programs.[20] The majority of institutions with services for military students aim to reduce cultural gaps that prevent Veterans from accessing social support needed for reintegration.[13,14,21,22] Thus, many universities and community colleges, including the University of California, Berkeley; San José State University (SJSU); Santa Monica College; and East Carolina University, hold a Veteran-specific orientation to provide points of contact for campus advisors, counselors, and other military student-specific resources and programs.[23,24] Targeted outreach programs allow Veterans to establish connections with peers, as well as with faculty and staff.[23,25,26] SJSU also offers an undergraduate capstone course that focuses on common issues faced by military Veterans as they transition back into civilian roles.[27] Research suggests that classes pertaining to Veterans' unique experiences and challenges provide valuable opportunities for military and civilian students to learn from each other's perspectives and to establish positive social connections.[22,27]

Student Veteran organizations and clubs can provide the sense of camaraderie student Veterans once enjoyed in the military.[28] In fact, the national organization, Student Veterans of America (SVA), reports that it "began on roughly 20 campuses in 2008 to create a network of connectedness through a peer support model."[29] SVA affiliates are now established in more than 850 institutions across the United States, including trade schools, community colleges, four-year private and public universities, and online higher education programs.[29] Student-led organizations often play an integral role in representing military students on campus and even influence campus policies. Existing literature reveals they also facilitate peer mentoring, social support, and the dissemination of Veteran-specific information.[29,30] The University of California, Santa Cruz, Services for Transfer and Re-Entry Students Office, for example, offers a peer mentor program led by a student Veteran coordinator.[24] Each peer mentor is trained to provide campus and community Veteran-specific resources, including updated and accessible contact information. Peer mentors also educate faculty, staff, administrators, and the student community on the challenges faced by military-connected students.[24]

Similarly, the Veterans Embracing Transition (VET) Connect Peer Leadership Program at SJSU employs student Veterans and military dependents to educate the campus and community about the needs and perspectives of Veterans.[31] Research suggests that the VET Connect Program reduces military students' isolation by connecting them to both peer and professional support across campus. By serving as peer leaders, Veterans integrate their student and military identities, develop professional skills such as public speaking, learn about campus resources, and gain insight into service experiences and coping mechanisms.[31] Overall, findings suggest that peer leadership may serve as a potent, high-impact practice that engages Veterans in higher education.[31,32]

Key 2: Ensure consistent and sustained support from campus leadership

For students serving in the National Guard or military reserve, consistent campus support is especially

critical to mitigate disruptions caused by service activation.[13,16] Institutions with large military and Veteran student populations, such as Appalachian State University (ASU), developed comprehensive measures to maintain military students' positive connections with the campus community while deployed.[33] For example, specific financial aid and grading policies were developed to accommodate sudden course withdrawals due to deployment. Students receive procedural information regarding early enrollment, financial aid, and housing, along with campus newspapers, while deployed. In addition, support groups are provided to family members of deployed students. Upon returning to the campus, student Veterans meet with faculty members and administrators to discuss their needs regarding reintegration.[33] The success of ASU's Veteran programs can be attributed to strong support from the campus community and university administrators, specifically the associate vice chancellor and the Veterans' Affairs coordinator.[33] As a result of this institutional support, priority registration for student Veterans and active-duty service members has been implemented on campus and recommended as a best practice in higher education.[34,35]

Many states, such as California, Pennsylvania, and Wisconsin, have passed legislation to this end. Some schools, such as those in the Minnesota State Colleges and Universities system, have assumed a major role in promoting legislation benefiting service members, Veterans, and dependents in higher education.[36] In addition, some institutions partnered with the federal Yellow Ribbon Program to jointly supplement the Post-9/11 G.I. Bill covering Veterans' tuition and school-related fees.[37] Working in partnership with the VA, SVA's executive director met with leaders from more than 100 institutions of higher education to push for increased support of student Veterans.[29]

Key 3: Implement an early alert system to ensure all Veterans receive academic, career, and financial advice before challenges become overwhelming

Some universities track the progress and needs of Veterans and military students across departments and offices to facilitate academic success and encourage students to seek assistance when needed.[23] Institutions such as ASU and West Kentucky University have established databases and communication channels to allow staff to advise student Veterans on academic, career, and financial matters.[33,38] Not surprisingly, evidence suggests that early alert systems reduce time to completion for all non-traditional students.[16] The 2012 American Council on Education (ACE) national survey results from 690 institutions revealed the campus services most used by student Veterans are financial aid counseling, employment assistance, and academic advising.[4,20] Student Veteran organizations throughout the United States have implemented on-campus programs to connect Veterans with financial, academic, and post-graduation aid. For example, the Veteran Student Organization of the University of Colorado Denver created Boots to Suits, a career mentoring effort. The Peer Advisors for Veteran Education, launched by the SVA in collaboration with the University of Michigan Depression Center, connects incoming military students with other student Veterans who provide assistance with navigating college life and resources.[29]

Key 4: Coordinate and centralize campus efforts for all Veterans, together with the creation of a designated space for them

Research conducted by ACE in 2012 indicated that, of 690 institutions surveyed, 71% had designated offices for student Veteran services, 68% had organizations or clubs for student Veterans, and 47% had a student Veteran lounge (compared with 12% in 2009).[20] Designated office space promotes the visibility of campus Veteran services and increases the frequency of service use.[4] SVA has advocated for the establishment of Veteran centers on campus through letter writing campaigns to university presidents and site visits to universities and colleges.[39] Indeed, campuses with a space for Veteran services were found to be more likely to offer specialized counseling and support groups to student Veteran populations.[4,20] Moreover, institutions with offices for student Veterans are more likely to tailor and update their services, including establishing outreach strategies and providing training to staff and faculty members.[4,20] Research suggests that use of the Veteran Resource Center at SJSU is associated with increased academic engagement and university satisfaction for student Veterans.[25]

Key 5: Collaborate with local communities and organizations, including government agencies, to align and coordinate various services for Veterans

It is imperative for colleges and universities to collaborate with government agencies and outside organizations to better serve Veterans and military students.[23,30] VetSuccess on Campus, a federal initiative, was designed

to assist U.S. military members, student Veterans, and dependents to achieve educational goals through access to campus resources, VA educational and health care benefits, and employers.[40] Similarly, Joining Forces Illinois involves the SVA in statewide efforts to coordinate Veteran and military support.[41]

Local non-profit organizations provide additional support to student Veterans in their reintegration. Mission Continues, for example, allows Veterans to continue serving their country after separating from the military and provides stipends to Veterans for volunteering in community-based social service programs.[42] Findings demonstrate that involvement in Mission Continues is linked to reduced isolation, increased sense of purpose, enhanced job skills, and a greater sense of civic involvement.[42]

Key 6: Utilize a uniform set of data tools to collect and track information on Veterans, including demographics, retention, and degree completion

A uniform set of data on student Veterans, including demographics, retention, and degree completion, is critical for institutions' policy-making and program development. Yet, such a uniform set of data was not created until 2011.[16, 43] Although there are a few databases established by local government agencies and institutions, there are significant discrepancies in data derived from different databases. For example, O'Rourke's 2013 study revealed discrepancies between the data provided by the VA and those provided by the Chancellor's Office of the California State University system regarding Veterans' use of educational benefits.[13]

Moreover, because many Veterans are reluctant to disclose their military identity on college admissions forms, institutions usually rely on the use of the G.I. Bill to approximate student Veteran populations. However, G.I. Bill usage may not accurately reflect the size or trajectory of Veteran populations on campuses.[16, 43] The 2017 National Veteran Education Success Tracker Project Report explored the academic outcomes of 853,111 student Veterans and revealed that the majority of student Veterans who earned a first bachelor's degree did so within five years — a graduation rate comparable to that of other non-traditional students.[44] In fact, the overall graduation rate for Veterans was 72%, higher than the national average of 67%.[45] In terms of tracking student Veterans' drop-out rate, the 2013 Student Affairs Administrators in Higher Education survey suggested that only about 25% of the institutions across the United States had a comprehensive understanding of the reasons behind student Veterans' drop-out.[46] Without a comprehensive and standardized set of assessment tools, developing and sustaining effective programs to support student Veterans may be impossible. Thus, creating a nationwide universal database on student Veterans should be a top priority for governmental and higher education systems across the United States.

Key 7: Provide comprehensive professional development for faculty and staff on issues and challenges unique to Veterans

Most civilian students, faculty, and staff have little knowledge of military culture and Veterans' specific needs, and they are unable to provide effective support to student Veterans as they transition to college and civilian society.[20] One of the common complaints reported by student Veterans is that they experience indifferent and negative interactions with faculty, including derogatory remarks about the military.[21, 47] The ACE survey revealed that 54% of institutions (n = 227) identified faculty and staff sensitivity toward student Veterans' challenges as a priority.[20] To that end, more than 45% of institutions provided professional development for faculty, and more than 60% provided professional development for staff.[20] For example, ASU and Minnesota state universities attribute success in serving military and Veteran students to well-trained staff and faculty who work flexibly to meet the unique needs of this population.[33, 36] Instructors at ASU provide personalized alternatives to course completion for active-duty students, such as allowing them to take final exams before deployment.[33]

Specific training for faculty and staff is clearly needed to improve military students' educational experiences. As of 2012, only 44% of 669 U.S. institutions surveyed reported training staff to help students affected by injuries such as TBI and PTSD.[20, 32] Institutions of higher education must offer specific training to staff and faculty on a regular basis to effectively support student Veterans. The University of Colorado Springs, for example, provides interactive training sessions on topics such as Veteran-specific campus resources, educational benefits, and military culture as well as on TBI and PTSD.[48]

Key 8: Develop systems that ensure sustainability of effective practices for Veterans

The institutionalization of services and training programs regarding the needs of military students is

essential. National grant programs created and implemented by the U.S. Department of Education, such as Veterans Upward Bound, Educational Opportunity Centers, and Centers of Excellence for Veteran Student Success (CEVSS), assist colleges and universities in supporting students transitioning from military life to post-secondary education.[49] In specific, the CEVSS offers grants to institutions that demonstrate excellence in Veteran programming to coordinate comprehensive services that address military students' social, financial, and academic challenges. At the university system level, the University of North Carolina's UNC SERVES initiative seeks to coordinate and sustain Veteran support on all 16 campuses throughout the state. In addition, Florida State University committed to supporting Veterans by working with the campus SVA chapter and reports retention rates of approximately 88% for student Veterans.[29]

Moreover, for military and Veteran students to accomplish their educational goals in the face of injuries and disabilities, institutions need to research and adapt new approaches to accommodate disabled students while facilitating an inclusive learning environment. For example, Universal Design (UD), as implemented at universities such as SJSU, assists military and Veteran students in academic integration.[50] UD accommodates the physical and psychosocial needs of all students related to classroom design and course curriculum.[50] Essentially, UD is a human-centered approach that endows course curricula with flexibility and effective options for accommodating students with diverse backgrounds and needs (Table 1).

Table 1. Summary of results

Key to Veterans' success	Results
1. Create a culture of trust and connectedness across the campus community to promote well-being and success for Veterans.	• As of 2012, 62% of surveyed higher education institutions nationally (N = 690) reported having Veteran-specific services:[20] o 49% had a Veteran-specific orientation.[20] o 47% had a student organization for student Veterans[20] (850 institutions across the United States).[29] • As of 2020, 2,299 higher education institutions committed to supporting Veterans through the 8 keys.[19] • The current review identified 4 exemplars of campus services targeted toward "creating a culture of trust and connectedness to promote well-being and success for Veterans."[19]
2. Ensure consistent and sustained support from campus leadership.	• As of 2012, more than 80% of surveyed higher education institutions nationally (*N* = 690) had developed institutional procedures to enable deployed military students to continue their education.[20] o 82% of campuses established tuition refunds for deployed students.[20] o 28% of campuses streamlined re-enrollment processes for students returning from deployment.[20] • The current review identified 4 exemplars of states passing and promoting legislation benefiting service members, Veterans, and dependents in higher education.
3. Implement an early alert system to ensure all Veterans receive academic, career, and financial advice before challenges become overwhelming.	• As of 2012 and the current review, a paucity of data exists regarding campuses' efforts to implement early alert systems that track the progress and needs of Veterans and military students. • The current review identified 2 institutions of higher education that have established databases and communication channels to allow staff to advise student Veterans on academic, career, and financial matters.[33, 38]
4. Coordinate and centralize campus efforts for all Veterans, together with the creation of a designated space for them (even if limited in size).	• As of 2012, of 690 institutions surveyed,[20] o 71% had designated offices for student Veteran services, o 68% had organizations or clubs for student Veterans, and o 47% had a student Veteran lounge. • The current review identified 1 exemplar of a collaborative campus effort across the Academic and Student Affairs Divisions offering designated campus spaces for Veterans.

(*Continued*)

Table 1. (Continued)

Key to Veterans' success	Results
5. Collaborate with local communities and organizations, including government agencies, to align and coordinate various services for Veterans.	• As of 2012 and the current review, all higher education institutions serving Veterans relied on collaborations with the U.S. Department of Veterans Affairs to identify and support Veterans. • The current review identified 3 national and 1 statewide campus community initiative to support student Veterans' success and retention (VSOC, The Mission Continues, SVA, Join Forces Illinois).
6. Utilize a uniform set of data tools to collect and track information on Veterans, including demographics, retention, and degree completion.	• As of 2012 and the current review, a standardized system for tracking the progress of military students is lacking for institutions of higher education. o Only about 25% of the institutions across the United States had a comprehensive understanding of the reasons behind student Veterans' drop-out.[46] o The current review identified 1 national effort (2017 NVEST) to examine the academic outcomes of student Veterans (*N* = 853,111), revealing that the majority graduated at a rate comparable to that of other non-traditional students.[44]
7. Provide comprehensive professional development for faculty and staff on issues and challenges unique to Veterans.	• As of 2012, more than 45% of institutions surveyed nationally provided professional development for faculty, and more than 60% provided professional development for staff.[20] • Only 44% reported that they had trained staff to help students affected by common injuries such as TBI and PTSD.[20, 32] • The current review identified 1 exemplar of an interactive training program for faculty and staff on topics such as Veteran-specific campus resources, educational benefits, military culture, and TBI and PTSD.[48]
8. Develop systems that ensure sustainability of effective practices for Veterans.	• As of 2016, 3 national grant programs were implemented by the U.S. Department of Education to ensure student Veteran success: o VUB o EOC o CEVSS. • The current review identified 3 exemplars of coordinated systems at universities that ensure and monitor sustainability of effective practices. • Further research is sorely needed to evaluate effectiveness of Veteran-specific campus programming.

