Interventions to improve the well-being of medical learners in Canada: a scoping review

Stephana J. Moss MSc, Krista Wollny RN MN, Mungunzul Amarbayan MPP, Diane L. Lorenzetti PhD, Aliya Kassam PhD

Abstract

Background: Medical education affects learner well-being. We explored the breadth and depth of interventions to improve the well-being of medical learners in Canada.

Methods: We searched MEDLINE, EMBASE, CINAHL and PsycINFO from inception to July 11, 2020, using the Arksey–O’Malley, 5-stage, scoping review method. We included interventions to improve well-being across 5 wellness domains (i.e., social, mental, physical, intellectual, occupational) for medical learners in Canada, grouped as undergraduate or graduate nonmedical (i.e., health sciences) students, undergraduate medical students or postgraduate medical students (i.e., residents). We categorized interventions as targeting the individual (learner), program (i.e., in which learners are enrolled) or system (i.e., higher education or health care) levels.

Results: Of 1753 studies identified, we included 65 interventions that aimed to improve well-being in 10 202 medical learners, published from 1972 through 2020; 52 (80%) were uncontrolled trials. The median year for intervention implementation was 2010 (range 1971–2018) and the median length was 3 months (range 1 h–48 mo). Most (n = 34, 52%) interventions were implemented with undergraduate medical students. Two interventions included only undergraduate, nonmedical students; none included graduate nonmedical students. Most studies (n = 51, 78%) targeted intellectual well-being, followed by occupational (n = 32, 49%) and social (n = 17, 26%) well-being. Among 19 interventions implemented for individuals, 14 (74%) were for medical students; of the 27 program-level interventions, 17 (63%) were for resident physicians. Most (n = 58, 89%) interventions reported positive well-being outcomes.

Interpretation: Many Canadian medical schools address intellectual, occupational and social well-being by targeting interventions at medical learners. Important emphasis on the mental and physical well-being of medical learners in Canada warrants further exploration.

Concerns exist about the impact of medical education on learner well-being. Programs housed within medical schools often address intellectual and occupational well-being, focusing specifically on skills related to learning and working; however, well-being is a multidimensional construct. Social, mental, and physical well-being have been shown to be negatively affected during undergraduate medical education, with increased prevalence of burnout in residency. Poor well-being can affect medical learners across the spectrum of programs, including undergraduate health sciences.

The Canadian Federation of Medical Students aims to “train healthier physicians to maximize the productivity and quality of health care services for Canadians.” Their strategic directions for 2020–2022 include developing health promoting communities, promoting a positive culture in medical education that prioritizes learner well-being, increasing collaboration within the medical community and optimizing student resources. Despite the growing literature as universities implement services to address the well-being of medical learners, earlier reviews on this topic have not evaluated interventions in Canadian medical schools and have found it difficult to define medical learner well-being.

The Wellness Innovation Scholarship for Health Professions Education and Health Sciences (WISHES) laboratory at the University of Calgary is taking a holistic approach to medical learner well-being. Based on Nussbaum’s human capabilities approach and acknowledging that well-being is multidimensional, WISHES focuses on measurable outcomes within the domains of mental, physical, occupational, and social well-being.
We conducted a scoping review that builds on previous literature and uses the WISHES holistic approach to well-being to explore the breadth and depth of interventions that aim to ultimately improve well-being among medical learners in Canada.17

Methods

Study design
Based on Joanna Briggs Institute’s Review Manual10 and the Arksey–O’Malley methodological framework,19 we used 5 steps for our review: identifying the research question, identifying relevant studies, study selection, charting the data, and collating, summarizing and reporting results.

Identifying the research question
Our primary research question was “What is the breadth and depth of interventions aimed to improve well-being among Canadian medical learners?” We included any intervention that aimed to improve well-being of medical learners in Canada, with any comparator or outcome.

Identifying relevant studies
We searched MEDLINE, EMBASE, CINAHL and PsycINFO from inception to July 11, 2020. We developed search strategies with an experienced medical librarian (D.L.L.), which combined synonyms and subject headings from 3 concepts: medical learners in Canada, well-being and interventions. We also searched review databases to identify review articles to screen reference lists for studies missed in our initial search. One author (S.J.M.) conducted all searches and reviewed reference lists. The complete MEDLINE search strategy is provided in Appendix 1, Supplemental Table 1, available at www.cmajopen.ca/content/9/3/E765/suppl/DC1.

