Predict, prevent and manage moral injuries in Canadian frontline healthcare workers and leaders facing the COVID-19 pandemic: Protocol of a mixed methods study

Mahée Gilbert-Ouimet [a,b,1], Azita Zahiriharsini [a,b,1,*], Caroline Biron [c], Lyse Langlois [d], Caroline Ménard [e], Manon Lebel [e], Jérôme Pelletier [a], Caroline Duchaine [f,b], Marianne Beaulieu [g], Manon Truchon [h,i]

[a] Department of Health Sciences, Université du Québec à Rimouski, 1595 Boulevard Alphonse-Desjardins, Lévis, QC, G6V 0A6, Canada
[b] CHU de Québec-Laval University Research Center, 1050 Chemin Ste-Foy, Quebec City, QC, G1S 4L8, Canada
[c] Department of Management, Laval University, Quebec City, QC, G1V 0A6, Canada
[d] Laval University, Quebec City, QC, G1V 0A6, Canada
[e] Department of Psychiatry and Neuroscience, Faculty of Medicine, Laval University and CERVO Brain Research Center, Quebec City, QC, G1V 0A6, Canada
[f] Faculty of Medicine, Laval University, 1050 ave de la Médecine, Quebec City, QC, G1V 0A6, Canada
[g] Nursing Faculty, Laval University, Quebec City, QC, G1V 0A6, Canada
[h] School of Psychology, Laval University, Quebec City, QC, G1V 0A6, Canada
[i] Centre de recherche interdisciplinaire en réadaptation et intégration sociale(CIRRIS), Quebec City, QC, G1M 2S8, Canada

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ABSTRACT

Moral injuries can occur when perpetrating, failing to prevent, or bearing witness to acts that transgress deeply held moral beliefs and expectations. The COVID-19 crisis highlighted the fact that psychosocial stressors at work, such as high emotional demands, are placing Canadian healthcare workers at risk of moral injuries. Evidence linking psychosocial stressors at work to moral injuries are needed to better predict, prevent and manage moral injuries, as these stressors are frequent and modifiable occupational risk factors. This protocol presents a study aiming to: 1) understand workplace events having the potential to either cause or reduce moral injuries, 2) predict the risk and severity of moral injuries using a disease prevention model, 3) identify biological signatures (biomarkers) associated with psychosocial stressors at work and moral injuries and 4) elaborate preliminary guidelines of organizational practices for frontline healthcare workers to reduce and manage moral injuries. This study is a mixed methods research with three components: qualitative, quantitative and biological. The data collection has been completed and because of the COVID-19 pandemic, it was adjusted to allow for gathering qualitative and quantitative data remotely. Frontline healthcare workers and leaders were included. Through focus groups and individual interviews, and an online questionnaire, events and psychosocial working conditions that may increase the risk of moral injuries will be documented. In addition, blood samples which were collected from a sub-sample of volunteer participants will measure an innovative set of biomarkers associated with vulnerability to stress and mental health. Data analyses are ongoing. We anticipate to identify workplace events that may trigger moral injuries. We expect that potential predictors of moral injury risk occurrence and severity will be identified from psychosocial stressors at work that can be improved by implementing organizational practices. We also expect to observe a different mental health state and biological inflammation signature across workers exposed compared to workers not exposed to psychosocial stressors at work. Based on these future findings, we intend to develop preliminary recommendations of organizational practices for managers. This research will contribute to expand our knowledge of the events in the workplace likely to generate or lessen the impact moral injuries, to build a model for predicting the risk of moral injuries at work, all in the specific context of the COVID-19 health crisis among healthcare workers.