Note: VSOC = VetSuccess on Campus; SVA = Student Veterans of America; NVEST = National Veteran Education Success Tracker; TBI = traumatic brain injury; PTSD = posttraumatic stress disorder; VUB = Veterans Upward Bound; EOC = Educational Opportunity Centers; CEVSS = Centers of Excellence for Veteran Student Success.

DISCUSSION

In summary, current research and policy guidelines suggest that student Veterans benefit from 1) a supportive campus climate that promotes integration with Veteran and civilian peers; 2) streamlined procedures related to academic advising and transfer of course credit; 3) Veteran-specific campus services, such as a Veteran Resource Center, and Veteran-specific programs, such as peer leadership efforts and Veteran orientation; 4) campus education targeting faculty, staff, and civilian students regarding the unique needs, experiences, and perspectives of students who have served; and 5) opportunities for participation in service and community engagement.

In practice, the absence of uniform data on student Veterans remains a significant challenge. Therefore, maintaining a national database on student Veterans should be a top priority in higher education. Of equal significance, it is imperative that institutions of higher education continually assess Veterans' needs and experiences on campus to ensure quality programming and sustained institutional support.

To conclude, on the basis of the current scoping review, the authors recommend that military students be surveyed annually to assess their knowledge of, and satisfaction with, campus climate, accessibility, student Veteran organizations, opportunities to access funding and support from the VA and other Veteran-supporting organizations, campus employment options, and career development opportunities. In addition, the authors recommend that faculty and staff be surveyed annually on their perception of the extent and quality of campus

programs for military students and student Veterans, as well as the available support and training opportunities to serve this population.

REFERENCES

1. U.S. Government Accountability Office. Veterans affairs: better understanding needed to enhance services to Veterans readjusting to civilian life [Internet]. Washington (DC): The Office; 2014 [cited 2019 July 11]. Available from: http://www.gao.gov/products/GAO-14-676.
2. Institute of Medicine. Characteristics of the deployed. In Returning home from Iraq and Afghanistan: assessment of readjustment needs of Veterans, service members, and their families. Washington (DC): National Academies Press; 2013. p. 31–46.
3. U.S. Department of Veterans Affairs. Table 2L: VETPOP2016 living Veterans by period of service, gender, 2015–2045 [Internet]. Washington (DC): The Department; 2016 [cited 2019 July 11]. Available from: https://www.va.gov/vetdata/docs/Demographics/New_Vetpop_Model/2L_VetPop2016_POS_National.xlsx.
4. Cook BJ, Kim Y. From soldier to student: easing the transition of service members on campus. Washington (DC): American Association of State Colleges and Universities; 2009.
5. Griffith J. Homecoming of soldiers who are citizens: re-employment and financial status of returning Army National Guard soldiers from Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF). Work. 2015;50(1):85–96. https://doi.org/10.3233/wor-131794. Medline:24284690
6. Student Veterans of America Research Department. Results from the 2016 SVA 20 Survey: student Veteran general breakdowns. Washington (DC): Student Veterans of America; 2016.
7. Blosnich JR, Kopacz MS, McCarten J, Bossarte RM. Mental health and self-directed violence among student service members/Veterans in postsecondary education. J Am College Health. 2015;63(7):418–26. https://doi.org/10.1080/07448481.2014.931282. Medline:24918517
8. Klaw EL, Demers AL, Da Silva N. Predicting risk factors for intimate partner violence among post-9/11 college student Veterans. J Interpers Violence. 2016;31(4):572–97. https://doi.org/10.1177/0886260514556102. Medline:25389195
9. Thomas KH, Albright DL, Phillips D, et al. Mental health status in service member and Veteran students at four-year postsecondary institutions: a pilot needs assessment. Best Pract Ment Health. 2018;14(1):1–4.
10. Clark ML. Out of combat and into the classroom: how combat experiences affect combat Veteran students in adult learning environments [dissertation]. Manhattan: Kansas State University; 2014.
11. U.S. Department of Defense. DoD worldwide numbers for traumatic brain injuries [Internet]. Falls Church (VA): Traumatic Brain Injury Center of Excellence; 2018 [cited 2019 Jul 14]. Available from: http://dvbic.dcoe.mil/dod-worldwide-numbers-tbi.
12. Pogoda TK, Hendricks AM, Iverson KM, et al. Multisensory impairment reported by Veterans with and without mild traumatic brain injury history. J Rehabil Res Dev. 2012;49(7):971–84. https://doi.org/10.1682/jrrd.2011.06.0099. Medline:23341273
13. O'Rourke Jr PC. How military service affects student Veteran success at community colleges. Long Beach: California State University; 2013.
14. Olsen T, Badger K, McCuddy MD. Understanding the student Veterans' college experience: an exploratory study. US Army Med Dep J. 2014; 30(Oct–Dec):101–8.
15. National Survey of Student Engagement. Major differences: examining student engagement by field of study: annual results 2010. Bloomington (IN): Indiana University Center for Postsecondary Research; 2010.
16. Cate CA. Million records project: research from student Veterans of America. Washington (DC): Student Veterans of America; 2014.
17. Rumann CB, Hamrick FA. Student Veterans in transition: re-enrolling after war zone deployments. J Higher Educ. 2010;81(4):431–58. https://doi.org/10.1353/jhe.0.0103
18. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol. 2005;8(1):19–32. https://doi.org/10.1080/1364570320000119616. Medline:31705429
19. U.S. Department of Education. 8 Keys to Veterans' success sites [Internet]. Washington (DC): The Department; n.d. [cited 2013 Aug 9]. Available from: https://www.ed.gov/veterans-and-military-families/8-keys-success-sites.
20. McBain L, Kim YM, Cook BJ, et al. From soldier to student II: assessing campus programs for Veterans and service members. Washington (DC): American Council on Education; 2012.
21. Ford K, Vignare K. The evolving military learner population: a review of the literature. Online Learning. 2015;19(1):7–30. https://doi.org/10.24059/olj.v19i1.503.
22. Hawn H. Veterans and Veteran families in general education. J Gen Educ. 2011;60(4):248–64. https://doi.org/10.5325/jgeneeduc.60.4.0248
23. Heineman JA. Supporting Veterans: creating a "military friendly" community college campus. Community Coll J Res Pract. 2016;40(3):219–27. https://doi.org/10.1080/10668926.2015.1112318.

24. O'Herrin E. Enhancing Veteran success in higher education. Peer Rev. 2011;13(1):15.
25. Young B, Klaw E. Assessing overall climate for military Veterans in college. Poster presented at: San José State University Spartan Psychological Association Research Conference (SPARC); 2018 May 1; San José, CA; and Association for Psychological Science Annual Convention; 2018 May 24–27; San Francisco, CA.
26. Evans JJ, Pellegrino L, Hoggan C. Supporting Veterans at the community college: a review of the literature. Community Coll Enterprise. 2015;21(1):47.
27. Alcala S, Li K, Young B, et al. The effects of peer leadership participation on student Veterans' ideas about self and others. In: Proceedings of 98th Western Psychological Association Convention; 2017 Apr 27–30; Sacramento, CA; XXXX.
28. Summerlot J, Green SM, Parker D. Student Veterans organizations. New Dir Stud Serv. 2009;2009(126):71–9. https://doi.org/10.1002/ss.318.
29. Student Veterans of America. SVA responds to President Obama's 8 keys to success [Internet]. Washington, DC: Student Veterans of America; c2019 [cited 2019 Jul]. Available from: https://studentveterans.org/media-news/176-sva-responds-to-president-obama.
30. Ostovary F, Dapprich J. Challenges and opportunities of Operation Enduring Freedom/Operation Iraqi Freedom Veterans with disabilities transitioning into learning and workplace environments. New Dir Adult Cont Educ. 2011;2011(132):63–73. https://doi.org/10.1002/ace.432.
31. Klaw E, Diaz J, Avalos R, et al. VET connect: an emerging peer leadership program for Veterans on campus. J Mil Veteran Fam Health. 2017;3(1):70–6. https://doi.org/10.3138/jmvfh.4116.
32. Wheeler HA. Veterans' transitions to community college: a case study. Community Coll J Res Pract. 2012;36(10):775–92. https://doi.org/10.1080/10668926.2012.679457.
33. Johnson T. Ensuring the success of deploying students: a campus view. New Dir Stud Ser. 2009;2009(126):55–60. https://doi.org/10.1002/ss.316
34. Collette RA, Davila-Carranza NS. Enhancing Veteran academic success: voices of CSUS student Veterans on their community college experience and transition to university. Sacramento: Division of Social Work, California State University; 2014.
35. Brown PA, Gross C. Serving those who have served: managing Veteran and military student best practices. J Cont High Educ. 2011;59(1):45–9. https://doi.org/10.1080/07377363.2011.544982.
36. Lokken JM, Pfeffer DS, McAuley J, et al. A statewide approach to creating Veteran-friendly campuses. New Dir Stud Ser. 2009;2009(126):45–54. https://doi.org/10.1002/ss.315.
37. U.S Department of Veterans Affairs. Yellow Ribbon Program [Internet]. Washington (DC): The Department; 2020 [cited 2017 Jun 29]. Available from: https://www.benefits.va.gov/GIBILL/yellow_ribbon.asp.
38. Wilson KB. Thank you for your service: military initiatives on college campuses. New Horizons Adult Education Hum Resour Dev. 2014;26(3):54–60. https://doi.org/10.1002/nha3.20072
39. Student Veterans of America. SVA responds to President Obama's 8 keys to success. 2013 Aug 12 [cited 2019 Jul] In: Tumblr [Internet]. [about 1 page]. Available from: http://terrortrials.blogspot.com/2013/08/sva-responds-to-obamas-eight-keys-to.html.
40. U.S. Department of Veterans Affairs, Veterans Benefits Administration. VetSuccess on Campus (VSOC) In: M28R, vocational rehabilitation and employment service manual [Internet]. Washington (DC): U.S. Department of Veterans Affairs; 2015 [cited 2017 Aug 14]. Available from: https://www.benefits.va.gov/WARMS/docs/admin28/M28R/Part_III/IIIB4.pdf.
41. Illinois Joining Forces. Resources [Internet]. Chicago: Illinois Joining Forces; c2019 [cited 2019 Jul]. [about 1 page]. Available from: https://www.illinoisjoiningforces.org/.
42. Matthieu MM, Smith ID, Morrow-Howell N, Moore McBride A. Impacts of the Mission Continues fellowship program on post-9/11 disabled military Veterans, their families, and their communities; St. Louis (MO): Washington University in St. Louis; 2013.
43. U.S. Government Accountability Office. VA education benefits: VA needs to improve program management and provide more timely information to students [Internet]. Washington (DC): The Office; 2013 [cited year month day]. Available from: http://www.gao.gov/products/GAO-13-338.
44. Cate CA, Lyon JS, Schmeling J, et al. National Veteran education success tracker: a report on the academic success of student Veterans using the post-9/11 GI Bill. Washington (DC): Student Veterans of America; 2017.
45. Cate CA. Million Records Project: research from Student Veterans of America [Internet]. Washington (DC): Student Veterans of America; 2014 [cited 2021 Jan 21]. Available from: https://studentveterans.org/wp-content/uploads/2020/08/mrp_Full_report.pdf.
46. National Association of Student Personnel Administrators. Measuring the success of student Veterans and active duty military students [Internet]. Washington (DC): The Association; 2013. Available from: https://www.naspa.org/rpi/reports/measuring-the-success-of-student-veterans-and-active-duty-military.
47. Persky KR, Oliver DE. Veterans coming home to the community college: linking research to practice. Community Coll J Res Pract. 2010;35(1–2):111–20. https://doi.org/10.1080/10668926.2011.525184.

48. University of Colorado, Colorado Springs. V.E.T.S. Faculty and staff training [Internet]. Colorado Springs (CO): The University; 2018. Available from: https://www.uccs.edu/military/faculty-and-staff-resources/vets-faculty-and-staff-training.
49. U.S. Department of Education. U.S. Department of Education programs supporting Veterans [Internet]. Washington (DC): The Department; 2016. Available from: https://www2.ed.gov/about/offices/list/ope/supporting-veterans.html.
50. Gonzalez CA, Elliott M. Faculty attitudes and behaviors towards student Veterans. J Postsec Edu Dis. 2016;29(1):35–46.

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REVIEW

Evaluating the quality of resilience apps for military members and public safety personnel

Kaitlin O'Toole[a] and Cary A. Brown[a]

ABSTRACT

Introduction: Military members and public safety personnel need targeted mental health interventions that are clinically effective, confidential, easily accessed, and cost effective. Smartphone apps are an emergent method of service delivery that provide an alternative to in-person therapy. However, although apps are increasingly prevalent, app development is unregulated and often lacks health care professional input and a clear evidence base. This study evaluates the quality of mental health apps for resiliency that are specifically targeted to military members and public safety personnel. **Methods:** After a comprehensive search for relevant apps costing no more than $5.00, a review was conducted, based on the Mobile Application Rating Scale. **Results:** Eighty-two apps were retrieved, and 12 met the inclusion criteria for evaluation. All evaluated apps were free and had been updated in the past two years. The resilience strategies offered by the majority of apps were diaphragmatic breathing, mindfulness practice, and progressive muscle relaxation. One app had been tested in a randomized controlled trial, seven had been tested with other methods, and four had not been research trialed. All apps except one were ranked as high quality, and the content provided evidence-based strategies for mental health resiliency interventions. **Discussion:** The apps reviewed are well suited to foster resilience among public safety personnel and military members. They offer evidence-based resiliency interventions and encourage help-seeking behaviors.