Our inclusion criteria were that studies from any publication year be primary research of interventions (e.g., mentoring, or educational interventions) for medical learners in Canada that aimed to improve well-being. We excluded studies if they were not primary research (e.g., editorials) or did not report any outcome from an intervention aimed to improve well-being. We defined a medical learner as an individual registered in an academic institution whose program is housed in a Canadian medical school and pertains to research or treatment of diseases and injuries or relating to medicine (i.e., undergraduate medical student, postgraduate medical student [resident physician], undergraduate nonmedical [health sciences] student, graduate science [MSc or PhD] student).20 We defined an intervention as any randomized or nonrandomized experimental study. We included studies if well-being was 1 component of a multicomponent intervention (e.g., education intervention to address intellectual well-being, not just clinical skills). We selected domains of well-being (i.e., social, mental, physical, intellectual, occupational)44 for our scoping review based on a needs assessment performed among medical learners at a Canadian medical institution; we validated operational definitions for domains.21

We used broad inclusion criteria (inclusive of all medical learners) to explore the breadth and depth of well-being support among medical learners as they transition through their studies into a health care profession. Understanding the comprehensiveness of well-being support throughout the academic trajectory will benefit efforts to develop effective interventions for students as they transition through medical education.22

Study selection
Three authors (S.J.M., K.W., M.A.) reviewed titles and abstracts, independently and in duplicate, after achieving 100% agreement on a pilot test of 50 random studies. The same authors reviewed the full text of selected articles, independently and in duplicate; we included articles in the final review if both reviewers agreed on inclusion. A fourth author (A.K.) resolved disagreements.

Charting the data
Independently and in duplicate, we (S.J.M., K.W., M.A., A.K.) charted data for included studies using a data collection sheet that was developed and piloted by the review team, resolving discrepancies through discussion. We collected information on document characteristics (e.g., year, geographic location), study characteristics (e.g., medical school, time frame), learner group, intervention domains (i.e., social, mental, physical, intellectual, occupational), level of intervention (i.e., individual, program, system), outcomes (e.g., assessment measures, themes or theories), limitations and conclusions.

Data analysis
We synthesized findings descriptively (Table 1) and categorized the level of intervention as targeted to the individual (i.e., the individual learner or group of individual learners), program (i.e., the program in which the learner is enrolled) or system (i.e., the academic institution or health care system in which learners learn or work). We recorded the primary level for each intervention. We categorized outcomes within 3 validated domains of well-being11 that represent part of the multidimensional construct of well-being: social (e.g., equity, diversity), mental (e.g., mindfulness, emotions), physical (e.g., exercise, nutrition), intellectual (e.g., tools, education) and occupational (e.g., research, resident rotation). Multiple outcomes (within multiple domains) could be recorded for each intervention.

We (S.J.M., K.W., M.A., A.K.) synthesized results from included qualitative studies using thematic synthesis for reviews on health research.23,24 We developed discrete themes that represented findings reported in primary studies, and considered these themes to generate new interpretive constructs, explanations or hypotheses.25 We integrated our qualitative and quantitative findings by using qualitative results to interrogate quantitative results, to identify research gaps and to synthesize lines of inquiry.26
We classified reported outcomes for each well-being domain as statistically significant if \( p < 0.05 \). We calculated descriptive statistics using STATA IC15 (StataCorp).

Ethics approval
We did not require ethics approval as all data were available in published records.

Results
Of 1753 relevant studies identified, we included 65 interventions that aimed to improved medical learner well-being (Figure 1). Characteristics of included studies are in Appendix 2, Supplemental Table 2, available at www.cmajopen.ca/content/9/3/E765/suppl/DC1.27–91

The 65 included studies\(^{27–91}\) were published between 1973 and 2020, and were conducted most frequently at University of Toronto (\( n = 16, 25\% \)) or McGill University (\( n = 8, 12\% \)) with undergraduate (\( n = 34, 52\% \)) or postgraduate medical education students (\( n = 31, 48\% \)) (Figure 2). Figure 3 illustrates the cumulative number of published studies on interventions. Among 44 studies that reported implementation year, the median was 2010 (range 1971–2018). The median intervention duration, reported from 47 studies, was 3 months (range 1 h–48 mo). Most studies (\( n = 52, 80\% \)) were uncontrolled trials, of which half were implemented with undergraduate medical students (\( n = 26 \)). We included 16 qualitative studies; most (\( n = 9 \)) were conducted with undergraduate medical students. Resident physicians were commonly from family medicine (\( n = 6 \)) and pediatrics (\( n = 6 \)), which included pediatric subspecialties (\( n = 2 \)); generalist practice was more broadly defined (\( n = 4 \)).