* Corresponding author. Department of Health Sciences, Université du Québec à Rimouski, 1595 boulevard Alphonse-Desjardins, Lévis, QC, G6V 0A6, Canada.
E-mail address: azita.zahiriharsini@uqar.ca (A. Zahiriharsini).
1 co-first authors

1. Introduction

The health crisis caused by COVID-19 is harmful to the mental health of frontline healthcare workers. Alarming prevalence of depression and anxiety have for example been reported worldwide (da Silva and Neto, 2021; Lai et al., 2020; Sahebi et al., 2021; Wang et al., 2020). A less documented yet severe and preoccupying mental health consequence of the pandemic is the increased risk of moral injury (MI) in these workers (F. Akram, 2021; Litam and Balkin, 2021; Shale, 2020). MI can arise from having to deal with the risk of being infected and infecting those close to them. The physical reorganization of workspaces, the imposition of rigid measures, the shortage of materials and ethical questions relating to decision-making related to patients are sources of stress that can lead to MI (Asaoka et al., 2020; Bassi, Negri, Delle Fave and Accardi, 2021a, 2021b; Batra et al., 2020; Li et al., 2020; Nie et al., 2020; Serrano-Ripoll et al., 2020; Shortland et al., 2020). To develop much needed interventions, the study presented in this research protocol mainly aims to broaden our knowledge of the events occurring in the workplace likely to generate or lessen the impact of moral injuries (MI), to improve the prediction of the risk of MI at work and to document the potential of mindful self-compassion (MSC) in protecting against MI, all in the specific context of the COVID-19 health crisis among Canadian frontline healthcare workers.

1.1. Moral injury: From battlefields to healthcare settings

MI has mostly been studied among the military population to describe the lasting emotional, psychological, social, behavioural, and spiritual impacts of actions that violate a service member's core moral values and behavioural expectations of self or others (Currier et al., 2018; Koenig et al., 2019; Litz et al., 2009). MI can lead to the experience of guilt, shame, and self-condemnatory behaviours in the aftermath of morally traumatic events (Currier et al., 2018; Litz and Kerig, 2019). Although most research has been primarily focused on military context, MI can occur among different professions in various contexts, including among healthcare workers (Greenberg et al., 2020; Griffin et al., 2019; Haight et al., 2017; Papazoglou et al., 2020; Williamson et al., 2018). The health crisis caused by COVID-19 seems to increase the risk of MI among these professionals (Cdc Covid- Response Team, 2020; Nguyen et al., 2020; The Lancet, 2020). In these uncertain times, where healthcare workers face new challenges and sources of stress, popularizing MI concept to the medical community and discussing it is especially timely and important (Faisal Akram, 2021; Greenberg et al., 2020; Haller et al., 2020).

MI can occur when individuals are not able to manage or cope with the emotions resulting from a situation which creates a conflict of values or violates a person's moral code or moral values (ethical dilemma) (Čartolovni, Stolt, Scott, & Suhonen, 2021; Farnsworth, Drescher, Evans, & Walser, 2017; Litz and Kerig, 2019). The current pandemic imposed such ethically confronting situations to healthcare workers worldwide (Akram, 2021; Cdc Covid- Response Team, 2020; Erdem and Lucey, 2021; Hines et al., 2020). For example, nurses and clinicians knowing the ethically appropriate action to take, but not being able to pursue due to clinical situations and institutional obstacles has been reported as morally injured (Giwa et al., 2021). Repeated exposure to such situations may not only lead to MI, but also contribute to increased rates of emotional outbursts, post-traumatic stress disorder (PTSD), burnout, job dissatisfaction, and intention to leave the clinical position (Aultman and Wurzel, 2014; Epstein and Hamric, 2009; Kingston, 2020; Kopala and Burkhart, 2005; Rushton et al., 2015; Scotland-Coogan and Davis, 2016).

1.2. Psychosocial stressors at work as potential predictors of moral injury

The global COVID-19 pandemic has exacerbated existing sources of stress in the workplace, especially in frontline healthcare professionals (Fernandez et al., 2020; Xu et al., 2021). These professionals are playing an important role in tackling the health crisis. Several of them experienced shortage of staff leading to excessive workloads, which tended to place them in unpredictable and high-risk situations (Eftekhar Ardebili et al., 2021; Fan et al., 2020; Theorell, 2020). The World Health Organization (WHO, 2020) noted that healthcare workers are facing multiple psychosocial stressors at work during the COVID-19 pandemic, which can lead to fatigue, occupational burnout, increased physical, mental and emotional distress and decreased mental health (World Health Organization, 2020). The COVID-19 crisis highlighted the fact that psychosocial stressors from the work environment, such as a high workload, emotional demands and low social support, are increasing (Kinman et al., 2020). These stressors might contribute to placing healthcare workers from Canada and aboard at an increased risk of MI.