Key words: first responders, mHealth, military members, public safety personnel, public safety personnel, resiliency, smartphone apps

RÉSUMÉ

Introduction : Les militaires et le personnel de la sécurité publique ont besoin d'interventions ciblées en santé mentale qui sont efficaces sur le plan clinique, sont confidentielles, sont faciles d'accès et sont rentables. Les applications pour téléphone intelligent sont de nouvelles méthodes de prestation de services qui peuvent remplacer les thérapies face-à-face. Cependant, même si les applications sont de plus en plus courantes, leur développement n'est pas réglementé et ne fait souvent pas appel à des professionnels de la santé ni à des données probantes claires. La présente étude évalue la qualité des applications en santé mentale conçues expressément pour les militaires et le personnel de la santé publique pour renforcer la résilience. **Méthodologie :** Après une recherche détaillée des applications pertinentes ne coûtant pas plus de 5 $, les chercheures ont analysé les résultats d'après l'échelle d'évaluation des applications mobiles. **Résultats :** Au total, les chercheurs ont extrait 82 applications, dont 12 respectaient les critères d'inclusion. Toutes les applications évaluées étaient gratuites et avaient été mises à jour au cours des deux années précédentes. La respiration diaphragmatique, l'exercice de la pleine conscience et la relaxation musculaire progressive étaient les stratégies de résilience que proposaient la majorité des applications. Une application a été mise à l'essai dans une étude aléatoire et contrôlée, sept l'ont été par d'autres méthodes et quatre n'ont pas fait l'objet d'une étude. Toutes les applications, sauf une, étaient de haute qualité, et leur contenu fournissait des stratégies fondées sur des données probantes pour intervenir afin de renforcer la résilience en santé mentale. **Discussion :** Les applications analysées se prêtent bien au renforcement de la résilience du personnel de la sécurité publique et des militaires. Elles offrent des interventions fondées sur des données probantes pour renforcer la résilience et encouragent les comportements d'appel à l'aide.

Mots-clés : applications pour téléphone intelligent, militaires, personnel de la sécurité publique, premiers répondants, résilience, télémédecine

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LAY SUMMARY

A growing number of smartphone apps are being recommended to help build resilience. It is important to test whether these apps are of good quality and evidence-based. This study systematically evaluated 12 popular resilience-related apps for military and public service personnel and found that the majority were of high quality.

INTRODUCTION

Mobile health (mHealth) is an emerging field to complement health care clinical practice.[1] Development of applications (apps) for mobile device usage is growing rapidly, and one can only assume it will continue.[2] Apps developed for well-being and health promotion are part of this rapid increase and are believed to offer significant advantages for individuals seeking confidential, timely health care.[2] One population that has the potential to benefit from such apps are military members (MM) and public safety personnel (PSP). This population has significant physical and mental health challenges as a result of unique and ongoing occupational stressors.[3–5] Computer apps to develop resiliency and resiliency-aligned coping skills are increasingly available. Resiliency is:

> The concept of adapting to or bouncing back from a negative event or experience. It is defined in a number of different ways (something one has, something one develops, or something one uses) indicating a lack of consensus over the specific qualities or components that make up resilience.[6]

These apps typically address the goals of resilience development, personal growth, and ability to recover from traumatic experiences without residual long-term negative outcomes. However, apps are not required to undergo any regulatory or certification process that would ensure user safety.[7] Also, because the development of many mental health apps does not include peer-reviewed research,[8] the information and advice provided may not be evidence based. This article presents the findings of a structured review to evaluate the quality of apps for developing resilience among MM and PSP.

BACKGROUND

Population demands

MM and PSP share a number of unique job demands and stressors. Public Safety Canada's 2019 document *Supporting Canada's Public Safety Personnel: An Action Plan on Post-Traumatic Stress Injuries* defines PSP as "broadly encompass[ing] front-line personnel who ensure the safety and security of Canadians across all jurisdictions."[9(p.3)] Examples can include tri-services (police, including the Royal Canadian Mounted Police, firefighters, and paramedics), correctional employees, border services personnel, operational and intelligence personnel, search and rescue personnel, Indigenous emergency managers, and dispatch personnel.[9] The Canadian Institute for Public Safety Research and Treatment echoes this definition and points out that *PSP* is an evolving term that helps researchers and policy-makers work with a shared understanding of psychological trauma across a diversity of trauma-exposed workers.[6] Similar to MM, PSP work in settings that are physically demanding and carry real risks of personal injury and exposure to traumatic events.[10–13] They also share the occupational hazards of disrupted sleep patterns and associated risk of depression and anxiety, frequent extended periods of psychological arousal, negative health and social life impacts consequent to shift work, exposure to noxious environments, and elevated temperatures.[14] In addition, MM and PSP work in high-stress situations, such as deployments or natural disasters, in which they are expected to continue a high level of performance with few to no breaks for extended hours or days, leading to even more disrupted sleep and less chance for emotional and physical recovery.[3,4]

They both also have higher rates of posttraumatic stress disorder (PTSD), operational stress injury, and depression than the general population, a situation theorized to be linked to exposure to multiple traumatic events.[15,16] A study in the United Kingdom found that 87% of emergency services workers reported experiencing poor mental health, stress, or low mood since starting their career.[17] In addition, substance misuse is reported to be a prevalent coping strategy among police officers.[18] Using substances as a coping strategy has been linked to health concerns (such as low self-esteem, marital conflict, reduced quality of work, obesity, fatigue, poor sleep, and emotional dysregulation) that can negatively affect mental well-being.[19]

Although demographics are shifting, the majority of MM and PSP are male.[20] It has been proposed that men frequently have difficulty seeking help for mental health concerns, especially those engaged in the armed forces, a situation that may be due to conditioned self-reliance, vulnerability to mental illness, and avoidant behaviours.[20–22] Similarly, the typically

masculine work culture in paramedic practice has been thought to be associated with the suppression of emotional expression.[23] Substance misuse has also been linked to the idealized "'tough guy' image common in police culture."[24(p.104)] These cultural factors, fear of stigma, and concerns for confidentiality may have an impact on many MM's and PSP's comfort with seeking services for mental health concerns.[25]

Occupational therapists, psychologists, and other mental health care providers require alternative tools that address attitudinal and resource barriers to seeking help for resiliency building and mental health. One such promising resource is apps that can provide access to information and resilience-developing strategies.

mHealth

The U.S. Defense Health Agency, Connected Health, reports important benefits of using apps in health care, including increased privacy and lessened stigma offered by private devices; immediate access to content, therefore removing wait times and appointment scheduling; ability to track symptoms and share them with health care providers; and access to education in any setting.[25] One consideration for users of mHealth apps is cost. According to Kertz and colleagues, 93% of smartphone users will download a free app, whereas only 35.8% of them will pay for an app.[26] A second consideration is the reliability and safety of content.

There is no requirement for health care app developers to involve medical professionals in app development, and as such apps may have a limited evidence base and may contain misleading claims.[27] Those who recommend apps to MM and PSP need to be able to evaluate the scientific quality of app content and ensure it aligns with the existing evidence base for therapeutic interventions.[25] This expectation is appropriate for clinically trained practitioners working in MM and PSP health care systems but would be an unrealistic expectation for many MM and PSP themselves.

Although some theorists propose resiliency as an innate set of traits,[14] this app review study aligns with the premise that resiliency is developed through a dynamic process involving learning and growth.[28] This view holds that resilience involves development and demonstration of an ongoing ability to adapt cognitively, emotionally, and behaviorally, not being significantly harmed by an adverse experience.[28] As such, mHealth apps for resiliency hold potential as an effective learning and intervention strategy, and the scientific quality of their design warrants evaluation.

METHODS

Search criteria

The app search was conducted on Google on November 25, 2018. With the intention to mimic a typical layperson's search strategy, the terms "best apps for military resilience trauma" and "best apps for first responder resilience trauma" were used. Search results were limited to the first page of Google hits because the results on the second page were typically irrelevant or repetitive. Google was selected as the database because of its popularity as a search tool. A preliminary search had been conducted on both the Apple App Store (https://www.apple.com/ca/ios/app-store/) and the Google Play Store (https://play.google.com/store?hl=en); however, it retrieved an exorbitant number of war games and photo apps with no relevance to the question. The finding of many unrelated apps was consistent with the concern expressed on the American Psychological Association member platform that app store searches yield results that may be overwhelming to sort through, particularly for those with specific mental health needs.[8] In addition, the content of app stores is ever-changing, and their basic search tools are limited, often missing relevant material and retrieving unrelated apps.[7] The authors thus selected the Google search engine strategy.

Apps were not retained for review if they were duplicates; cost more than $5.00; were not specifically developed for MM or PSP; could not be accessed on either the Apple App Store or Google Play Store; did not have a clear mental health component; were intended to be used alongside an in-person therapist (e.g., ACT Coach); solely provided resources, peer support, or mood tracking without any direct tools or skill development (e.g., Real Warriors); focused only on substance use (e.g., VetChange); and were directed to military health care providers or upper-level staff rather than MM themselves (e.g., The Navy Leader's Guide for Managing Sailors in Distress). Apps were downloaded to either iPhone or Samsung (Android) devices if developed for only one platform; those available for both were divided between the two devices to form an even distribution.

Rating tool

The Mobile Application Rating Scale (MARS) was selected because it is a widely used, reliable, and multidimensional tool to both rate and classify mHealth apps.[2] The MARS assesses app quality on four dimensions: (A) engagement (composed of the subcategories

entertainment, interest, customization, interactivity, and match to target audience); (B) functionality (composed of the subcategories performance, ease of use, navigation, and gestural design), (C) aesthetics (composed of the subcategories layout, graphics, and visual appeal); and (D) information (composed of the subcategories accuracy of description in app store; goals that are specific, measurable, and achievable; quality of the information; quantity of the information; visual information; credibility; and evidence base). Each subcategory of these four dimensions contains a series of questions that guide the rater, using a scale ranging from 1 (inadequate) to 5 (excellent). Not applicable (N/A) is entered if indicated. The mean score for each of the four dimensions is calculated from the scores of the subcategories. For example, for Dimension D, information, the evidence base subcategory guides the rater with options in response to the question "Has the app been trialed/tested; verified by evidence (in published scientific literature?)." Response options include

- N/A; the app has not been trialed or tested
- The evidence suggests the app does not work
- The app has been trialed (e.g., acceptability, usability, satisfaction ratings) and has partially positive outcomes in studies that are not randomized controlled trials (RCTs), or there is little or no contradictory evidence
- The app has been trialed (e.g., acceptability, usability, satisfaction ratings) and has positive outcomes in studies that are not RCTs, and there is no contradictory evidence
- The app has been trialed and outcome tested in one to two RCTs with positive results
- The app has been trialed and outcome tested in more than three high-quality RCTs with positive results.

The overall quality score for each app is calculated by the researcher from the mean scores on Dimensions A–D. The MARS tool also includes Dimension E, subjective quality (based on the intended user's perspective), and provides the opportunity to record app-specific items on the MARS assessment form. These final items are not part of the app's quality score.

To increase the rigor of the review, the researcher (KO) completed the MARS training video posted on YouTube.[29] PubMed and Google Scholar searches were conducted to retrieve the current evidence base required to rate the apps on Dimension D, information (evidence base subcategory), regarding the use of evidence-based content by each app designer. Although the search was initially limited to articles addressing resiliency interventions for MM or PSP, the findings were very sparse, and the inclusion criteria were thus expanded. This resulted in the retrieval of 31 peer-reviewed publications that, when categorized, indicated evidence-based support for interventions in the area of mindfulness,[e.g., 30] progressive muscle relaxation,[e.g., 31] breathing techniques,[e.g., 32] non-pharmacological sleep interventions,[e.g., 33] and guided imagery.[e.g., 31]

RESULTS

Search results

The search resulted in 82 apps (see Supplemental Table 1). Applying exclusion criteria (Figure 1) and removing duplicates resulted in the retention of 12 apps[34–45] for evaluation with the MARS tool.[2]

Summary of app characteristics

Although the protocol was to accept apps that cost $5.00 or less, ultimately the relevant 12 apps were all available at no cost and did not provide options to purchase upgrades. All apps had been updated within 16 months of the February 2019 study (Table 1). The 12 apps were created by four developers (Table 1) — seven by the U.S. Department of Veterans Affairs, three by the National Center for Telehealth & Technology, one by Rape Abuse Incest National Network (an American organization receiving government funding and operating the Department of Defense Safe Helpline), and one by the Australian Government, Department of Veterans' Affairs.

Three of the apps were available only for Apple devices, and the remainder were available for both Apple and Android devices (Table 2). An iPhone 6s was used for the testing Apple device, and a Galaxy Grand Prime was used for the Android device. The majority of apps evaluated using an iPhone did not have enough consumer ratings to provide a star rating; however, all apps for Android phones received consumer ratings between 4.0 and 4.7 out of 5 stars on the Google Play Store.