Fifty-one (78%) interventions targeted intellectual well-being (e.g., clinical skills modules\(^{46}\)) and 32 (49%) targeted occupational well-being (e.g., resident rotation bundle\(^{47}\)). 23 (35%) targeted both domains (e.g., specialty exploration and discovery programs\(^{92}\)). Among 19 interventions for individuals, most (\( n = 14 \)) were for medical students. Program interventions (\( n = 27 \)) were primarily for resident physicians (\( n = 17 \)). Medical students and residents were represented similarly in system interventions (undergraduate, \( n = 9 \); postgraduate, \( n = 10 \)). Two system interventions were for undergraduate health sciences students. Few studies (\( n = 2 \)) incorporated formal mentorship programs in their intervention as a method to promote learner well-being. Only 3 studies considered barriers or stigma among medical learners to accessing appropriate mental health services.

Quantitative studies
Quantitative outcomes are reported in Appendix 3, Supplemental Table 3, available at www.cmajopen.ca/content/9/3/
E765/suppl/DC1. Statistical evaluation of interventions was explored extensively (n = 41, 63%), namely evaluating perceptions of well-being pre- and postintervention, satisfaction with the intervention, and determining attitudes and agreement regarding use of interventions. Figure 4 illustrates the number of studies that reported a significantly positive effect of interventions by well-being domain, level of intervention and learner group. In Appendix 4, available at www.cmajopen.ca/content/9/3/E765/suppl/DC1, we provide summaries on assessment tools used to measure outcomes within well-being domains, as well as a summary of statistical findings.

**Qualitative studies**

Sixteen studies explored well-being qualitatively. Most (n = 12) focused on promoting and understanding intellectual well-being in medical education (Table 2). Five qualitative studies reported favourable outcomes; 3 studies concluded that formal audit is needed  and 2 studies uncovered shortcomings related to postgraduate education content (i.e., intellectual, occupational well-being) and undergraduate medical education leadership (i.e., social, intellectual well-being). A key finding was that well-being among learners is a multi-dimensional construct that includes 4 components: genuine sense of personal fulfillment and gratification in medical education, grounded understanding of requirements for medical education programs, enhanced peer cohesion and functionality, and promoting cognitive flexibility to strengthen knowledge for diverse perspectives. Three conditions were identified as predicting and promoting well-being: effective coping and emotional regulation through individual strategies, individual
## Table 2: Summary of findings from qualitative studies