The two most recognized and well-defined theoretical models to measure psychosocial stressors at work (PSW) are the demand-control-support (DCS) model (Johnson et al., 1989; Karasek Jr, 1979) and the effort-reward imbalance (ERI) model (Siegrist, 1996). According to the (DCS) model, a high psychological demand combined with a low decision latitude at work (job strain) leads to deleterious effects on health (Karasek, 1990). Psychological demand refers to the amount of work to be done, the complexity of the tasks and the time constraints (Johnson, 1989). Control describes the ability to make decisions about one's work, to be creative, and to use and develop one's skills. Social support refers to the help and support from co-workers and superiors, which can amplify the effect of job strain or have its own adverse consequences. According to the ERI model, an imbalance between the effort invested in the work and the rewards obtained in exchange can also affect health (Siegrist, 1996). Reward has three dimensions: economic (remuneration), social (esteem and respect) and organizational (professional status and career perspective).

Over the past two decades, other theoretical models have expanded to include more psychosocial dimensions and emphasized the importance of an equilibrium between various psychosocial demands and resources. For instance, the job-demand-resources (JD-R) model by Bakker and Demerouti (2007) postulates that stress at work is a response to an imbalance between the job demands and the resources available to deal with those demands (Bakker and Demerouti, 2007; Demerouti et al., 2001; Schaufeli and Bakker, 2004). Emerging PSW also appeared to capture a wider set of psychosocial working conditions. Some of them might be particularly relevant in healthcare workers and in the current pandemic context, namely high emotional demands, numeric stress, low psychological safety climate (PSC), and low ethical culture. These four dimensions are increasingly linked to workers' health and well-being. Briefly, *emotional demands* have been understood as those aspects of a job that require sustained emotional effort because of interactional contact with clients or patients (De Jonge and Dormann, 2006; Vegchel et al., 2004). Workers, including healthcare workers, who are exposed to high emotional demands at work tend to report elevated levels of emotional exhaustion (Demerouti et al., 2001), psychological distress, burnout, and job dissatisfaction (Bakker and Demerouti, 2007). *Numeric stress* refers to feeling overwhelmed by the use of digital technologies and social media applications or overwhelmed by the quantity of information transmitted (Adisa et al., 2017; Kristensen and Borg, 2003). *Psychosocial safety climate (PSC)* refers to the policies, practices and procedures that are present in the work environment for the protection of the psychological and social risk or harm in Dollard' model (2007) (M. Dollard, 2007). PSC is conceived as an organizational resource in the JD-R model that can influence both job demands and job resources and subsequently, that can benefit to workers' psychological health and employee engagement (Maureen F Dollard and Bakker, 2010; Maureen F. Dollard, Dormann, Tuckey and Escartín, 2017; Law et al., 2011). The *ethical culture* of an organization has different manifestations: the resolution of ethical issues by management, the reprimand of unethical behaviour, the absence of pressure to act in a way that offends one's professional conscience and the ethical behaviours of managers themselves (Truchon, 2019). Langlois and Lapointe (2010) pointed out that organizations'ethics-related characteristics affect the degree to which ethical

judgment is exercised by leaders (Langlois and Lapointe, 2010, 2014), which in turn can reinforce or undermine the implementation of more ethically organizational culture (Lapointe et al., 2020). The literature on ethical culture reports associations between ethical culture and workers' psychological (Huhtala et al., 2016; Mitonga-Monga et al., 2016) and physical health (Kangas et al., 2017).

