

**Investigating the demographic and behavioural predictors of mental health and burnout in
medical students: A cross-sectional study**

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ABSTRACT

Background: Medical students are at risk for poor mental health and burnout compared to the general population (Dyrbye et al., 2014). A preponderance of research has examined predictors of mental illness in medical students (Brazeau et al., 2014; Hope & Henderson, 2014). However, few studies have investigated predictors of mental health, and no studies to our knowledge have compared predictors of mental health and burnout in medical students. Further, several studies have assessed physical activity and burnout in medical students but these have neither examined specific intensities of physical activity nor have considered the role of sedentary behaviour in predicting medical student burnout (Dyrbye, Satele, & Shanafelt, 2017b; Wolf & Rosenstock, 2017). Thus, there is a dearth of knowledge on how demographics relate to mental health and burnout, and how mild, moderate, and vigorous physical activity, and sedentary behaviour relate to burnout in medical students.

Purpose: To investigate and compare demographic predictors (gender, ethnicity, age, level of education, year of study, and proposed specialty) of mental health and burnout, to examine behavioural predictors (mild, moderate, vigorous, and total physical activity, and sedentary behaviour) of burnout, and to investigate moderate-to-vigorous physical activity as a moderator of the relationship between sitting and burnout in first to fourth year medical students.

Methods: The sample consisted of 129 first to fourth year medical students at two large Canadian universities. Participants were recruited through electronic newsletters, medical student Facebook groups, and an in-class announcement. This study used a cross-sectional design. Data were collected through online surveys of validated self-report questionnaires measuring demographics, mild, moderate, vigorous, and total physical activity, sitting, mental health, and burnout.

Results: Third year of study was a significant negative predictor of mental health while female gender, ‘other’ ethnicity and third year of study were significant positive predictors of burnout. Moreover, female gender, ‘other’ ethnicity, and fourth year of study predicted mental health differently from burnout. Second and third year of study predicted mental health and burnout similarly. Mild physical activity and sitting were significant negative predictors of burnout. Moderate-to-vigorous physical activity was not a significant moderator of the relationship between sitting and burnout.

Conclusions: Findings of this study support Keyes’ Dual Continua Model (2014) and Maslach’s theorization of burnout (Maslach, Jackson, & Leiter, 1996) and can inform targeted programs to prevent poor mental health and burnout in medical students. Future research is recommended on these key topics.

CHAPTER I: INTRODUCTION

Mental health is defined as the combination of our psychological well-being (having a sense of purpose in life), social well-being (having a sense of belonging to a community), and emotional well-being (feeling happy, satisfied, and interested in life; Keyes, 2014; van Dijk, Lucassen, van Weel, & Speckens, 2017) and has been the subject of much research (Doré, Loughlin, Schnitzer, Datta, & Fournier, 2018; Keyes, Dhingra, & Simoes, 2010; Spiker & Hammer, 2018). It has been clearly distinguished from mental illness (Keyes, 2005; Payton, 2009), which has been defined as a mental, behavioural, or emotional disorder, such as depression or anxiety (National Institute of Mental Health, 2017b). However, there is a known link between mental health and mental illness as they are negatively correlated (Keyes, 2005) and changes in mental health can predict future risk for mental illness (Keyes et al., 2010). One group that has been consistently shown to be at risk for mental illness is medical students (Bore, Kelly, & Nair, 2016; Dyrbye, Thomas, & Shanafelt, 2006c; Puthran, Zhang, Tam, & Ho, 2016).

Regarding mental illness, research has shown that medical students begin medical school with lower rates of depression than age-matched peers (Brazeau et al., 2014); however, once in medical school, medical students have a higher prevalence of depression than age-matched peers (Matheson et al., 2016; Statistics Canada, 2018). Another construct in this area is psychological distress, which has been defined as an emotional response to a stressor that can result in psychological harm (Ridner, 2004); one example is burnout (Brazeau et al., 2014). In two systematic reviews, burnout was found to be consistently higher in medical students than the general population. Other research has estimated rates of depression and anxiety in medical students to be as high as 66.5%, and the prevalence of burnout to be as high as 49.6% (Dyrbye et

al., 2014). Medical students are indeed exposed to stressors that put them at an increased risk for poor mental health and burnout (McLuckie et al., 2018).