Summary of MARS results

Table 3 details the mean scores for the MARS component sections (engagement, functionality, aesthetics, and information), total subjective app quality, and the overall MARS score for each app. As detailed in Table 3, the majority of apps earned high total mean scores out of a

Supplemental Table 1. Excluded apps

App name	Round 1					Round 2				Included in study
	Duplicate	Cost prohibitive	For general population	Inaccessible	No MH focus	Needs therapist	No tools	Only substance use	For health care providers or leaders	
Search Term 1										
1. AIMS for Anger Management										✓
2. Breathe2Relax										✓
3. CBT-I Coach						x				
4. Concussion Coach										✓
5. LifeArmor										✓
6. Mindfulness Coach										✓
7. Mood Coach										✓
8. Moving Forward										✓
9. mTBI Pocket Guide					x					
10. T2 Mood Tracker							x			
11. Tactical Breather										✓
12. VetChange								x		
13. Positive Activity Jackpot				x						
14. Calm			x							
15. Breathe2Relax	x									
16. MoodKit			x							
17. Pacifica			x							
18. LifeArmor	x									
19. DBT Diary Card and Skills Coach			x							
20. TalkLife			x							
21. Koko				x						
22. Lantern				x						
23. Virtual Hope Box			x							
24. BetterHelp		x								
25. My3App			x							
26. My VA Apps-Safety Plan for Veterans				x						
27. SAMHSA- Suicide Safe				x						
28. Circle of 6			x							
29. iBlueButton Veterans					x					
30. BioZen				x						
31. Breathe2Relax	x									
32. Co-occurring Conditions Toolkit				x						
33. LifeArmor	x									
34. MTBI Pocket Guide	x									

(*Continued*)

Supplemental Table 1. (Continued)

App name	Round 1					Round 2				Included in study
	Duplicate	Cost prohibitive	For general population	Inaccessible	No MH focus	Needs therapist	No tools	Only substance use	For health care providers or leaders	
35. Navy Leader's Guide for Managing Sailors in Distress									x	
36. PE Coach						x				
37. Positive Activity Jackpot	x									
38. Provider Resilience									x	
39. PTSD Coach										✓
40. T2 Mood Tracker	x									
41. Tactical Breather	x									
42. Virtual Hope Box	x									
43. Objective Zero							x			
44. Safe Helpline (DoD)- Sexual assault support for the DoD community										✓
45. TriCare Pharmacy Contractor Express Script				x						
46. Real Warriors							x			
47. Breathe2Relax	x									
48. T2 Mood Tracker	x									
49. LifeArmor	x									
50. PTSD Coach	x									
51. Virtual Hope Box	x									
52. Provider Resilience	x									
53. Provider Resilience	x									
54. HighRes										✓
55. Provider Resilience	x									
56. PTSD Coach	x									
57. PTSD Family Coach										✓
58. Mindfulness Coach	x									
59. VetChange	x									
60. Anger and Irritability Management Skills	x									
61. CPT Coach						x				
62. PE Coach	x									
63. CBT-I Coach	x									
64. ACT Coach						x				
65. STAIR Coach						x				

(*Continued*)

Supplemental Table 1. (Continued)

App name	Round 1					Round 2				Included in study
	Duplicate	Cost prohibitive	For general population	Inaccessible	No MH focus	Needs therapist	No tools	Only substance use	For health care providers or leaders	
66. Mood Coach	x									
67. Concussion Coach	x									
68. Parenting to Go				x						
69. Moving Forward	x									
70. Stay Quit Coach								x		
Search Term 2										
71. Let Me Know				x						
72. Inner Balance		x								
73. PTSD Coach	x									
74. PTSD Family Coach	x									
75. PTSD Mindfulness Coach				x						
76. CrewCare				x						
77. First Responder Fitness Podcasts				x						
78. Talkspace		x								
79. Stop, Breathe & Think: Meditation and Mindfulness			x							
80. Public Safety Peer Support/ Supervisor Coach		x								
81. Calm	x									
82. Fit Responder Fitness				x						

Notes: Some apps fit multiple exclusion criteria; therefore, the table indicates only the main reason for exclusion.

possible mean score of 5 for app quality, with 11 apps scoring 3.7 or more (range 3.7-4.5), with only Tactical Breather scoring lower at 2.9. The highest scoring app was Mindfulness Coach, at 4.5. AIMS for Anger Management, Concussion Coach, and PTSD Family Coach scored second highest, each with 4.4. The highest total subjective quality scores were Mindfulness Coach at 17 out of a possible 20 points; AIMS for Anger Management, DoD Safe Helpline, and PTSD Family Coach each earned 15 out of 20. The lowest scoring app for both total mean quality score and total subjective quality score was Tactical Breather (scores of 2.9 out of 5 and 8 out of 20, respectively). For the app-specific component of increased resilience, the highest scoring apps were AIMS for Anger Management (4.8), PTSD Family Coach (4.5), and LifeArmor and Mood Coach (4.3).

MARS Question 19 (evidence base) was completed on the basis of the evidence retrieved from the PubMed and Google Scholar searches (Table 4). Four apps appeared to have undergone no testing published in scientific literature (AIMS for Anger Management, DoD Safe Helpline, High Res, and Moving Forward), and they were therefore scored N/A. Eight apps had been included in published scientific literature. PTSD Coach had been modified for use in six additional countries and tested in at least three RCTs.[46, 47] On the basis of the MARS guidelines, PTSD Coach scored 5 out of a possible 5 for demonstrating favorable outcomes in three or more RCTs. The remaining seven apps had been included in non-RCT outcome studies[48–52] and scored either a 2 or 3 because little or no contradictory evidence refuting the usefulness of the app was found.

Only six apps contained citations to their evidence base (AIMS for Anger Management, DoD Safe Helpline, LifeArmor, PTSD Family Coach, Mindfulness Coach, Moving Forward). Ten apps included contact

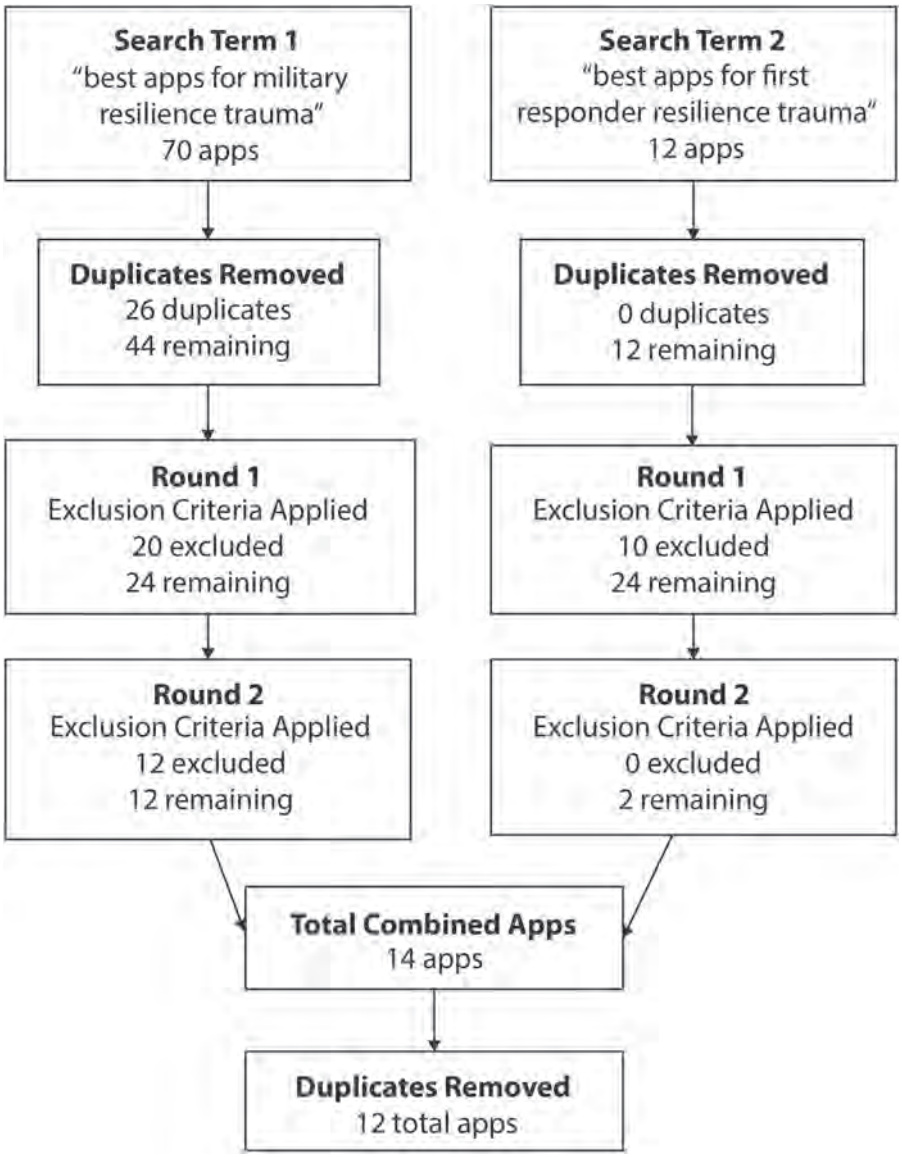

Figure 1. Search Procedure

information for other health care providers or helplines (e.g., 911, domestic violence hotline, or Veterans crisis line), and eight included a hyperlinked phone number for direct dialing. The two that did not link to resources, Tactical Breather and Breathe2Relax, focused exclusively on deep breathing. Two apps, Breathe2Relax and LifeArmor, contained broken video links. Ten apps were scored N/A for Question 17, which addresses the usefulness of the visual information provided. Many apps did not use visuals to explain their concepts, relying instead on blocks of text. Icons were occasionally used but tended to be decorative rather than providing explanations of concepts.

The common resilience techniques provided in the apps (Table 5) were as follows: deep or diaphragmatic breathing ($n = 10$), progressive muscle relaxation ($n = 7$), mindfulness practice ($n = 7$), sleep strategies ($n = 5$), and visualization ($n = 4$). Two apps, Breathe2Relax and PTSD Family Coach, required an Internet connection for crucial features of the app. The remaining apps did not require an Internet connection to use the app itself, but did require Internet to access resources on linked websites. In these cases, the links to websites were for further reference and did not detract from the information in the app itself.

DISCUSSION

The majority of apps scored highly and were developed by credible government agencies associated with the military and Veterans. They had high-quality aesthetics,

Table 1. App specifications

App	Developer	Version	Last updated
AIMS for Anger Management[34]	VA	1.2	January 2019
Breathe2Relax[35]	National Center for Telehealth & Technology	1.7.7	2018
Concussion Coach[36]	VA	1.0.26	June 28, 2018
DoD Safe Helpline[37]	RAINN	3.1.34	February 26, 2019
High Res[38]	Australian Government, Department of Veterans' Affairs	4.2.0	July 2, 2017
LifeArmor[39]	National Center for Telehealth & Technology	2.3	2018
Mindfulness Coach[40]	VA	2.1	October 1, 2018
Mood Coach[41]	VA	2.4	February 28, 2019
Moving Forward[42]	VA	1.3	February 28, 2019
PTSD Coach[43]	VA	3.2	July 27, 2018
PTSD Family Coach[44]	VA	2.0	October 4, 2018
Tactical Breather[45]	National Center for Telehealth & Technology	1.4.2	2018

Note: VA = U.S. Department of Veterans Affairs; RAINN = Rape Abuse Incest National Network.

Table 2. App specifications

App	Used	Available	No. of stars*
AIMS for Anger Management[34]	iPhone 6s	Both	N/A
Breathe2Relax[35]	iPhone 6s	Both	4.2
Concussion Coach[36]	Galaxy Grand Prime	Both	4.0
DoD Safe Helpline[37]	Galaxy Grand Prime	Both	4.3
High Res[38]	Galaxy Grand Prime	Both	4.7
LifeArmor[39]	iPhone 6s	iPhone	N/A
Mindfulness Coach[40]	Galaxy Grand Prime	Both	4.7
Mood Coach[41]	iPhone 6s	iPhone	N/A
Moving Forward[42]	iPhone 6s	iPhone	N/A
PTSD Coach[43]	Galaxy Grand Prime	Both	4.4
PTSD Family Coach[44]	Galaxy Grand Prime	Both	4.4
Tactical Breather[45]	iPhone 6s	Both	N/A

Note: N/A = not applicable.

*As rated by users of the app and displayed on the app store listing.

and their content was very well tailored to this specific population. However, all but one had a U.S. Government affiliation, and that may limit their usefulness to individuals from different countries and those who potentially experience culture-specific stressors that might not be included. As seen in Table 3, the MARS tool evaluates multiple components, and when making decisions about recommending any particular app, readers should consider the aspect that most applies to the clients they are serving.

The fact that only one app underwent assessment in an RCT should not be taken as an indicator that the others are of poor quality or content. Factors limiting RCT app evaluations include lengthy time period requirements, difficulty maintaining adherence to a rigid protocol, and the high cost associated with conducting an RCT.[53] It is concerning that 10 of the 12 apps were scored N/A for visuals used to explain concepts. Visuals are important in apps because large blocks of text can be overwhelming and non-aesthetic, and they can disadvantage individuals with different learning styles. Optimal learning among adults occurs when they are taught using a mixture of visual, kinesthetic, and auditory strategies.[54] It is concerning that the study revealed

Table 3. App MARS results

App	App quality ratings (out of 5)					Total subjective quality (out of 20)	App-specific component (increased resilience; out of 5)
	Engage	Function	Aesth	Info	Total mean score		
AIMS for Anger Management[34]	4.4	4.0	4.7	4.6	4.4	15.0	4.8
Breathe2Relax[35]	4.2	4.0	3.0	4.4	3.9	13.0	4.2
Concussion Coach[36]	3.8	4.8	4.7	4.3	4.4	14.0	4.2
DoD Safe Helpline[37]	4.2	4.0	4.3	4.2	4.2	15.0	3.5
High Res[38]	4.0	4.0	3.3	3.8	3.8	11.0	4.0
LifeArmor[39]	3.6	4.0	3.3	3.8	3.7	13.0	4.3
Mindfulness Coach[40]	4.6	4.3	5.0	4.0	4.5	17.0	4.0
Mood Coach[41]	4.0	4.5	4.7	4.0	4.3	10.0	4.3
Moving Forward[42]	3.8	4.0	3.3	4.8	4.0	12.0	3.8
PTSD Coach[43]	4.0	4.3	4.0	4.3	4.2	13.0	4.2
PTSD Family Coach[44]	4.4	4.3	5.0	4.0	4.4	15.0	4.5
Tactical Breather[45]	2.0	3.8	2.0	3.8	2.9	8.0	3.3

Note: MARS = Mobile Application Rating Scale; Engage = engagement; Function = functionality; Aesth = aesthetics; Info = information.