1.3. Self-compassion: being kind to ourselves as a protection against moral injury

Self-compassion has been defined as a significant predictor of stress symptoms that involves feelings of self-understanding, caring and kindness toward oneself and has been found to positively related to coping strategies when confronted with unwanted negative emotions (Finlay-Jones et al., 2015; K. Neff, 2003). A growing body of research has indicated that individuals with higher levels of self-compassion may perceive lower levels of stress as a result of the engagement in adaptive coping mechanisms and emotion regulation strategies (Allen and Leary, 2010; Bridges et al., 2004; Glück, 2020; Graff et al., 2009; MacBeth and Gumley, 2012; K. Neff, 2003).

Self-compassion-based interventions can effectively manage one's stress response and protect against the development of mental health problems following morally injurious experiences, by improving resilience to occupational stress, overall well-being and professional effectiveness among healthcare professionals (Barnett et al., 2007; Forkus et al., 2019; Maunder and Levenstein, 2008; Patsiopoulos and Buchanan, 2011; Zessin et al., 2015). While mindfulness is the ability to turn toward negative thoughts and feelings (such as hopelessness, frustration, anger, and confusion), self-compassion involves positive psychological strengths in response to perceived stressors and struggles with kindness, sympathy, positive reframing and acceptance (Allen and Leary, 2010; Bluth, 2017; Germer, 2009). Mindful self-compassion (MSC) combines the skills of mindfulness and self-compassion, which provides powerful tools for coping with life adversity and challenges and enhancing emotional resilience (Neff and Germer, 2013).

1.4. Tackling both the individual and the working environment to lower moral injury

Psychosocial interventions have been considered the most effective ways to reduce distress, alleviate psychological symptoms and promote psychological resilience during the ongoing pandemic (Al-Refae et al., 2021; Dawel et al., 2020; Galea et al., 2020). However, such interventions rarely included actions to reduce PSW. The reduction of PSW as well as the adoption of individual adaptation strategies, such as MSC, could help to reduce the impact of the current sanitary crisis on the mental health of workers, in addition to providing tools to deal with this crisis and future ones. A required step to build such interventions is to improve the understanding of the predictors of MI, by documenting the associations between psychosocial stressors at work, self-compassion and this type of injury. The current study will contribute to fill this gap.

1.5. Beyond moral injury: examining the overall physiological inflammation response to stressors

Chronic stress is associated with changes in the immune system, an exacerbated inflammatory response and increased levels of circulating cytokines, which results in a psychological burden reflected in increased cytokine release linked to inflammation (Powell et al., 2013). Increased levels of circulating pro-inflammatory cytokines have been used recently to assess objectively physiological responses to stress (Derry et al., 2013). Longitudinal studies have shown an association between higher exposure to PSW and increased concentrations of inflammatory biomarkers (Eguchi et al., 2016; Magnusson Hanson et al., 2019), mainly according to the stressors of the demand-control-support (DCS) model (Cuitún Coronado et al., 2018; Magnusson Hanson et al., 2019). In the present study,

methods for measuring the stress-related physiological response will be developed. We propose to use, for the first time, an innovative set of biological signatures (biomarkers) to examine physiological responses to PSW, and MI. In a subsequent phase of the study, the evolution of these biomarkers will also be examined to evaluate the effectiveness of an intervention tackling MSC and PSW.

1.6. Study objectives and hypotheses

The study presented in this protocol aims to (1) understand how events in the workplace are likely to generate or lessen the impact of moral injuries as well as the means that can be put in place to reduce them; (2) predict the risk of moral injury using a theoretical model integrating various psychosocial stressors at work and mindful self-compassion; (3) identify a biological signature (biomarkers of inflammation) associated with poor psychosocial conditions at work and moral injuries; and (4) develop preliminary organizational practice guidelines for frontline leaders to reduce the occurrence or lessen the impact of moral injuries.

In order to achieve the above study objectives, the study attempts to test the following hypotheses: (1) potential indicators of moral injuries experienced will be identified through interviews; (2) potential causes and protective factors of moral injuries, as well as psychosocial stressors at work as predictors of moral injuries will be identified through evidence-based questionnaires; and (3) different biological signatures will be identified across psychosocial stressors at work and mental injury statuses.