These rates are concerning as medical students are future physicians who are a valued component of our healthcare system and if they are unwell, patients will suffer. Given this, some studies predominantly from the USA have started to examine demographic predictors mostly of mental illness. For example, some research suggests that students may be at a greater risk of mental illness or burnout in their third year of study (Wolf & Rosenstock, 2017) or if they are intending to pursue primary care specialties (Compton, Carrera, & Frank, 2008). However, there is an overall lack of studies on the mental health of medical students and also a dearth of Canadian data on predictors of mental health and burnout in medical students (Dyrbye, Thomas, & Shanafelt, 2006c). Moreover, the majority of studies have not clearly distinguished the constructs of mental health and burnout from mental illness. Some studies exist regarding a few predictors of burnout among Canadian medical students (Babenko, Mosewich, Abraham, & Lai, 2018; McLuckie et al., 2018; Tucker, Bouvette, Daly, & Grassau, 2017); however, there remains a gap in knowledge of the relationship between other predictors, such as age and educational level, and medical students' burnout, as well as their mental health. Finally, few studies have assessed a combination of demographic predictors together (Bore et al., 2016; Cecil, Mchale, Hart, & Laidlaw, 2014), neglecting to consider multiple key factors at one time.

With regards to behavioural predictors, research suggests that some medical students may incur an increased risk for burnout if they achieve inadequate physical activity levels (Dyrbye, Satele, & Shanafelt, 2017b; Wolf & Rosenstock, 2017). However, it is unclear what recommendations should be made to medical students regarding physical activity intensity (i.e.

mild, moderate, or vigorous) and sedentary behaviour (i.e. sitting)¹, as the literature on this is sparse and has only targeted the general population (Naczenski, de Vries, van Hooff, & Kompier, 2017; Sloan et al., 2013).

As such, the proposed study aimed to investigate the demographic and behavioural predictors of mental health and burnout in a subset of Canadian medical students. The specific objectives of this study are: Article 1: (1) to examine how six common demographics (gender, ethnicity, age, level of education prior to admission, year of study, and proposed specialty) predict mental health in Canadian medical students (2) to determine if predictors are similar for mental health and burnout; Article 2: (3) to investigate how total physical activity, physical activity intensity (i.e. mild, moderate, and vigorous), and sitting predict burnout² in medical students (4) to examine how moderate-to-vigorous physical activity moderates the relationship between sitting and burnout.

¹ Upon further reading since the proposal of this thesis, the authors noticed a trend of studies examining physical activity and sedentary behaviour together. Given the state of emerging literature on sedentary behaviour, and that a measure of “sitting hours” was included in the larger study, the authors decided to include it as a variable.

² This project is part of a larger study in which the PhD will be assessing the link between physical activity and mental health; thus, only physical activity in relation to burnout will be assessed in this study.

CHAPTER II: LITERATURE REVIEW

Concerns about Medical Students' Mental Health

Recently, there has been a growing concern regarding the mental health of medical students. In a systematic review spanning forty-three countries, the pooled prevalence of mild to severe depressive symptoms among medical students was 27.2% with longitudinal studies reporting a mean increase in depressive symptoms of 13.5% from the beginning to end of medical school (Rotenstein et al., 2016). A national survey found a higher prevalence than this, estimating that as many as 58.2% of American medical students may have depression (Dyrbye et al., 2014). Similarly, a depression prevalence of 41.5% has been found in Canadian medical students (Matheson et al., 2016). In comparison, depression rates in aged-matched peers in the general population have been estimated at 6.7% for Americans and 4.7% for Canadians (National Institute of Mental Health, 2017a; Statistics Canada, 2018).

Moreover, Dyrbye and colleagues (2011a) found that 82% of US medical students report at least one symptom of distress (e.g. burnout, fatigue) during their education. In fact, research has estimated that as many as 49.6% of American medical students have experienced burnout (Boni et al., 2018; Dyrbye et al., 2014). Similar estimates have been found in Canada, showing that approximately 37% of medical students reported burnout (Glauser, 2017). Clearly, mental health issues in medical students are in need of attention.

Mental Health Concepts

Keyes' Complete State Model of Mental Health (2005) is a strong and commonly used theoretical framework for conceptualizing mental health and illness. This model states that mental health and mental illness are two separate but correlated unipolar dimensions that collectively frame a complete model. In sum, mental health is the combined psychological,

social, and emotional well-being of an individual, where individuals can be classified as either languishing, flourishing, or moderately mentally healthy (Keyes, 2002).

According to Keyes' Dual Continua Model (2014), languishing is the lowest level of mental health characterized by feelings of despair, emptiness, and stagnation. Flourishing is the highest level of mental health characterized by positive emotions and good psychosocial functioning. Moderate mental health is neither flourishing nor languishing (Keyes, 2014).

In contrast, mental illness is any mental, behavioural, or emotional disorder such as depression, anxiety, or mood disorders (National Institute of Mental Health, 2017b).