| Study            | Level                  | No. and type of students | Intervention                                                                 | Analysis                  | Themes or theory                                                                 | Author findings from original study                                                                 |
|------------------|------------------------|--------------------------|------------------------------------------------------------------------------|---------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Undergraduate medical students |                        |                          |                                                                              |                           |                                                                                 |                                                                                                  |
| Brown et al., 2018³⁴⁵  | Intellectual, occupational Individual 123; first-year undergraduate medical students | Program for Improvement in Medical Education for engagement in quality improvement training | Thematic                  | Continuous support; genuine interest in improving medical education; team-based learning and problem solving; regular project feedback; access to education resources for quality improvement | Medical education is an appropriate setting to teach preclerkship medical students about quality improvement, which might lead to increased knowledge of quality improvement. |
| Byszewski et al., 2017⁶⁷⁸⁹ | Intellectual, occupational Individual 93; undergraduate medical students | Multimedia podcast resource on what a geriatric specialty entails | Thematic                  | Students found the podcast a creative method to present a specialty and suggested creating podcasts for other medical fields; students provided suggestions for including patient testimonials and “A day in the life of…” | A multimedia podcast for medical students can raise awareness of geriatric medicine as a potential career choice and can be used as a novel multimedia approach for a variety of career options when considering residency programs. |
| Cadieux et al., 2017⁰¹ | Intellectual, occupational System 62; first-year undergraduate medical students | Leadership course grounded in business pedagogy | Thematic                  | Understanding change; effective teamwork; leading in patient safety; leadership in action | Leadership in medical education should be applicable to the learner’s stage of training and may be better supported if leadership is framed as a competency throughout their career. |
| Chew et al., 2012¹²⁴ | Intellectual, occupational Individual 18; second-year undergraduate medical students | Preclerkship HIV elective | Thematic                  | Enthusiasm for small group sessions; clinical observerships; community agency placements; diversity of topics covered | Student-run initiatives can supplement medical curriculum content and promote student leadership and interest, community partnerships, and faculty mentorship. |
| Ellaway et al., 2014⁵⁶⁷ | Social, intellectual System 101; first-year undergraduate medical students | Mobile device program | Grounded theory             | Mobile devices augment, but are not replacements for, laptop computers, and mobile devices in medical education are perceived as a tool and source of support | Medical learners use mobile devices depending on the learning culture and contexts of their specific medical programs and education ecologies. |
| Law et al., 2019⁸⁹ | Intellectual, occupational Individual 17; undergraduate medical students | Computer programming certificate course | Thematic                  | Value of the course; potential application of learning | Computer science and medicine would benefit from enhanced 2-way communication when developing technology for use in medicine. |
| Lynch et al., 2014⁸⁹ | Social, intellectual Individual 4; undergraduate medical students | Linking students from North America and Europe with a peer-to-peer learning approach | Thematic                  | Peer connection; trust in data veracity; aid to clinical learning process | Connecting students across continents in a community of peer-to-peer learning encourages peer cooperation with potential to disseminate key clinical learnings. |
| Welsher et al., 2018⁹⁰ | Intellectual Individual 23; preclerkship undergraduate medical students | Video-based observational practice communities that augment simulation-based skill education and connect geographically distributed learners | Thematic                  | Ease of use; technical knowledge; versatile and accessible; observational tools beneficial to learning; desire for more networked, observational learning activities | Video-based observational practice communities are feasible to support simulation-based learning of clinical skills in a distributed group of health professional trainees. |
and program affirmation of the role of being a learner in a medical school, and systems that favour attributing meaning to being a learner. Qualitative studies provided insight into catalyzing the shift from reducing manifestations of distress to proactively optimizing well-being.

**Interpretation**

We conducted a scoping review of published interventions conducted in Canadian medical schools to improve the well-being of medical learners. Our review shows that many Canadian medical schools have implemented various interventions to enhance the well-being of medical learners. The review highlights the importance of incorporating interventions that not only address immediate concerns but also promote long-term well-being and professional development.

**Table 2 (part 2 of 2): Summary of findings from qualitative studies**

| Study | Well-being domain† | Level | No. and type of students | Intervention | Analysis | Themes or theory | Author findings from original study |
|-------|---------------------|-------|--------------------------|-------------|----------|-----------------|-------------------------------------|
| Yeung et al., 2017 | Social, intellectual | Individual | 20; second-year undergraduate medical students | Longitudinal Students as Teachers program | Thematic | Program increased perceived knowledge and provided students with opportunities to practice teaching and to provide and receive feedback, and to reflect on their practice | Early exposure to medical education theories allows opportunity to apply theories practically through ongoing teaching and feedback sessions that include reflective exercises. |
| Campagna-Vaillancourt et al., 2014 | Social | Program | 45; otolaryngology–head and neck surgery | Multiple Mini interview (MMI) for the selection of applicants to residency | Thematic | Meet more staff; less stressful; multiple first impressions; different aspects of personality; objective and fair; team assessment | Using the MMI for admission to a residency program has good acceptability and reliability, and is feasible. |
| Malhotra et al., 2008 | Mental, intellectual | Program | 12; internal medicine | Mini Clinical Evaluation Exercise | Phenomenological | Education; assessment; exam preparation | The mini Clinical Evaluation Exercise is anxiety provoking at first, but may provide insight into clinical competence over time. |
| Myden et al., 2012 | Intellectual, occupational | Program | 6; orthopedics | Computer-assisted surgery simulations | Thematic | Confidence; awareness; deepening knowledge; changed perspectives | High-impact educational interventions endorsing cognitive flexibility increases confidence, changes awareness, and deepens knowledge and perspectives. |
| Sachedina et al., 2019 | Occupational | Individual | 17; cardiac critical care | Code Blue Simulation Program (CBSP) | Thematic | The CBSP is a useful tool to help prepare residents to serve as code blue learners and the authenticity of the CBSP cases was useful | The CBSP enhanced resident preparedness. Differences between simulated and real codes should be addressed to enhance fidelity. |
| Sukhera et al., 2018 | Mental | System | 10; psychiatry | Mental illness implicit association test | Grounded theory | Vulnerability provoked tension between personal and professional identities reconciled through striving for ideal while acknowledging the actual | Addressing implicit bias among health professionals is influenced by the process of recognizing and managing biases. |
| Tait et al., 2013 | Mental, intellectual, occupational | Individual | 7; family medicine, psychiatry | The Dignity Interview | Thematic | Experience of the interview; patient as teacher; residents reflecting on their own lives; resident reflections on palliative or end-of-life care education; physician role in conflict | Conversations with dying patients and soliciting a patient’s story are poorly taught and modelled in medical education. |
| Tan et al., 2013 | Social, occupational | Program | 130; family medicine | Online virtual patient clinical case in palliative care | Thematic | Useful content; beneficial teaching modality; realism of case; awkward navigation; worried about missing key points in the case | The online virtual patient case in palliative care is a useful teaching tool to address need for increased formal palliative care experience in medical education. |