2. Methods

2.1. Overview

The present study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist items, which are developed as reporting guidelines for the publication of observational studies (von Elm et al., 2014), the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) checklist items for the reporting of protocols of experimental studies (Chan et al., 2013), and recommendations from an expert steering committee (the authors of this manuscript).

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2.2. Study design

The study is a mixed methods research including: a qualitative, a quantitative and a biological component. Data collection for these three components has been completed and data analyses are ongoing. For the qualitative component, focus groups and individual interviews were conducted with physicians, nurses, patient support workers, managers, and other job categories (more than 21 categories) to better understand the events causing moral injuries and the means that can be put in place to reduce them (objective 1). For the quantitative component, a questionnaire was administrated to predict the risk and severity of moral injuries (objective 2). For the biological component, blood samples were collected to measure 38 inflammatory biomarkers in an attempt to identify a biological signatures associated with work stressors and moral injuries (objective 3). Then, preliminary organizational practice guidelines for frontline leaders to reduce the impact of MI on well-being in the workplace will be developed (objective 4).

Actions to improve the psychosocial working environment were already identified through interviews with healthcare workers and volunteers of a private hospital specialized in palliative care. The interview grid for the qualitative component was adapted to the COVID-19 context and extended to explore MI. In the quantitative component, a theoretical model aiming to predict the risk of moral injuries has been developed. This model includes a set of risk and protective factors resulting from the

characteristics of the work environment (e.g. support from superiors) and individuals (e.g. self-compassion), as well as indicators of well-being and physical and psychological health. The model is measured using an extended version of the validated self-administered questionnaire called the Occupational Health and Well-being Questionnaire (OHWQ) (Truchon et al., 2021a; Truchon et al., 2021b). The OHWQ was enriched by including the following variables: self-compassion, MI, burnout, PTSD. Literature reviews as well as meetings between project's researchers allowed to identify the best questionnaires to measure and evaluate these variables and to integrate them into our questionnaire, now called OHWQ+ (further details are provided in section 2.5). Translations of certain questionnaires, from English to French, were carried out using a recognized method (Vallerand, 1989). Biomarkers of inflammation were collected and will be analysed to identify biological signatures linked to PSW and the resulting MI. Guidelines then synthesized organizational practices that may improve PSW associated with MI.

2.3. Setting and sample size

This study focuses on both regulated and non-regulated healthcare workers (physicians, nurses, orderlies, respiratory therapists, patient support workers and others such as dental centers and ambulance services, etc.) as well as leaders (head nurses, managers) of hospitals and long-term care centers treating patients with COVID-19.

Participants were recruited in Canada in 3 urban regions of the Quebec province (Montréal, Capitale-Nationale and Laval) as well as in several non-metropolitan regions (Laurentides, Saguenay-Lac-Saint-Jean, Mauricie and Center du Québec, Montérégie).

2.4. Eligibility criteria

To be included, participants must have been healthcare workers (nurses, patient attendants, respiratory therapists, nutritionists, medical imaging technologists, radiation oncology and medical electrophysiology, medical technologists, dental hygienists, physiotherapists, doctors) involved in the care of patients with COVID-19 (e.g. hospitals and CHSLDs) and speak French to be able to complete the questionnaire.

2.5. Data collection

Individual interviews and focus groups were conducted from March 2021 to April 2021 among 42 participants (health workers and managers). The aim of the qualitative component was to identify events and circumstances having the potential to cause moral injuries. Individual interviews and focus group were conducted by trained research assistants who then transcribed verbatim and coded the transcriptions using qualitative content analysis method. The integration of both individual and group interviews has been shown to enhance the understanding of the structure of the phenomenon and, therefore, data richness (Lambert and Loiselle, 2008).