Table 4. Results for evidence base subcategory

App	Score
AIMS for Anger Management[34]	N/A
Breathe2Relax[35]	3
Concussion Coach[36]	3
DoD Safe Helpline[37]	N/A
High Res[38]	N/A
LifeArmor[39]	3
Mindfulness Coach[40]	2
Mood Coach[41]	2
Moving Forward[42]	N/A
PTSD Coach[43]	5
PTSD Family Coach[44]	3
Tactical Breather[45]	3

Note: In response to Mobile Application Rating Scale Question 19 (evidence base; total possible score = 5). N/A = not applicable.

very few apps focused specifically on PSP. This could be a notable deterrent for PSP who are exploring mental health options but feel the resources focused on MMs lack relevance to them.

It is reassuring that the apps' common themes of therapeutic breathing, progressive muscle relaxation, guided imagery, sleep hygiene and education, and mindfulness exercises are in line with current interventions for improving mental well-being and resiliency.[55–58] Personal factors found to have positive effects on developing psychological resilience include behavioural control, positive coping, self-management, self-regulation, and positive thinking,[59] which can be strengthened through strategies such as mindfulness and diaphragmatic breathing.[58]

Self-management and self-regulation concepts were frequently present in these apps. Although evidence relative to MM and PSP is sparse, cognitive behavioural therapy (CBT) and mindfulness have been linked to improvements in anxiety levels in other populations.[60] The principles of CBT were evident in many apps; for example, AIMS for Anger Management and High Res used strategies such as anger logs, thought stopping, and challenging thoughts to help users reframe their negative thinking patterns.[61] Similarly, relaxation-based strategies (such as progressive muscle relaxation) have been linked to a positive impact on emotional and cognitive burnout in other populations,[60] and these strategies were also present in many of the apps. It was encouraging to see that five apps addressed sleep hygiene, which is recognized as having positive implications for the psychological health and resilience of MM.[62,63]

It is important to note that, although mental health apps are growing in availability and are potentially highly

Table 5. Resilience strategies included in each app

App	DB	PMR	Mindfulness	Sleep	Visualization
AIMS for Anger Management[34]	x	x			
Breathe2Relax[35]	x				
Concussion Coach[36]	x	x	x	x	x
DoD Safe Helpline[37]	x	x	x		
High Res[38]	x	x	x	x	
LifeArmor[39]	x			x	
Mindfulness Coach[40]			x		
Mood Coach[41]					
Moving Forward[42]	x	x	x		x
PTSD Coach[43]	x	x	x	x	x
PTSD Family Coach[44]	x	x	x	x	x
Tactical Breather[45]	x				

Note: DB = deep or diaphragmatic breathing; PMR = progressive muscle relaxation.

useful, this is still an emerging, understudied area.[64] As such, current evidence suggests that this type of self-guided intervention should not be assumed to be sufficient in itself, and findings of more rigorous studies currently underway will be of significant consequence.[65]

Study limitations include that only English-language apps were reviewed, there was only one primary reviewer, the MARS tool introduces possible ambiguity by having some unscored questions where a N/A grade can be assigned, and low scores are awarded when graphics are unclear but not when graphics are completely absent. In addition, we were not able to include intended app users in the scoring of Dimension E, subjective quality. Further limitations were that the search focused only on the top results from Google, which may have missed other apps of quality, and that the smartphone devices used to evaluate apps were used within Canada, which excluded apps that were geographically inaccessible. Also, applying an inclusion criterion of a cost of $5.00 or less resulted in retrieval of only free apps, which may have resulted in the exclusion of other high-quality but more costly resiliency apps for MM and PSP.

This review adds to the body of evidence supporting the usefulness of apps in the provision of mental wellness interventions for MM and PSP. Apps can be used in conjunction with health care practitioners' interventions, or they can be used to increase awareness and mental well-being among individuals not yet able to access, or uncomfortable with, in-person treatment. The 12 reviewed apps rated highly on overall appearance, engagement value, and appropriateness for their population, and they were created by reputable developers. Although few apps focus specifically on PSP, the needs and experiences they share with MMs suggest that it can be appropriate for them to access the tools in military-focused apps. However, improving resources for PSP mental health is clearly an area of need that should be addressed by future app developers and mHealth researchers. Because apps do not necessarily need a thorough evidence base to be published in app stores,[7] it is important to teach service providers and app users how to evaluate health-focused apps available on the marketplace for their evidence base, therapeutic claims, and overall quality. Also, greater involvement of mental health care providers (such as occupational therapists and psychologists) on app development teams will contribute much needed evidence-based content. All of these steps will help ensure that valuable MM and PSP will receive the mental health services to which they are so clearly entitled.

REFERENCES

1. Buijink A, Visser B, Marshall L. Medical apps for smartphones: lack of evidence undermines quality and safety. Evid Based Med. 2013;18(3):90–2. https://doi.org/10.1136/eb-2012-100885. Medline:22923708
2. Stoyanov S, Hides L, Kavanagh D, et al. Mobile App Rating Scale: a new tool for assessing the quality of health mobile apps. J Med Internet Res. 2015;3(1):e27. https://doi.org/10.2196/mhealth.3422. Medline:25760773

3. Sareen J, Afifi TO, Taillieu T, et al. Trends in suicidal behaviour and use of mental health services in Canadian military and civilian populations. Can Med Assoc J. 2016;188(11):E261–7. https://doi.org/10.1503/cmaj.151047. Medline:27221270
4. Lker A, McKune A, Ferguson S, et al. Chronic occupational exposures can influence the rate of PTSD and depressive disorders in first responders and military personnel. Extreme Physiol Med. 2016;5:8. https://doi.org/10.1186/s13728-016-0049-x. Medline:27429749
5. Fikretoglu D, Liu A, Zamorski MA, et al. Perceived need for and perceived sufficiency of mental health care in the Canadian Armed Forces: changes in the past decade and comparisons to the general population. Can J Psychiatry. 2016 (1, Supplement):36S–45S. https://doi.org/10.1177/0706743716628855. Medline:27270740
6. Canadian Institute for Public Safety Research and Treatment. Glossary of terms: a shared understanding of the common terms used to describe psychological trauma: version 2.0 [Internet]. Regina (SK): The Institute; 2019 [cited 2020 June 25]. Available from: http://hdl.handle.net/10294/9055. https://www.doi.org/10.37119/10294/9057.
7. Balebako R, Marsh A, Lin J, et al. The privacy and security behaviors of smartphone app developers. In: Proceedings of Network and Distributed System Security Symposium; 2014 Feb 23–26; San Diego, CA. p. 1–10. https://doi.org/10.1184/R1/6470528.v1
8. Owings-Fonner N. A review of the latest apps and tools for practicing psychologists [Internet]. Washington (DC): American Psychological Association Services; 2019 Mar [cited 2020 June 20]. Available from: https://www.apaservices.org/practice/business/technology/tech-column/apps-tools-psychologists.
9. Public Safety Canada. Supporting Canada's public safety personnel: an action plan on post-traumatic stress injuries [Internet]. Ottawa: Public Safety Canada; 2019 [cited June 2020]. Available from: https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/2019-ctn-pln-ptsi/2019-ctn-pln-ptsi-en.pdf.
10. Irwin KC, Konnert C, Wong M, et al. PTSD symptoms and pain in Canadian military Veterans: the mediating roles of anxiety, depression, and alcohol use. J Trauma Stress. 2014;27(2):175–81. https://doi.org/10.1002/jts.21897. Medline:24639069
11. Carleton RN, Afifi TO, Taillieu T, et al. Exposures to potentially traumatic events among public safety personnel in Canada. Can J Beh Sci. 2019;51(1):37. https://doi.org/10.1037/cbs0000115.
12. Carleton RN, Afifi TO, Turner S, et al. Chronic pain among public safety personnel in Canada. Can J Pain. 2017;1(1):237–46. https://doi.org/10.1080/24740527.2017.1410431
13. Vun E, Turner S, Sareen J, et al. Prevalence of comorbid chronic pain and mental health conditions in Canadian Armed Forces active personnel: analysis of a cross-sectional survey. Can Med Assoc J Open. 2018;6(4):E528. https://doi.org/10.9778/cmajo.20180093. Medline:30389752
14. Lewis-Schroeder NF, Kieran K, Murphy BL, et al. Conceptualization, assessment, and treatment of traumatic stress in first responders: a review of critical issues. Harv Rev Psychiatry. 2018;26(4):216. https://doi.org/10.1097/hrp.0000000000000176. Medline:29975339
15. Statistics Canada. Canadian community health survey, 2012: mental health component. Ottawa: Statistics Canada; 2013.
16. Van Ameringen M, Mancini C, Paterson B, et al. Post-traumatic stress disorder in Canada. CNS Neurosci Therapeut. 2008;14(3):171–81. https://doi.org/10.1111/j.1755-5949.2008.00049.x. Medline:18801110
17. Clompus S, Albarran R. Exploring the nature of resilience in paramedic practice: a psycho-social study. Int Emerg Nurs. 2016;28:1–7. https://doi.org/10.1016/j.ienj.2015.11.006. Medline:26706122
18. Arble E, Daugherty A, Arnetz B. Models of first responder coping: police officers as a unique population. Stress Health. 2018;34(5):1–10. https://doi.org/10.1002/smi.2821. Medline:29882624
19. Kivari C, Oliffe J, Borgen W, et al. No man left behind: effectively engaging male military Veterans in counseling. Am J Men's Health. 2018;12(2):241–51. https://doi.org/10.1177/1557988316630538. Medline:26846407
20. Schafer K, Sutter R, Gibbons S. Characteristics of individuals and employment among first responders [Internet]. Washington (DC): U.S. Department of Labor; 2015 [cited 2020 June]. Available from: https://www.hsdl.org/?abstract&did=803088.
21. Coleman SJ, Stevelink SA, Hatch SL, et al. Stigma-related barriers and facilitators to help seeking for mental health issues in the Armed Forces: a systematic review and thematic synthesis of qualitative literature. Psychol Med. 2017;47(11):1880–92. https://doi.org/10.1017/s0033291717000356. Medline:28290262
22. Sharp ML, Fear NT, Rona RJ, et al. Stigma as a barrier to seeking health care among military personnel with mental health problems. Epidemiol Rev. 2015;37(1):144–62. https://doi.org/10.1093/epirev/mxu012. Medline:25595168
23. Ricciardelli R, Carleton RN, Mooney T, et al. Playing the system: structural factors potentiating mental health stigma, challenging awareness, and creating barriers to care for Canadian public safety personnel. Health. 2020;24(3):259–78. https://doi.org/10.1177/1363459318800167. Medline:32283964