*Reported as per the Summary of Qualitative Findings Table structure.†Well-being domains include social, mental, physical, intellectual or occupational well-being. Levels include individual, program or system level.
Medical schools address intellectual, occupational and social well-being through interventions targeted to individual medical learners and their respective programs, within the medical education system. The well-being of graduate students in health sciences programs does not appear to have been addressed through targeted interventions. Across all medical learners in Canada, mental and physical well-being is an important area that requires further exploration.

Few included studies used formal faculty adviser or mentor programs as a method to promote social well-being. Mentorship is an interactive process to encourage learning and development, grounded in social learning principles, that has been used extensively in medical schools in the United States. Academic mentors model the importance of key components of social well-being — inclusion, diversity and professionalism — in medical education. Formal mentorship programs that are integrated with curricular content can be used to offer career guidance to graduate science researchers, or to develop clinical skills among medical students and resident physicians. Mentorship programs for social well-being report high satisfaction, career promotion, improved clinical performance and patient safety. We encourage Canadian medical schools to consider social well-being among their medical learners.

Barriers to mental health treatment for medical learners are common and important to recognize for effective mental health interventions. Learners with mental health disorders and symptoms are often undiagnosed and undertreated. We found a gap in increasing access and reducing stigma around mental health interventions within Canadian medical schools. In 2019, Wilkes and colleagues surveyed 69 undergraduate medical students and reported that 83% of students considered medical education a source of stress, and 70% met criteria for exhaustion; however, only 36% of students reported seeing a mental health professional to address mental health concerns. There is a need for formal programs focused on mental well-being, inclusive of increasing awareness, reducing stigma and improving access to mental health services.
health services. Although such programs are associated with lower depression and suicidal ideation rates in the United States, the effectiveness of this approach in Canadian medical schools is unknown.111

We found a scarcity of interventions aimed to improve the physical well-being of medical learners.112 Physical well-being does not have comparable widespread acceptance as an aspect of physician well-being.111,114 Adherence to various dimensions of physical well-being is low among undergraduate medical education students.115 In an online cross-sectional survey of fourth-year medical students at the University of British Columbia, Holtz and colleagues showed that those who perceived exercise counselling to be highly important to clinical practice participated in daily physical activity.116 Although it may be hubristic to suggest interventions to improve learner physical well-being will improve patient outcomes,117 we contend that encouraging physical well-being should be a core component in developing competent and professional future physicians.118

Many interventions in Canadian medical schools promote collectives of learners to encourage a collaborative state of mind rather than peer-to-peer competition. All but 2 Canadian medical schools have adopted a pass/fail grading system for medical education.119 A pass/fail system has been shown to improve intellectual well-being,120 enhancing teamwork among learners121 without negative impact on academic performance.122 Pass/fail grading systems, complemented by standards-based evaluations, are a step along the continuum to recognizing learners as professionals, enhancing intellectual well-being and preparing medical students for life as enduring learners.123,124 Further, many studies reported that medical learners have higher satisfaction and greater achievement of knowledge-related outcomes when skills are taught in condensed workshops, ranging from 2 hours,19 to 5 days,41 to 2 weeks.21 More research is needed to understand massed versus dispersed learning to maximize intellectual well-being.