PSW and MI were self-reported using validated questionnaires. Our disease prevention model already includes a questionnaire measuring: i) organizational resources: ethical sensitivity, ethical culture, leadership, reward, management of change, psychological safety, support from colleagues, ii) occupational resources: autonomy, skill development, sense of work, job satisfaction, iii) job demands: workload, psychological and emotional demands, numeric stress, iv) psychological distress: distress, memory, irritability, and v) physiological alterations: overall physical symptoms, presenteeism (i.e. being at work while sick), musculoskeletal disorders. Using existing validated questionnaires and data from interviews, we expanded our model to predict the risk and severity of MI in healthcare workers. An extended model include new adapted measures of: 1) the frequency and intensity of events that could lead to MI ('stress of conscience questionnaire', Glasberg et al. (2006), 2) MI indicators: self-oriented and other-oriented MI were measured using the Expressions of Moral Injury Scale-Military Version (EMIS-M) developed by Currier

et al. (2018), and 3) one's ability for self-compassion ('Self-Compassion Neff, 2003 (Neff, 2003)). A commonly used questionnaire is the Moral Injury Symptom Scale–Health Professionals (MISS-HP) (Mantri, Lawson, Wang, & Koenig, 2020) which does not differentiate self- and others-oriented MI and has religious components less transposable to the Quebec culture. The model was tested among 572 healthcare workers.

Data collection also includes collecting blood sample to examine biological signatures through an innovative set of 38 blood biomarkers of inflammation. Blood samples were collected by qualified research nurses among a random sub-sample of 89 civil healthcare workers from the 572 participants recruited in the study. We performed Milliplex assays to establish specific blood signatures and identify potential biomarkers of mental health conditions. To do so, blood serum from each participant was processed through the Milliplex MAP Human Cytokine/Chemokine Magnetic Bead Panel which includes 38 analytes notably interleukin-1beta, interleukin-6 and tumour necrosis factor alpha, which have been associated with vulnerability to stress and treatment-resistant depression in multiple preclinical and clinical studies. Analyses will be performed to identify which biomarkers are higher due to stress from work and moral injuries. Table 1 summarizes all the variables measured at the study as well as instruments used to measure them and data collection methods including self-reported questionnaires, interviews, and blood sample for measurements of inflammatory markers.

Table 1
List of all variables measured in the study.

Variables	Instruments used	Data collection methods
1. Potential indicators of moral injuries (events likely to generate or lessen the impact of MI)	Trained researchers	Focus groups and individual interviews
2. Sociodemographic variables	Sociodemographic characteristics of the population (age, sex, gender, masculine or feminine traits, minority, education level and number of years worked)	Self-reported questionnaire
3. General health indicators Psychosocial stressors at work (PSW)	Questions about "morning tiredness" and "Self-rated health"	Self-reported questionnaire
	Questions about these dimensions: i) organizational resources: ethical sensitivity, ethical culture, leadership, reward, management of change, psychological safety, support from colleagues, ii) occupational resources: autonomy, skill development, sense of work, job satisfaction, iii) job demands: workload, psychological and emotional demands, numeric stress, iv) psychological distress: distress, memory, irritability, and v) physiological alterations: overall physical symptoms, presenteeism (i.e. being at work while sick), musculoskeletal disorders (Karasek et al., 1998; Kristensen and Borg, 2003; Siegrist, 1996)	Self-reported questionnaire
4. The frequency and intensity of events that could lead to moral injuries	'Stress of conscience questionnaire', Glasberg et al. (2006)	Self-reported questionnaire
5. Potential predictors of moral injuries	'Moral Injury Scale', Currier et al. (2018)	Self-reported questionnaire
6. One's ability for self-compassion	'Self-Compassion Scale', Neff (2003)	Self-reported questionnaire
7. Biological signatures	An innovative set of 38 blood biomarkers of inflammation	Blood samples

2.6. Data analyses

For the qualitative component, content analysis method was used to interpret the text data through a systematic classification process involving coding and identifying themes (Bengtsson, 2016). Open coding will be carried out to allow codes to emerge from the dataset and avoid coding based on predispositions of the authors. Immersion in the data is an important first stage in the analysis process during which transcripts will be read and re-read many times to become completely familiar with the content beyond interview transcripts. Repeated reading and re-reading of transcripts without coding helps identify emergent themes from the data without losing the connections between key concepts and their context and enables subsequent interpretation of research context. NVivo, the qualitative data analysis software will be used to manage and organize the coding procedures and retrieve codes afterwards.