24. Papazoglou K, Andersen J. A guide to utilizing police training as a tool to promote resilience and improve health outcomes among police officers. Traumatology. 2014;20(2):103–11. https://doi.org/10.1037/h0099394.
25. Armstrong C, Edwards-Stewart A, Ciulla R, et al. Department of Defense mobile health practice guide. 3rd ed. Joint Base Lewis-McChord (WA): Defense Health Agency Connected Health, U.S. Department of Defense; 2017.
26. Kertz SJ, Kelly JM, Stevens KT, et al. A review of free iPhone applications designed to target anxiety and worry. J Technol Behav Sci. 2017;2(2):61–70. https://doi.org/10.1007/s41347-016-0006-y.
27. O'Neill S, Brady R. Colorectal smartphone apps: opportunities and risks. Colorectal Dis. 2012;14(9):e530–4. https://doi.org/10.1111/j.1463-1318.2012.03088.x. Medline:22646729
28. Tugade M., Fredrickson B. Resilient individuals use positive emotions to bounce back from negative emotional experiences. J Pers Soc Psychol. 2004;86(2):320–33. https://doi.org/10.1037/0022-3514.86.2.320. Medline:14769087
29. Stoyanov S. MARS training video [Internet]. 2016. Available from: https://www.youtube.com/watch?v=25vBwJQIOcE&t=3s.
30. Hofmann S, Sawyer A, Witt A, et al. The effect of mindfulness-based therapy on anxiety and depression: a meta-analytic review. J Consult Clin Psychol. 2010;78(2):169–83. https://doi.org/10.1037/a0018555. Medline:20350028
31. Varvogli L, Darviri C. Stress management techniques: evidence-based procedures that reduce stress and promote health. Health Sci J. 2011;5(2):74–89.
32. Chen YF, Huang XY, Chien CH, et al. The effectiveness of diaphragmatic breathing relaxation training for reducing anxiety. Perspect Psychiatr Care. 2017;53(4):329–36. https://doi.org/10.1111/ppc.12184. Medline:27553981
33. Freeman D, Sheaves B, Goodwin GM, et al. The effects of improving sleep on mental health (OASIS): a randomised controlled trial with mediation analysis. Lancet Psychiatry. 2017;4(10):749–58. https://doi.org/10.1016/s2215-0366(17)30328-0
34. US Department of Veterans Affairs. AIMS for anger management [Mobile application software]. Version 1.2. Washington (DC): The Department; 2019 [cited 2020 June 20]. Available from: https://itunes.apple.com/us/app/aims-for-anger-management/id1243035440?mt=8.
35. National Center for Telehealth & Technology. Breathe2Relax [Mobile application software]. Version 1.7.7. Joint Base Lewis-McChord (WA): The Center; 2018 [cited 2020 June 25]. Available from: https://itunes.apple.com/ca/app/breathe2relax/id425720246?mt=8.
36. US Department of Veterans Affairs. Concussion coach [Mobile application software]. Version 1.0.26. Washington (DC): The Department; 2018 [cited 2020 June 25]. Available from: https://play.google.com/store/apps/details?id=gov.va.mobilehealth.ncptsd.concussioncoach.
37. Rape Abuse Incest National Network (RAINN). DoD safe helpline [Mobile application software]. Version 3.1.34. Washington (DC): RAINN; 2019 [cited 2020 June 20]. Available from: https://play.google.com/store/apps/details?id=org.rainn.SafeHelpline.
38. Australian Government, Department of Veterans' Affairs. High res [Mobile application software]. Version 4.2.0. Brisbane (QLD): 2017 [cited 2020 June 25]. Available from: https://play.google.com/store/apps/details?id=com.gov.dva.
39. National Center for Telehealth & Technology. Lifearmor [Mobile application software]. Version 2.3. Joint Base Lewis-McChord (WA): The Center; 2018 [cited 2020 June 25]. Available from: https://itunes.apple.com/ca/app/lifearmor/id499648341?mt=8.
40. US Department of Veterans Affairs. Mindfulness coach [Mobile application software]. Version 2.1. Washington (DC): The Department; 2018 [cited 2020 June 25]. Available from: https://play.google.com/store/apps/details?id=gov.va.mobilehealth.ncptsd.mindfulnesscoach.
41. US Department of Veterans Affairs. Mood coach [Mobile application software]. Version 2.4. Washington (DC): The Department; 2019 [cited 2020 June 25]. Available from: https://itunes.apple.com/us/app/mood-coach/id1060947437?mt=8.
42. US Department of Veterans Affairs. Moving forward [Mobile application software]. Version 1.3. Washington (DC): The Department; 2019 [cited 2020 June 25]. Available from: https://itunes.apple.com/us/app/moving-forward/id804300239?mt=8.
43. US Department of Veterans Affairs. PTSD coach [Mobile application software]. Version 3.2. Washington (DC): The Department; 2018 [cited 2020 June 25]. Available from: https://play.google.com/store/apps/details?id=is.vertical.ptsdcoach.
44. US Department of Veterans Affairs. PTSD family coach [Mobile application software]. Version 2.0. Washington (DC): The Department; 2018 [cited 2020 June 25]. Available from: https://play.google.com/store/apps/details?id=gov.va.mobilehealth.ncptsd.ptsdfamilycoach&hl=en.
45. National Center for Telehealth & Technology. Tactical breather [Mobile application software]. Version 1.4.2. Joint Base Lewis-McChord (WA): The Center; 2018 [cited 2020 June 25]. Available from: https://itunes.apple.com/ca/app/tactical-breather/id445893881?mt=8.

46. Kuhn E, van der Meer C, Owen JE, et al. PTSD coach around the world. mHealth. 2018;4:15. https://doi.org/10.21037/mhealth.2018.05.01. Medline:29963560
47. Wickersham A, Petrides PM, Williamson V, et al. Efficacy of mobile application interventions for the treatment of post-traumatic stress disorder: a systematic review. Digit Health. 2019;5:2055207619842986. https://doi.org/10.1177/2055207619842986. Medline:31019722
48. Hoffman P. A systematic review of smartphone applications for parent, coach, and referee sideline concussion symptom identification and intervention in youth soccer [master's thesis]. Dayton (OH): Wright State University; 2015.
49. Luxton D, Hansen R, Stanfill K. Mobile app self-care versus in-office care for stress reduction: a cost minimization analysis. J Telemed Telecare. 2014;20(8):431–5. https://doi.org/10.1177/1357633x14555616. Medline:25316037
50. Pospos S, Young I, Downs N, et al. Web-based tools and mobile applications to mitigate burnout, depression, and suicidality among healthcare students and professionals: a systematic review. Acad Psychiatry. 2018;42(1):109–20. https://doi.org/10.1007/s40596-017-0868-0. Medline:29256033
51. Owen J, Kuhn E, Jaworski B. VA mobile apps for PTSD and related problems: public health resources for Veterans and those who care for them. mHealth. 2018;4:28. https://doi.org/10.21037/mhealth.2018.05.07. Medline:30148141
52. Chittaro L, Sioni R. Evaluating mobile apps for breathing training: the effectiveness of visualization. Comput Human Behav. 2014;40:56–63. https://doi.org/10.1016/j.chb.2014.07.049
53. Pham Q, Wiljer D, Cafazzo JA. Beyond the randomized controlled trial: a review of alternatives in mHealth clinical trial methods. J Med Internet Res. 2016;4(3):e107. https://doi.org/10.2196/mhealth.5720. Medline:27613084
54. Russell S. An overview of adult-learning processes. Urol Nurs. 2006;26(5):349–52.
55. Brown R, Gerbarg P. Sudarshan K. Yogic breathing in the treatment of stress, anxiety, and depression — Part II: clinical applications and guidelines. J Altern Complement Med. 2005;11(4):711–17. https://doi.org/10.1089/acm.2005.11.711. Medline:16131297
56. Burns D. The effect of the Bonny method of guided imagery and music on the mood and life quality of cancer patients. J Music Ther. 2001;38(1):51–65. https://doi.org/10.1093/jmt/38.1.51. Medline:11407965
57. Gregory P, Morgan K, Lynall A. Improving sleep management in people with Parkinson's. Br J Community Nurs. 2012;17(1):14–20. https://doi.org/10.12968/bjcn.2012.17.1.14. Medline:22585251
58. Rees B. Overview of outcome data of potential meditation training for soldier resilience. Mil Med. 2011;176(11):1232–42. https://doi.org/10.7205/milmed-d-11-00067. Medline:22165650
59. Meredith L, Sherbourne C, Gaillot S, et al. Promoting psychological resilience in the U.S. military. Rand Health Q. 2011;1(2):2.
60. Recabarren R, Gaillard C, Guillod M., et al. Short-term effects of a multidimensional stress prevention program on quality of life, well-being and psychological resources: a randomized controlled trial. Front Psychiatry. 2019;10:88. https://doi.org/10.3389/fpsyt.2019.00088. Medline:30914974
61. McGinn L, Sanderson W. What allows cognitive behavioral therapy to be brief: overview, efficacy, and crucial factors facilitating brief treatment. Clin Psychol: Science Practice. 2001;8(1):23–37. https://doi.org/10.1093/clipsy.8.1.23.
62. Pedersen E, Troxel W, Shih R, et al. Increasing resilience through promotion of healthy sleep among service members. Mil Med. 2015;180(1):4–6. https://doi.org/10.7205/milmed-d-14-00264. Medline:25562849
63. Brown CA, Berry R, Schmidt A. Sleep and military members: emerging issues and nonpharmacological intervention. Sleep Disord. 2013;2013:160374. Available from: https://doi.org/10.1155/2013/160374.
64. Baumeister H, Reichler L, Munzinger M, et al. The impact of guidance on Internet-based mental health interventions: a systematic review. Internet Interv. 2014;1:205–15. https://doi.org/10.1016/j.invent.2014.08.003
65. Karyotaki E, Furukawa TA, Efthimiou O, et al. Guided or self-guided Internet-based cognitive-behavioural therapy (iCBT) for depression? Study protocol of an individual participant data network meta-analysis. Br Med J Open. 2019;9(6):e026820. https://doi.org/10.1136/bmjopen-2018-026820. Medline:31171550

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The authors have nothing to disclose.

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Kaitlin O'Toole and Cary Brown conceived and designed the study. Kaitlin O'Toole acquired and analyzed the data. Both authors revised the article for important intellectual content and approved the final version submitted for publication.

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Data safe haven for military, Veteran, and family health research

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LAY SUMMARY

Big data promises to revolutionize health care but presents challenges to researchers hoping to use it. The challenges include acquiring the data, creating a working environment capable of processing the data, and knowing how to effectively use the data to solve problems. A data safe haven is a solution used in several health care domains. It provides safe and secure transfer, storage, and access for sensitive health care data. The Canadian Institute for Military and Veteran Health Research Data Safe Haven (CDSH) provides a secure data repository and analytics platform for researchers of military, Veteran and family health. The CDSH provides state-of-the-art analytics software and can be easily expanded in terms of capacity and functionality. Researchers access the CDSH using a remote desktop over a secure communication channel. The CDSH can simplify grant applications, project initiation, and project operation. It can also enhance collaboration and enable researchers to address new problems.

INTRODUCTION

Big data and associated analytics have been described as one of the most powerful transformative forces affecting health care today. They have the potential to revolutionize health care in various ways, such as the more routine practice of evidence-based medicine, which leads to better decision making in patient care; the creation of new, personalized approaches to medicine based on both genomics and vastly improved data availability; and the development of new and innovative approaches for improved chronic illness and disease management.[1]

Health researchers seeking to exploit big data analytics to further their research, however, face a number of challenges.[2] One challenge is understanding how big data can be used in their research. Big data are data sets that are too large or complex to be dealt with by traditional data processing application software[3] and so offer opportunities to solve new or existing problems through the discovery of new patterns, trends, and relationships (referred to as advanced analytics).

A second challenge with the use of big data is the establishment of an appropriate working environment for the research. Big data places increased demand on hardware resources such as processing and data storage and requires new approaches to efficiently perform functions such as data analysis, search, sharing, transfer, visualization, and querying. In addition, the privacy constraints associated with health data require that the environment enforce strict security measures regarding the use and storage of the data.[4]

A third challenge with the use of big data for health care research is acquiring the data. Health data are distributed across a variety of sources, such as administrative, hospital, and clinical databases that are owned and managed by different organizations. Comprehensive and complete medical records for any given population are generally not available for research purposes because of the access challenges and strict privacy protection practices that are necessarily enforced by the organizations that own, store, and maintain these health databases.[2]

In Canada, restricted access to health care data is made available through different organizations at the national level (e.g., the Canadian Institute for Health Information and Canadian Primary Care Sentinel Surveillance Network)[5,6] or at the provincial level (e.g.,

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ICES).[7] These organizations make data available to researchers either through an approval process to request extracted datasets or through restricted remote processing. Acquiring access to most health databases for research purposes becomes a difficult or prohibitive process that entails substantial administration overhead related to ethics and possibly government regulations approval.[4]

A fourth challenge to researchers is the nature of the big data in health care. The data collected in administrative and clinical settings is generated for the delivery of health care rather than for research. As a result, the data may not provide a full or accurate clinical picture, let alone a full description of the health of the population.[2] Researchers need to use advanced analytical methods and develop new strategies for dealing with the deficiencies in the data.

The Canadian Institute for Military and Veteran Health Research (CIMVHR), working in partnership with IBM Canada Ltd. and recognizing the potential of big data for research in military, Veteran, and family health, initiated the Data Safe Haven project to address the challenges of using big data in health research. The remainder of this article defines data safe havens and examines the role they play in health research, gives an overview of the CIMVHR Data Safe Haven, and discusses the benefits it offers to researchers, as well as future work.

BACKGROUND

Given the need to effectively manage and exploit big data in the health domain, the development of what are called data safe havens has become increasingly popular. A data safe haven is a repository in which useful, but potentially sensitive, data are maintained securely under governance and informatics systems that are suited to the nature of the data and how they are used.[8] Data safe havens help to address the first two challenges of big data described earlier. They can provide researchers with hardware and software support for advanced big data analytics and a secure environment for the transport, storage, use, and maintenance of the data. Burton et al. identify the following three requirements for a data safe haven:[8]

1) *Data maintenance and release must be socially acceptable and appropriate*. A data safe haven's processes and policies should be transparent, accountable, and consistent with formal ethical and legal requirements. Data held in the safe haven should be discoverable and accessible in a straightforward manner by authorized users.
2) *Data must be verifiable*. A data safe haven should provide effective processes for quality control and assurance, auditing, data curation, archiving, and backup.
3) *Data must be safe and secure*. A data safe haven should preserve confidentiality, integrity, and availability of the data and ensure data access meets agreed-on security constraints.

Prior research has proposed several safe havens for health data.[8–10] Each of these systems is mainly customized to specific use cases and data sources and normally not generalized to be used by or licensed to external organizations. The shared health data usually undergo anonymization and de-identification processes as an essential step to protect the privacy and security of patients. This allows the safe haven operators and the original data owners to maintain data privacy requirements. Safe haven initiatives are underway in Canada to create data safe havens to support research in areas such as the brain,[11] cancer,[12] and genomics.[13]

CIMVHR DATA SAFE HAVEN

The CIMVHR Data Safe Haven (CDSH) was originally envisioned as a secure general repository for health data that would support the needs of the CIMVHR community in research on the health and well-being of military members, Veterans, and their families. However, very early in the project, it became clear that health data, as they relate to military, Veteran, and family populations, are distributed across a variety of domains, including the Canadian Armed Forces, federal and provincial governments, and local health authorities, each with their own set of security and privacy restrictions. Therefore, it was determined that these ongoing data access challenges would have to be overcome before a general repository could be viable.

The CDSH, therefore, was developed with the focus of supporting CIMVHR-affiliated researchers by providing a secure repository and analytics platform for data acquired and held by individual research projects and their affiliated organizations or institutions. When a project is approved to use the safe haven, agreements can be put in place to transfer the project's de-identified data into the safe haven, and the working environment

required by the research team members to conduct their analytics work is established. Each project has its own workspace within the safe haven, and data are not shared between project workspaces unless specifically authorized by the projects. The safe haven administrator assigns a user login identifier and access privileges to each research team member. Users' access privileges to data within the project workspace are specified by the project leader. The CDSH is the first data safe haven built for the health data of Canadian military, Veterans, and their families. It is housed at the Queen's University Centre for Advanced Computing (CAC),[14] so all data in the safe haven remain within Canada. The CAC operates a high-security, high-availability data centre that specializes in secure advanced computing resources and support for academic and medical clients. The CDHS is designed to satisfy the requirements for a safe haven listed previously. Its security mechanisms ensure the data are safe and verifiable. It also provides an environment in which data are discoverable and accessible to authorized users. The architecture of the safe haven is shown in Figure 1.