Occupational well-being is an increasingly researched area in Canadian medical schools, particularly in resident trainees.125 Compared with physicians, residents in Canada have a 48% increased risk of burnout, 95% increased risk of depression and 72% increased risk of suicidal thoughts.126 Residency programs play a predominant role in the occupational well-being of residents; medical leaders have stressed the need for universities to make occupational well-being a core competency of medicine by redesigning medical programs.127 We found many interventions that aimed to improve occupational well-being at the program and system level by addressing culture, learning and work environments; however, more research is needed to ensure that efficacious interventions are effectively implemented in a contextually adaptive manner to respond to individual learner needs.

We suggest 3 key directions when considering future interventions. First, positive psychological outcomes are important,128 given that positive psychological adaptations evolve to meet the demands of stressful experiences.129,130 Highly resilient individuals are known to cultivate positive adaptations proactively;131,132 it is unknown whether or not positive psychological adaptations are by-products of interventions or whether they improve coping. Future interventions for improved mental well-being should consider the aggregate of negative and positive mental well-being outcomes.

Second, the well-being of graduate science education students in Canada has not been considered widely. Scientific research is an important element in graduate science education programs, and learners conducting scientific research may face unique well-being challenges.133,134 In Canada, the integrative MD-PhD program is a popular approach for training physician-scientists,135 representing a substantial investment of institutional, federal and societal resources.136 Medical schools might consider interventions for all learners conducting scientific medical research to augment their success as future investigators.

Lastly, process evaluation is needed to assess the implementation of interventions and outcomes over time. Though most studies reported positive improvements, it is possible that interventions were not reliably delivered or consistently adhered to.137 As others have mentioned,12 we suggest that intervention evaluations include the study of sequential
phases of implementation to determine synergies among well-being domains associated with improvement in learner well-being. Interventions may have adverse effects that should be weighed against potential benefits, and success during one stage of training may not be helpful during the next stage of training.

**Limitations**

The protocol for our review was not registered; we included only primary studies and did not search grey literature, which may fill gaps we identified or report interventions with negative outcomes. Our definition of medical learner is not a validated definition. We categorized studies based on 5 domains of well-being, but there may be other well-being domains related to medical learning (e.g., spirituality). We found authors nearly exclusively reported successes and few failures, which suggests positive publication bias. Given the multidimensional constructs of interventions, it was not possible to determine specific components of interventions associated with more favourable outcomes. The lack of a universal definition for learner well-being added complexity to study selection, but our broad inclusion criteria allowed us to produce a comprehensive summary of literature. Our review was limited to medical learners in Canada and the included studies did not report on subpopulations of learners (e.g., Indigenous students, international students). We were unable to comment on different race and ethnocultural factors influencing the learning experience.

**Conclusion**

Interventions to improve the well-being of medical learners in Canadian medical schools vary. Many Canadian medical schools have addressed intellectual, occupational and social well-being through interventions targeted to individual medical learners, their medical learning programs or the educational or health care systems. The well-being of graduate students in health sciences programs does not appear to have been addressed through targeted interventions. Across all medical learners in Canada, mental and physical well-being is an important area for further exploration. Comprehensive and inclusive interventions aimed to improve well-being for medical learners in Canada are needed.