For the quantitative and the biological components, statistical analyses will be performed by a qualified biostatistician. The prevalence of MI will be compared between the individuals exposed to PSW and unexposed individuals (reference). Prevalence ratios (PR) of MI and their 95% CI will be modelled using robust Poisson regressions. Models will sequentially be adjusted for sociodemographic factors, sex and gender, lifestyle factors and other psychosocial factors. Statistical analyses will be conducted by SAS 9.5 software. To analyse the biomarkers, Graphics illustrating the associations will also be produced using GraphPad Prism software. We will use as a measure of association the difference in means of the biomarker concentrations. Statistical analyses will be done to identify biological signatures from these biomarkers in groups exposed, intermediate and non-exposed to poor psychosocial working condition, and MI as stated in the third objective of the study. An analysis of covariance (ANCOVA) integrating potentially confounding factors (socio-demographic variables) will be used. Independent analyses will be carried out for each of the markers, which make it possible to determine which ones will be modulated and constitute the specific "biological signatures" of the different exposure groups studied. The differences in adjusted means and their 95% confidence intervals will be calculated.

3. Expected results

We expect our study to produce unprecedented evidence about indicators and predictors of MI, and about the physiological inflammatory stress responses of Canadian healthcare workers and leaders facing MI during the COVID-19 crisis. Through qualitative interviews, we expect to identify events that generated MI and the emotions that accompanied these events among healthcare workers during the pandemic (e.g. shame, guilt, isolation, anger, self-doubt, self-punishment, sabotage). Through the quantitative component, we anticipate that our extended integrative model will allow to identify predictors of MI occurrence and severity among a wide set of modifiable psychosocial stressors at work. We expect our integrative model to predict a large percentage of the variance of the risk of MI. Individual self-compassion (including mindfulness) might also be identified as a predictor by this model.

We also anticipate that biomarkers of inflammation, i.e. a biological signature, associated with poorer working conditions and MI will be identified. To our knowledge, this is the first study evaluating a large panel of inflammatory biomarkers in association with stressors from work or MI, thereby providing an objective portrait of the physiological stress response.

Finally, we intend to publish, present and distribute the preliminary guidelines of organizational practices to prevent and manage MI. Tools currently available to understand and reduce the impacts of these stressors on MI will be synthesized ("Moral stress amongst healthcare workers during COVID-19: a guide to moral injury," 2020). Our results, combined with this synthesis will result in a series of preliminary recommendations for leaders in frontline healthcare workers in the context of a sanitary crisis.

These results will offer an evidence-based corpus of knowledge needed to develop, implement and evaluate, in a subsequent phase of the study, a mobile application to ('Kind-me') predict, prevent and manage MI in workers in complex moral contexts.

4. Discussion

We have developed a study to better understand MI occurring in frontline healthcare workers during the COVID-19 crisis. MI are strong predictors of mental health problems (Currier et al., 2015a; Currier et al., 2015b; Held et al., 2017; Nash et al., 2013; Wisco et al., 2017), which were already the most frequent, costly, and debilitating group of health problems among adults of OECD countries before the pandemic (Emily and Valerie, 2014; OECD, 2017). Mental health problems are also the primary cause of sickness absence from work (Harvey et al., 2009; Nystuen et al., 2001). Prevention strategies targeting MI among healthcare workers were called for around the world, including by the Ministry of National Defense in Canada (2020). Our study is part of this initiative. This study will contribute to improve the prediction, prevention and management of MI by examining how a comprehensive set of PSW and mindful self-compassion are linked to MI occurrence and adverse impacts. Thereby, our study will produce new knowledge on MI indicators, predictors in frontline workers and leaders facing the COVID-19 pandemic.