The internal network of the safe haven is segmented into two zones, labelled Zones A and B in Figure 1. Zone A contains safe haven components accessible only by the safe haven administrators, such as virtualization infrastructure; images of virtual machines (VMs) that are required for deployment; and administrative tools for user management, access configurations, system auditing, and system backup (administrator servers with lock symbol in Figure 1).

Zone B contains the components accessible by the researchers using the safe haven to store and analyze their data. These components include front-end VMs, which allow researchers to log in and submit batch jobs, as well as back-end virtual servers (see Figure 1), which perform the analytic processing and manage the health data. Researchers do not have access to any of the safe haven components of Zone A and an individual researcher's access can be further restricted to specific services and databases within Zone B depending on the requirements of the research project.

The CDSH provides remote researchers and administrators access using a remote desktop protocol via a secure virtual private network (VPN) connection to the internal network of the safe haven through a firewall.[15–17] All of the VPN connections are authenticated and authorized by their respective VPN servers (VPN servers with key symbol in Figure 1). The firewall strictly controls traffic to and from the internal network of the safe haven and ensures that only authorized users are allowed in the safe haven. After authentication, users are presented with a remote desktop that provides access to the databases, applications, and services for which they are authorized. The data for a project are not accessible to CDSH users beyond the members of that project unless explicit data-sharing agreements are established. CDSH administrators are also able to enforce different levels of restriction on data access within a project. For example, data movement into and out of the safe haven can be limited to a set of privileged users.

The CDSH components run on multiple VMs. A back-end VM hosts the databases and analytic software (back-end VMs with document symbol in Figure 1), and a front-end VM hosts the user interfaces (front-end

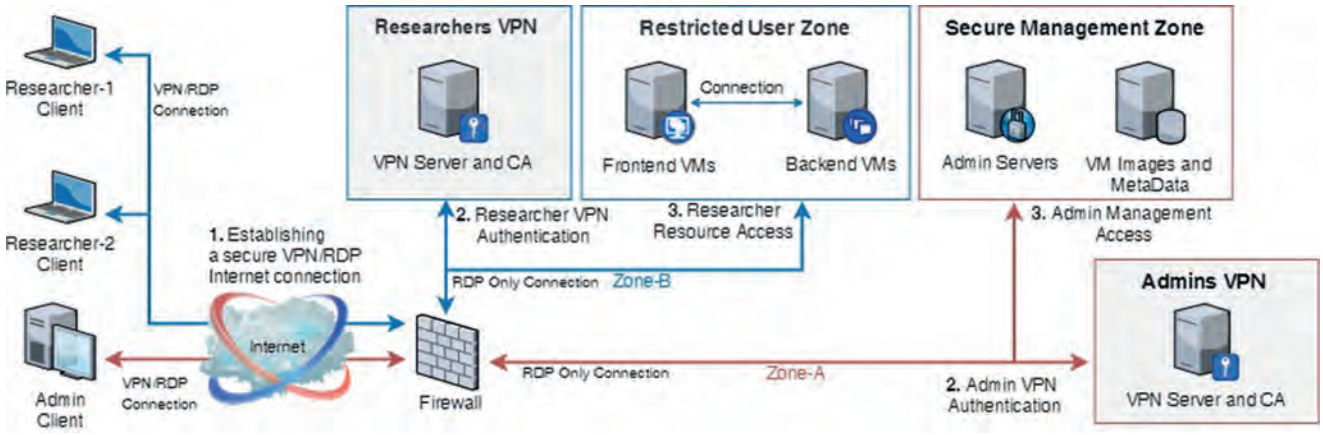

Figure 1. CIMVHR Data Safe Haven Architecture

Notes: CIMVHR = Canadian Institute for Military and Veteran Health Research; VPN = virtual private network; CA = certification authority; VMs = virtual machines; admin = administrator; RDP = remote desktop protocol.

VMs with monitor symbol in Figure 1). The data safe haven is built using both open-source and commercial software. The commercial software licenses are all obtained through academic or research agreements between the companies and Queen's University. The current data safe haven prototype provides users with a secure login to a remote desktop on Windows Server,[18] and it gives them the choice of using SAS,[19] Cognos Analytics,[20] Python,[21] or R[22] to perform analytics and machine learning experiments. Additional software can easily be included if needed by a research project. A federated database is implemented in the back-end VMs using IBM DB2 that can provide access to a number of data sources,[23] including databases and structured files. Every authorized research group is given access to this federated database in which data can be queried and extracted for further analysis.

DISCUSSION

The CDSH is intended to serve as a data steward for CIMVHR research projects. Ownership of the data remains with the researchers, and the role of the CDSH is to provide projects with data storage and management, authorized and controlled access to data, and a secure environment for data analytics using state-of-the-art tools. The CDSH is operational, and multiple projects are now underway.

The CDSH can benefit researchers by simplifying grant applications, project initiation, and project operation. Researchers using the CDSH avoid the need to create their own secure data storage and analysis environment. By design, the CDSH satisfies security and privacy concerns of health data owners and ethics approval boards. It is developed with the latest technology and hosted in Canada within a secure facility with a proven track record of maintaining health data. The specification of data management plans in both funding applications and ethics board approval applications is therefore greatly simplified. The burdens of maintaining the hardware and software environments and ensuring the integrity of the data are also eliminated for the researchers and handled by the CDSH service provider.

In the future, the CDSH can serve as a tool to enhance collaboration among researchers and between researchers and government organizations such as the Canadian Armed Forces and Veterans Affairs Canada, who own large health databases, by allowing them to share and combine data in a secure environment. Establishing collaborative relationships with government organizations will require added layers of regulatory approval but will yield enormous benefits for health care research. Future work on the CDSH will support these collaborations through the specifications of a common data model and data dictionaries and the development of tools for data translation and data linking.

SUMMARY

The CDSH is a service developed to support CIMVHR-affiliated researchers by providing a secure data repository and analytics platform for their research projects. Projects using the CDSH are given their own working environment with state-of-the-art analytics tools, and data access constraints are defined according to the needs of the project. The CDSH is housed at the Queen's University CAC, which is a high-security, high-availability data centre that specializes in secure advanced computing resources and support for academic and medical clients. CIMVHR is currently in discussions to determine the ongoing maintenance and administration of the CDSH beyond its original scope to ensure that it can continue to be made available for future research projects.

REFERENCES

1. Daschle TA. Academic medicine in a transformational time. Acad Med. 2015;90(1):11–13. https://doi.org/10.1097/acm.0000000000000577. Medline:25545002
2. Deeny SR, Steventon A. Making sense of the shadows: priorities for creating a learning healthcare system based on routinely collected data. BMJ Qual Saf. 2015; 24(8):505–15. https://doi.org/10.1136/bmjqs-2015-004278. Medline:26065466
3. Wikipedia. Big data [Internet]. [cited 2020 Apr]. Available from: https://en.wikipedia.org/wiki/Big_data.
4. Price WN, Cohen IG. Privacy in the age of medical big data. Nat Med. 2019;25(1):37. https://doi.org/10.1038/s41591-018-0272-7. Medline:30617331
5. Canadian Institute for Health Information. Canadian Institute for Health Information [Internet]. Ottawa: The Institute [cited 2020 Aug]. Available from: https://www.cihi.ca/en.
6. Canadian Primary Care Sentinel Surveillance Network. Canadian Primary Care Sentinel Surveillance Network (CPCSSN) [Internet]. Halifax (NS): The Network; 2021 [cited 2020 Aug]. Available from: https://cpcssn.ca/.
7. ICES. ICES [Internet]. Toronto: ICES; 2021 [cited 2020 Aug]. Available from: https://www.ices.on.ca/.

8. Burton PR, Murtagh MJ, Boyd A, et al. Data safe havens in health research and healthcare. Bioinformatics. 2015;31(20):3241–48. https://doi.org/10.1093/bioinformatics/btv279. Medline:26112289
9. Robertson D, Giunchiglia F, Pavis S, et al. Healthcare data safe havens: towards a logical architecture and experiment automation. J Eng. 2016;11:431–40. https://doi.org/10.1049/joe.2016.0170.
10. Presser L, Hruskova M, Rowbottom H, et al. Care. data and access to UK health records: patient privacy and public trust. Tech Sci [serial on the Internet]. 2015 Aug [cited 2020 Jun 2]; 2015081103. Available from: https://techscience.org/a/2015081103/.
11. Vaccarino AL, Dharsee M, Strother S, et al. Brain-code: a secure neuroinformatics platform for management, federation, sharing and analysis of multi-dimensional neuroscience data. Front Neuroinform. 2018;12(28). https://doi.org/10.3389/fninf.2018.00028. Medline:29875648
12. Ontario Institute for Cancer Research. Informatics [Internet]. Toronto: The Institute; 2021 [cited 2018 Mar]. Available from: https://oicr.on.ca/research-portfolio/informatics/.
13. Genome Canada. Canadian Data Integration Centre [Internet]. Toronto: Genome Canada; 2021 [cited 2018 Mar]. Available from: https://genome-cdic.ca/.
14. Queen's University. The Centre for Advanced Computing [Internet]. Kingston (ON): The University; 2021 [cited 2020 Apr]. Available from: https://cac.queensu.ca/.
15. Microsoft. Remote desktop protocol [Internet]. Redmond (WA): Microsoft; 2018 [cited 2020 Apr]. Available from: https://docs.microsoft.com/en-us/windows/win32/termserv/remote-desktop-protocol?redirectedfrom=MSDN.
16. Venkateswaran R. Virtual private networks. IEEE Potentials. 2001;20(1):11–5. https://doi.org/10.1109/45.913204.
17. Surana J, Singh K, Bairagi N, et al. Survey on next generation firewall. Int J Eng Dev Res. 2017;5(2):984–8.
18. Microsoft. Build your future with Windows Server 2019 [Internet]. Redmond (WA): Microsoft; n.d. [cited 2020 Apr]. Available from: https://www.microsoft.com/en-ca/cloud-platform/windows-server.
19. SAS. Analytics platform [Internet]. Toronto: SAS; 2021 [cited 2020 Apr]. Available from: https://www.sas.com/en_ca/software/platform.html.
20. IBM. IBM Cognos analytics [Internet]. Markham (ON): IBM; n.d. [cited 2020 Apr]. Available from: https://www.ibm.com/ca-en/products/cognos-analytics.
21. Python. Python programming language [Internet]. Fredericksburg (VA): Python; 2021 [cited 2020 Apr]. Available from: https://www.python.org/.
22. R Foundation. The R Project for Statistical Computing [Internet].Vienna: The Foundation; n.d. [cited 2020 Aug]. Available from: https://www.r-project.org/.
23. IBM. DB2 11.5 supported data source [Internet]. Armonk (NY): IBM; n.d. [cited 2020 Apr]. Available from: https://www.ibm.com/support/knowledgecenter/SSEPGG_11.5.0/com.ibm.db2.luw.welcome.doc/doc/welcome.html.

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COMPETING INTERESTS

IBM Canada Ltd. has made investments in this research project and other CIMVHR research projects that use IBM products in the course of conducting the research. Some IBM products are mentioned in this research publication.

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Veterans' self-expression in poetry

Dale Tracy[a]

ABSTRACT

Research shows the positive effects of creative self-expression and, specifically, poetry therapy for Veterans, including Veterans experiencing posttraumatic stress disorder. Studies also state the need for more research in the area. This article suggests the benefit of research studying not only what Veterans say about their experiences with poetry but also what Veterans say in their poetry — and how they say it. The author analyzes a poem that takes as its topic what it means to express military experience in a poem. "Here, Bullet," the title poem of Brian Turner's collection of poetry about his time as an American infantry team leader in Iraq, features a speaker who creates the "here" of the poem as an alternative space to the "here" of the endangered body. This is a "here" that readers, including the re-reading poet, might visit, encountering difficult experiences within the confines of the poem that they can also leave. This article's implications are that Veterans' poetry, when treated as art, can tell people something about what poetry writing and reading offer Veterans. The fullest picture of what poetry means for and does for Veterans would include close analysis of the poetry itself.

Key words: arts therapy, Brian Turner, creative self-expression, lyric speaker, poetry therapy, PTSD, trauma, soldier-poet, Veteran, war poetry

RÉSUMÉ

Les recherches démontrent les effets positifs de l'expression créative et, notamment, de la thérapie par la poésie chez les vétéran(e)s, y compris ceux et celles qui souffrent d'états de stress post-traumatique (ÉSPT). Les études démontrent également la nécessité de réaliser plus de recherches dans ce secteur. Cet article suggère les bienfaits de ces recherches, non seulement de ce que les vétéran(e)s racontent *au sujet* de leurs expériences à travers la poésie, mais également de ce qu'ils racontent *dans* leurs poèmes et *de la manière* dont ils le racontent. L'auteur a analysé un poème qui aborde ce que signifie l'expression de l'expérience militaire dans un poème. *Here, Bullet*, tiré du recueil éponyme de Brian Turner sur son affectation comme chef de patrouille de l'infanterie américaine pendant l'occupation de l'Irak, décrit un narrateur qui crée le « ici » du poème pour s'échapper dans un autre lieu que le « ici » du corps en péril. C'est ce « ici » que le lecteur ou la lectrice (y compris le poète qui relit ses textes) peut visiter, pour vivre des expériences difficiles dans les limites du poème, mais aussi décider de quitter. D'après cet article, lorsqu'elle est considérée comme de l'art, la poésie des vétéran(e)s révèle quelque chose sur ce que sa rédaction et sa lecture peuvent leur apporter. Le portrait complet de ce que la poésie signifie et de ce qu'elle apporte aux vétéran(e)s exigerait une analyse approfondie des poèmes eux-mêmes.