**References**

1. Jennings ML, Slavin SJ. Resident wellness matters: optimizing resident education and wellness through the learning environment. Acad Med 2015; 90:1246-50.
2. Ripp JA, Privitera MR, West CP, et al. Well-being in graduate medical education: a call for action. Acad Med 2017;92:914-7.
3. Slavin SJ, Chibnall JT. Finding the why, changing the how: improving the mental health of medical students, residents, and physicians. Acad Med 2016;91:1194-6.
4. Tawfik DS, Profitt J, Morgenthaler TI, et al. Physician burnout, well-being, and work unit safety grades in relationship to reported medical errors. Mayo Clin Proc 2018;93:1571-80.
5. Vogel L. Physician health charter calls on health systems, organizations to share responsibility for burnout. CMAJ 2018;190:E812-3.
6. Vogel L. Medical education needs reform to improve student well-being and reduce burnout, say experts. CMAJ 2018;190:E1426-7.
7. Brazeau CMLR, Shanafelt T, Durning SJ, et al. Distress among matriculating medical students relative to the general population. Acad Med 2014; 89:1520-5.
65. Law M, Rapoport MJ, Selm D, et al. Evaluation of a national online education program for geriatric psychiatry. Acad Psychiatry. 2003;27:40-9.
66. Law M, Veinot P, Campbell J, et al. Computing for medicine: Can we prepare medical students for the future? Acad Med 2019;94:353-7.
67. Livingston MC, Bass S, Emery AW, et al. Six medical students in a community hospital. Can J Surg 1979;12:1001-6.
68. Lynch NP, Cil T, Lehanne E, et al. Transatlantic peer-to-peer learning: an initial feasibility study. Surg Innov 2014;21:643-8.
69. Mahora S, Hata R, Courneya CA. Internal medicine residents’ perceptions of the Mini-Clinical Evaluation Exercise. Med Teach 2010;32:814-9.
70. McKendy KM, Posel N, Fleiszer DM, et al. A learner-created virtual patient curriculum for surgical residents: successes and failures. J Surg Educ 2016;73:559-66.
71. McMillan HJ, Writer H, Moreau KA, et al. Lumbar puncture simulation in family medicine clerkship. Acad Med 2007;82:1258-60.
72. Meterissian S, Liberman M, McLeod P. Games as teaching tools in a surgical medical student clerkship. Med Teach 2007;29:e258-60.
73. Morgan PJ, Cleave-Hogg D. A Canadian simulation experience: faculty and student opinions of a performance evaluation study. Br J Anaesth 2000;85:779-81.
74. Mydén CA, Anglin C, Kopp GD, et al. Computer-assisted surgery simulation: exploring the relationship between identity and operating room: educational benefits to the trainee. Comput Assist Recon Ther 2012;17:113-27.
75. Podums E, Shafir MS, Keystone JS, et al. Rewarding anxiety. J Surg Educ 2010;67:123-22.
76. Posluns E, Shafir MS, Keystone JS, et al. Rewarding anxiety. J Surg Educ 2010;67:123-22.
77. Sachedina AK, Blissett S, Remtulla A, et al. Preparing the next generation of medical students: perceptions of students, student affairs deans, and mental health providers. J Med Educ 1993;68:360-3.
78. Selote J, Kantaro S, Qing M, et al. Rewarding medical teaching excellence. A comparison of a one-on-one advising to an Advisory College Program. Med Teach 2010;32:e429-35.
79. Selote J, Kantaro S, Qing M, et al. Rewarding medical teaching excellence. A comparison of a one-on-one advising to an Advisory College Program. Med Teach 2010;32:e429-35.
80. Selote J, Kantaro S, Qing M, et al. Rewarding medical teaching excellence. A comparison of a one-on-one advising to an Advisory College Program. Med Teach 2010;32:e429-35.
81. Smyth M, Toguri JT, Dow T, et al. Medical student exposure to anesthesiology through the Pre-clerkship Residency Exploration Program: impact on specialty interest and understanding of anesthesiology. Can J Anaesth 2019;66:1126-8.
82. Sternsraus R, Steinerth B, Bhanj F, et al. Evaluating a novel resident role-modelling programme. Clin Teach 2018;15:252-7.
83. Sukhera J, Wodzinski M, Teunissen PW, et al. Striving while accepting: a narrative exploration of residents’ experiences on the help-seeking behaviors of medical students with burnout. Acad Med 2015;90:961-9.
84. Tait PS, Tait PS, Tait PS, et al. Informal mentoring between faculty and residents: the impact of mentoring on residency training stressful? Can J Surg 2006;49:200-3.
85. Tait PS, Tait PS, Tait PS, et al. Informal mentoring between faculty and residents: the impact of mentoring on residency training stressful? Can J Surg 2006;49:200-3.
86. Tait PS, Tait PS, Tait PS, et al. Informal mentoring between faculty and residents: the impact of mentoring on residency training stressful? Can J Surg 2006;49:200-3.
87. Tait PS, Tait PS, Tait PS, et al. Informal mentoring between faculty and residents: the impact of mentoring on residency training stressful? Can J Surg 2006;49:200-3.
88. Tait PS, Tait PS, Tait PS, et al. Informal mentoring between faculty and residents: the impact of mentoring on residency training stressful? Can J Surg 2006;49:200-3.
89. Tait PS, Tait PS, Tait PS, et al. Informal mentoring between faculty and residents: the impact of mentoring on residency training stressful? Can J Surg 2006;49:200-3.
90. Tait PS, Tait PS, Tait PS, et al. Informal mentoring between faculty and residents: the impact of mentoring on residency training stressful? Can J Surg 2006;49:200-3.
91. Tait PS, Tait PS, Tait PS, et al. Informal mentoring between faculty and residents: the impact of mentoring on residency training stressful? Can J Surg 2006;49:200-3.
92. Tait PS, Tait PS, Tait PS, et al. Informal mentoring between faculty and residents: the impact of mentoring on residency training stressful? Can J Surg 2006;49:200-3.
93. Tait PS, Tait PS, Tait PS, et al. Informal mentoring between faculty and residents: the impact of mentoring on residency training stressful? Can J Surg 2006;49:200-3.
129. Block J, Kremen AM. IQ and ego-resiliency: conceptual and empirical connections and separateness. *J Pers Soc Psychol* 1996;70:149-61.