The present study will also improve our understanding of workers' physiological response to stress by identifying biomarkers of low grade inflammation associated with work stressors and MI status. Previous evidence demonstrated that inflammatory biomarkers of stress are associated with the risk of developing mental health problems such as depression (Smith et al., 2018), dementia (Koyama et al., 2013), anxiety disorder (Costello et al., 2019), and PTSD (Bennett et al., 2015). They are also associated with an increased risk of several chronic diseases such as diabetes (Liu et al., 2016) and cardiovascular diseases (Danesh et al., 1998; Lobbes et al., 2006). However, previous studies tended to focus on a single or a few biomarkers, such as tumor necrosis factor alpha (TNF-α), transforming growth factor beta (TGF-β), interleukin-6 (IL-6), interleukin-18 (IL-18), interferon-δ (IFN-δ), monocyte chemoattractant protein (MCP-1), interleukin 1 beta (IL-1β) (Blake and Ridker, 2003; Liu et al., 2014; Menzel et al., 2021). Since low-grade inflammation relies on complex interactions, measuring it with a limited set biomarkers might lead to considerable underestimations (Morrisette-Thomas et al., 2014). To our knowledge, our study will be the first to attempt to identify, from a set of 38 biomarkers, a preliminary biological signature of low-grade inflammation associated with poorer working conditions and MI. Evaluating such a large panel of inflammatory biomarkers in association with stress from work or MI will provide an objective portrait of the physiological impacts of these factors on health.

We believe that our study might provide insights for the prevention and management of MI beyond the pandemic at two levels of public health prevention: 1) the individual level, by enriching employee assistance services, and 2) the workplace level, by suggesting preliminary organizational practices to favour adequate PSW that may reduce or moderate MI. Efforts deployed beyond the individual level tend to produce stronger and longer lasting gains on health, reducing the alarming costs of sickness absences and favoring productivity.

Our study will offer the basis needed to design the Kind-Me mobile application. This application will be designed to predict, prevent, and manage MI in healthcare workers and leaders in the context of a sanitary crisis. Moral stressors are inherent in sanitary crises environments and cannot be eradicated of the work. Such new prevention tools are therefore needed to reduce MI occurrence and impacts in healthcare workers during such crises. The Kind-Me application will tackle the psychosocial work environment and mindful self-compassion. Targeting both organizational stressors and an individual coping skill could help reducing MI by acting upstream of their occurrence and preventing the adverse chronic inflammatory process. Moreover, a growing body of research supports the importance of such integrated prevention approaches, i.e.,

targeting both organizational and individual factors (Lamontagne et al., 2007; Sorensen et al., 2011). Finally, it is worth noting that while our application will specifically target frontline healthcare workers, it could be, in a next step, adapted and scaled up to other workers and leaders facing MI, such as military workers and officers, police and firefighters.

5. Conclusion

Through qualitative and quantitative data collections, this study will first innovate by identifying modifiable organizational and individual risk and protective factors associated with MI in frontline workers and leaders in a context of the COVID-19 sanitary crisis. This study will also innovate by documenting the physiological inflammatory responses of workers exposed to these factors and experiencing MI. The study will finally result in the elaboration of organizational and individual recommendations for frontline leaders to reduce organizational risk factors. Those results will offer an evidence-based corpus of knowledge needed to develop, implement and evaluate future integrative psychosocial workplace intervention at both levels: organizational and individual. In the upcoming phase of the study, a mobile application ('Kind-me') that might contribute to prevent and manage MI and related work absences and productivity losses will be conceived.

Ethics approval and consent to participate

Ethical approval was granted by the ethics committee of the 'Centre intégré universitaire de santé et de services sociaux de la Capitale-Nationale' in Quebec, Canada. All participants provided written consent for the study, were made aware that data is anonymised, securely stored, will be analysed for publication, participation is voluntary, and they are free to leave the study at any time.

CRediT authorship contribution statement

Mahée Gilbert-Ouimet: Investigation, Writing – review & editing, Writing – original draft. **Azita Zahiriharsini:** Writing – review & editing, Writing – original draft. **Manon Truchon:** Investigation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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