Mots-clés : art-thérapie, Brian Turner, ÉSPT, expression créative, narrateur lyrique, poésie de guerre, poètes-soldats, traitement par la poésie, traumatisme, vétérane, vétérans

LAY SUMMARY

Research shows that Veterans benefit from writing poetry for therapeutic purposes. This article suggests the need for future research that considers the effects of the artistic choices that Veterans make when using poetry to engage their experiences. The author focuses on one Veteran's poem about what it means to write poetry as a Veteran. Brian Turner's "Here, Bullet" comes from his poetry collection about his time as an American infantry team leader in Iraq. This poem centres on a solider whose body is in danger in a conflict setting. The poem becomes an alternative space to his body, a space in which he can work with his experiences. Treating Veterans' poetry as art can help people working with Veterans in therapeutic settings learn more about what value Veterans find in reading and writing poetry.

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INTRODUCTION

Can Veterans benefit from poetry? *The Journal of Poetry Therapy* publishes peer-reviewed interdisciplinary research focused on therapeutic creative written expression. Among this journal's articles, which focus on the value of various uses of writing, are those demonstrating this value for Veterans, including subjects such as poetry writing for Veterans with posttraumatic stress disorder (PTSD),[1] therapeutic journaling for Veterans in a court-based program,[2] expressive arts (including poetry) for student Veterans,[3] and therapeutic implications of the metaphors Veterans use in interviews to describe experiences of PTSD.[4] More broadly, studies show art therapy to be "qualitatively and quantitatively beneficial" for Veterans and military members.[5(p.96)]

Veterans' accounts of their experiences in poetry workshops offer additional insight. To take one recent project as an illustration, the Veterans' Poetry Workshop at Oxford Brookes University (supported by Blesma, the Limbless Veterans; the New York University Veterans Writing Workshop; and the William Joiner Institute for the Study of War and Social Consequences) recently published *"My Teeth Don't Chew on Shrapnel": An Anthology of Poetry by Military Veterans*.[6] This open-access e-book came out of workshops that took place in 2019 and 2020, alongside interviews with participants (British and American Veterans). As an example, in one of these interviews, Jamie Broadie, Veteran of the U.S. Army National Guard, stated that she found that writing about her trauma "helps to process it and bring it out from just holding it in my body, which can really exacerbate stress ... getting it out onto the page allows and encourages other people to do the same, I think."[6(p.47)]

What does it mean for Veterans to bring trauma out from the body and onto the page? Both processing it for herself and communicating it to others, Broadie said. Her poem "My Body Is," included in the anthology, tells the reader more. After experiencing sexual assault in a military situation, the poem's speaker tries to reclaim her body: "I wrap my hand around my wrist."[6(p.49, line 34)] Grabbing the wrist is not a tender gesture; it calls up the image of a handcuff. Yet outside of the body's closed loop, the poem ends on an assertion, bookended by words indicating possession: "My body is mine."[6(p.50, line 38)]

Thus, in addition to what Veterans say about poetry, studies focused on poetry and Veteran health might analyze what Veterans say in poetry — and how they say it. Researchers writing about creative self-expression for Veterans call for further studies.[2, 5, 7] The value of attending, in such future research, to Veterans' poems as poems — as artistic creations demanding nuanced interpretation — can be suggested. Studies of art therapy typically focus on what Veterans say about their experiences with creative expression, and attention to the creative expression itself is attention to the "content of the artwork."[5(p.88)] But how Veterans say what they say is important: Patrick S. Foley's focus, as a social work researcher, on Veterans' use of metaphors to describe the experiences of PTSD indicates the need to attend to such choices of expression.[4] Foley studies interviews; for art, such attention is imperative. This article adds to existing research by highlighting the knowledge that comes out of the poetry itself.

In what follows, a Veteran-poet is introduced to examine a poem chosen for extended analysis because it is about expressing military experience in a poem. If a poem is read only for content, readers ignore the fact that the writer has chosen to express that content in, specifically, a poem — that is, it is treated as regular communication rather than art. The "speaker" is the "I" in a poem, the one whose perspective a poem is from. No matter how similar they are, the speaker is never exactly the poet because writing oneself into a poem involves a process of enhanced selection and presentation, a process of creative decision making.

APPROACHING CREATIVE SELF-EXPRESSION WITH BRIAN TURNER

Brian Turner's *Here, Bullet*[8] is a collection of poems about his time as an American infantry team leader in Iraq, and Turner continues to explore his time in Iraq in *Phantom Noise*[9] and *My Life as a Foreign Country: A Memoir*.[10] Although this article focuses on the title poem of his earliest book, Turner shows interest in what poetry offers for communicating about traumatic experience across these publications and in his public comments.

In a talk "about PTSD (posttraumatic stress disorder) and some of the traumas I'm carrying," Turner explained that, for him, creative writing produces:

> vehicles to meditate and to discover things about the world. I'm not trying to preach when I sit down to write about this stuff. I try to write what is discovery for me and also what is maybe worthwhile to share with someone else.[11]

Turner's poetry does not preach about what he is already carrying but instead functions as a vehicle that brings

him to discovery about the world. Attention to such discovery counters an impulse in the discourse around trauma in creative expression to foreground evidentiary testimony (the bare facts of experience) to the exclusion of authorial agency (the ability to choose how to engage and tell those facts).[12] War literature scholar Jeff Sychterz corrects such a potential misunderstanding in relation to the concept of haunting that saturates Turner's work:

> It would be wrong for us to assume ... a Wilfred-Owen-like passive victimization, as if the poet suffers in some totalizing way from his wartime experiences and "the poetry is in the pity" (Owen 535). The ghosts in Turner's poetry do not, or at least do not simply, point to the kind of traumatic melancholy identified in trauma studies, "in which one is haunted or possessed by the past and performatively caught up in the compulsive repetition of traumatic scenes — scenes in which the past returns and the future is blocked or fatalistically caught up in a melancholic feedback loop" (LaCapra 21).[13(p.7)]

Sychterz explains that Turner's poetry "registers the war's effects through a number of tropes" such as "bullets or shrapnel embedded in his body or as ghosts that haunt the poet."[13(p.2)] Turner makes creative choices about expressing haunting. While representing the war's effects, "Turner's ghosts also represent the play of imagination."[13(p.11)] Haunting, for Turner, stands in at once for traumatic experiences and the creative engagement of those experiences, the lack of control and the reassertion of control.

"HERE, BULLET"

The speaker in "Here, Bullet" responds to the inescapable potential for bodily harm in conflict situations with a poem that offers a form of control. In "Here, Bullet," the speaker invites the bullet "here," to his own "bone and gristle and flesh":[8(p.13, line 2)] the danger he faces is the bullet's desire to arrive "here," at his body. The bullet might find him anywhere because "here" is wherever his body is, and his body is always somewhere. However, *here,* a word the short poem repeats eight times, is deictic — that is, its meaning is entirely contextual — "here" is where you say it from. The second half of the poem offers the poem itself as an alternative "here" to the speaker's body:

> ... here, Bullet,
> here is where I complete the word you bring
> hissing through the air, here is where I moan
> the barrel's cold esophagus, triggering
> my tongue's explosives for the rifling I have
> inside of me, each twist of the round
> spun deeper, because here, Bullet,
> here is where the world ends, every time.[8(p.13, lines 9–16)]

Yes, the speaker's death would complete the word, but so, too, does this poem. The poem ends instead of the body. The poem's last line is "where the world ends,"[8] followed by the empty space of the blank margin. The speaker replaces the potential end of being with the controllable end of making, the end of a "here" he created.

However, the speaker "complete[s] the word" the bullet brings with his "tongue's explosives for the rifling [he has] / inside of [him]," suggesting that his power of creation is a power defined by violence.[8(p.10, lines 13–14)] This is the sort of moment in a poem that could lead readers to understand the poet to be delivering unmediated trauma, to understand the rifling inside Turner to explode through the poem. But although the speaker's "tongue's explosives" are beyond his control, Turner, the poet, has crafted this poem: to whatever degree of consciousness and control words as bullets arose in the poem, Turner kept them there in the revision process. The speaker is an element of language, a feature of the poem — not a reflection of Turner like he would get in a mirror or his shadow, a consequence of himself outside of his creative power. This creative power produces an imagined space for visiting difficult experiences.

In an interview, Turner expresses his idea of imagination as a "here" readers can visit:

> I believe the imagination is a real space, or series of interconnected and adjacent landscapes. It is inhabited by the past — a past that is haunted by the present. We are the spirits that visit the past, through the conduit of memory and dream. The opposite is true, too. Language is one of the transports that carries us between worlds.[14]

Haunt means "to frequent or be much about (a place)," and it also refers to "unseen or immaterial visitants," of which the concept of ghosts is a sub-meaning.[15] Although Turner imagines — across his creative writing and public comments — war to turn him into a ghost and to produce ghosts that haunt him, this comment suggests that imagination also turns readers — and the poet as potential re-reader — into ghosts, the unseen visitants to the "here" of the poem, the place where haunting means exercising creative control.

The speaker finds control inside a poem as an alternate "here," a space that Turner could visit as a reader haunting his past, but a space also open to other readers. In the same interview, Turner suggests what is at stake in using language as a transport:

> One of the questions I have for myself is this: How do I integrate my wartime and military experiences into the rest of my life so that I can lead a full and healthy life, and, if possible, be useful for others along the way?[14]

The language transports readers — others for whom he might be useful — into the imagined "here," not into Turner's memories, but into his poem, designed as a space for haunting. Readers are not transported into the speaker's position, into the "tongue's explosives." Rather, they are the unseen visitants who haunt the poem, voluntarily visiting a "here" that closes at the margin and offers itself to their active reading.

For Turner, the way to integrate past experiences with present and future ones is to imagine those experiences in a form that allows one to haunt them. Language is one possible transport between the real space of here, in the physical and mental body, and the also-real space of the imagined "here." If the imagination is a "series of interconnected and adjacent landscapes" that are "inhabited by the past" and "haunted by the present,"[14] then the imagination connects past experiences and present ones by allowing one to visit the past with some control. Because Turner uses written language for this visit, others can retrace his steps: the poem's imaginative "here" is available beyond the poet to other readers.

CONCLUSION

"Here, Bullet" suggests that imagination — here, in the form of creative writing and the active reading it demands — provides a space to work with and express experiences. In this poem, the speaker creates the "here" of the poem as an alternative space to the "here" of the endangered body. This is a "here" that readers, including the re-reading poet, might visit, encountering difficult experiences within the confines of the poem that they can also leave. This poem thus comments on the use of poetry for Veterans, and future poetry therapy studies might include interpretive attention to Veterans' poems — possibly through interdisciplinary collaboration. The fullest picture of what poetry means for, and does for, Veterans would include close analysis of the poetry itself.

REFERENCES

1. Deshpande A. Recon mission: familiarizing Veterans with their changed emotional landscape through poetry therapy. J Poet Ther. 2010;23(4):239–51. https://doi.org/10.1080/08893675.2010.528222.
2. Canada KE, Brinkley A, Peters C, et al. Military Veteran: therapeutic journaling in a Veteran treatment court. J Poet Ther. 2015;28(2):113–28. https://doi.org/10.1080/08893675.2015.1011373.
3. Canto AI, McMackin ML, Hayden SCW, et al. Military Veterans: creative counseling with student Veterans. J Poet Ther. 2015;28(2):147–63. https://doi.org/10.1080/08893675.2015.1011473.
4. Foley PS. The metaphors they carry: exploring how Veterans use metaphor to describe experiences of PTSD. J Poet Ther. 2015;28(2):129–46. https://doi.org/10.1080/08893675.2015.1011375.
5. Davis HE. Art therapy with Veterans: a comprehensive review of the literature with recommendations [master's thesis] [Internet]. Bloomington (IN): Indiana University; 2018 [cited 2021 Jan 27]. Available from: http://hdl.handle.net/1805/16333.
6. Oxford Brookes Poetry Centre. My teeth don't chew on shrapnel: an anthology of poetry by military Veterans. Oxford (UK): Oxford Brookes Poetry Centre; 2020.
7. Albright DL. Bridging the gap: creative expression and military Veteran. J Poet Ther. 2015;28(2):71–2. https://doi.org/10.1080/08893675.2015.1031461.
8. Turner B. Here, bullet. Farmington (ME): Alice James; 2005.
9. Turner, B. Phantom noise. Farmington (ME): Alice James; 2010.
10. Turner, B. My life as a foreign country: a memoir. New York: Norton; 2014.
11. Heard on campus: Brian Turner discusses PTSD at Penn State Altoona [Internet]. Penn State News; 2019 [cited 2021 Jan 27]. Available from: https://news.psu.edu/story/563544/2019/03/15/campus-life/heard-campus-brian-turner-discusses-ptsd-penn-state-altoona.
12. Tracy, D. With the witnesses: poetry, compassion, and claimed experience. Montreal: McGill-Queen's University Press; 2017.
13. Sychterz J. Poetry, the Iraq War, and the ethics of trauma. War, Literature & the Arts: Int J Human [serial on the Internet]. 2018 [cited 2021 Jan 21];30:[17 pages]. Available from: https://www.wlajournal.com/wlaarchive/30/SYCHTERZ.pdf.
14. McGuire TG. Among the lightning trees: a conversation with Brian Turner. War, Literature &

the Arts: Int J Human [serial on the Internet]. 2015 [cited 2021 Jan 21];27:[32 pages]. Available from: https://www.wlajournal.com/wlaarchive/27/McGuire.pdf.
15. Haunt. In: Oxford English Dictionary Online [Internet]. Oxford (UK): Oxford University Press; 2021 [cited 2021 Jan 29]. Available from: https://www-oed-com.journal.rmc.ca/view/Entry/85975.

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