130. Lazarus RS. From psychological stress to the emotions: a history of changing outlooks. *Annu Rev Psychol* 1993;44:1-21.

131. Kumpfer KL, Bluth B. Parent/child transactional processes predictive of resilience or vulnerability to “substance abuse disorders.” *Subst Use Misuse* 2004;39:671-98.

132. Kumpfer KL, Summerhayes JF. Prevention approaches to enhance resilience among high-risk youth: comments on the papers of Dishion &Connell and Greenberg. *Ann N Y Acad Sci* 2006;1094:151-63.

133. Evans TM, Bira L, Gasteum JB, et al. Evidence for a mental health crisis in graduate education. *Nat Biotechnol* 2018;36:282-4.

134. Storrie K, Ahern K, Tuckett A. A systematic review: students with mental health problems — a growing problem. *Int J Nurs Pract* 2010;16:1-6.

135. Skinnider MA, Squair JW, Twa DDW, et al. Characteristics and outcomes of Canadian MD/PhD program graduates: a cross-sectional survey. *CMAJ Open* 2017;5:E308-14.

136. Brass LF, Akabas MH, Burnley LD, et al. Are MD-PhD programs meeting their goals? An analysis of career choices made by graduates of 24 MD-PhD programs. *Aad Med* 2010;85:692-701.

137. McKenna KM, Hashimoto DA, Maguire MS, et al. The missing link: connection is the key to resilience in medical education. *Aad Med* 2016;91:1197-9.

138. Kim KW, Lim HC, Park JH, et al. Developing a basic scale for workers’ psychological burden from the perspective of occupational safety and health. *Saf Health Work* 2018;9:224-31.

139. Swanwick T, Forrest K, O’Brien BC, editors. *Understanding medical education: evidence, theory, and practice* 3rd ed. Hoboken (NJ): John Wiley & Sons, Inc.; 2019.

140. de Souza M. Promoting wholeness and wellbeing in education: exploring aspects of the spiritual dimension. In: de Souza M, Francis LJ, O’Higgins-Norman J, et al., editors. *International Handbook of Education for Spirituality, Care and Wellbeing*. Dordrecht (The Netherlands): Springer; 2009:67-92.

141. Kripalani S, Bassen-Jones J, Katz MG, et al. A prescription for cultural competence in medical education. *J Gen Intern Med* 2006;21:1116-20.

**Affiliations:** Departments of Community Health Sciences (Moss, Wollny, Lorenzetti, Kassam), and Critical Care Medicine (Moss, Amarbayan), Cumming School of Medicine, and Faculty of Nursing (Wollny, Amarbayan), and School of Public Policy (Amarbayan), and Health Sciences Library (Lorenzetti), University of Calgary, Calgary, Alta.

**Contributors:** Stephana Moss and Aliya Kassam conceived and designed the study. All authors contributed to data acquisition, analysis and interpretation. Stephana Moss and Aliya Kassam drafted the manuscript, which all authors critically revised. All authors gave final approval of the version to be published and agreed to be accountable for all aspects of the work.

**Funding:** This study was funded by the Office of Postgraduate Medical Education and supported by the Office of the Senior Associate Dean of Education at the Cumming School of Medicine.

**Content licence:** This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY-NC-ND 4.0) licence, which permits use, distribution and reproduction in any medium, provided that the original publication is properly cited, the use is noncommercial (i.e., research or educational use), and no modifications or adaptations are made. See: https://creativecommons.org/licenses/by-nc-nd/4.0/

**Data sharing:** All data presented are available in the published record.

**Supplemental information:** For reviewer comments and the original submission of this manuscript, please see www.cmajopen.ca/content/9/3/E765/suppl/DC1.