Psychological distress is a separate construct which is defined as a poor emotional state that arises from an individual's response to a specific stressor causing harm (Ridner, 2004); licensing examinations are one example contributing to psychological distress in medical students. Based on Keyes' theorizations (2005, 2014), and on other experts' (Lamers, Westerhof, Bohlmeijer, Klooster, & Keyes, 2011; van Dijk et al., 2017), mental health, mental illness, and psychological distress must be considered separately as they have been found to exist on separate but related continua (Payton, 2009). This conceptualization has indicated that mental illness or psychological distress and relatively high levels of mental health can be experienced concurrently (Lamers et al., 2011; van Dijk et al., 2017). However, there is a known link between mental illness and psychological distress such that if psychological distress is left unattended, it can develop into mental illness (Hakanen & Schaufeli, 2012; Wolf & Rosenstock, 2017). Thus, it is important to intervene before psychological distress transpires into a mental illness.

Burnout is a form of psychological distress seen via a combination of symptoms that indicate a chronic state of distress (Leiter & Maslach, 2016; Maslach et al., 1996). It has been defined as a psychological syndrome resulting from a response to emotional and interpersonal

stressors, such as heavy workload or patient contact (Maslach, Schaufeli, & Leiter, 2001). More specifically, it is characterized by three dimensions: emotional exhaustion (EE), depersonalization (DP), and a decreased sense of personal accomplishment (Maslach & Leiter, 2016; Maslach et al., 2001). EE is characterized by feelings of emotional depletion and exhaustion resulting from one's work; DP is feelings of detachment and dehumanization regarding patient interaction; and a lack of personal accomplishment pertains to decreased feelings of competence and achievement concerning one's work (Maslach & Leiter, 2016). Burnout has been widely measured in medical students using the twenty-two item Maslach Burnout Inventory (MBI) which measures EE and DP. Single item measures of EE and DP have been validated as being sufficient for representing total burnout in medical students using the two-item MBI (West, Dyrbye, Satele, Sloan, & Shanafelt, 2012; West, Dyrbye, Sloan, & Shanafelt, 2009).

Which Medical Students are at an Increased Risk of Poor Mental Health?

The literature has pointed to certain demographic predictors³ of mental health in medical students; however, there is conflicting evidence on some of these predictors and a lack of evidence on others, leaving many gaps in the literature. Research suggests that female medical students have a higher prevalence of depression, anxiety (Dyrbye et al., 2006c), and burnout (Dyrbye & Shanafelt, 2016) than male medical students. Medical students of ethnic minority seem to be at an increased risk of mental health problems (Dyrbye et al., 2006b). It has also been suggested that medical students who are relatively older (i.e. > 30 years), have higher levels of education prior to admission, are in their third year of study, and are intending to pursue primary

³ In line with terminology used in previous studies among medical students (Bore et al., 2016; van Dijk et al., 2017) and with the data analysis used (Pallant, 2007), the term 'predictors' was chosen to describe independent variables of the present study. However, the authors acknowledge that because this study used a cross-sectional design, another term that could be used here is 'correlates'.

care (e.g. family medicine) may be at an increased risk for depression and burnout (Compton, Carrera, & Frank, 2008; Dyrbye et al., 2006a; Tucker, Bouvette, Daly, & Grassau, 2017).

Nevertheless, research on some of these variables is still lacking, such as age and educational level prior to medical school, which warrant investigation as mental health in the general population has been shown to fluctuate across the lifespan and levels of education (Kim & Kim, 2017). Further, research is lacking on demographic predictors of mental health and burnout among Canadian medical students as studies have only examined how gender and year of study predict psychological distress and burnout (McLuckie et al., 2018; Tucker et al., 2017) and is non-existent for other demographics (i.e. ethnicity, age, educational level, proposed specialty), to the best of our knowledge.

Concerning behavioural predictors, physical activity (PA) is any bodily movement produced by the skeletal muscles that causes increases in energy expenditure, breathing, and heart rate (Canadian Society for Exercise Physiology, 2017b). Research suggests that medical students who meet national PA guidelines are at a lower risk of burnout (Babenko, Mosewich, Abraham, & Lai, 2018; Dyrbye, Satele, & Shanafelt, 2017b). However, the body of research on this is minimal and does not touch upon how PA intensity (i.e. mild, moderate, and vigorous PA) may impact medical student burnout. According to the Canadian Society for Exercise Physiology (CSEP, 2017b), mild intensity refers to PA that requires minimal effort and does not result in sweating or shortness of breath, such as slow walking or stretching. Moderate intensity refers to PA that elevates the heart rate but is not exhausting, including cycling at less than ten miles per hour, walking briskly, or doubles tennis (CSEP, 2017b). Finally, vigorous intensity refers to PA where the heart is beating rapidly, as with jogging, running, skipping, or cross-country skiing (CSEP, 2017b). Current exercise psychology literature among the general population has begun

to reveal that mild, moderate, and vigorous PA intensities have different effects on mental health outcomes (Ku, Fox, & Chen, 2016; Schuch et al., 2017), and thus these relationships may be pertinent to medical students.

Given that research has shown a link between sedentary behaviour and psychological distress (Sloan et al., 2013), sedentary behaviour may influence burnout. Sedentary behaviour has been defined as any waking behaviour involving ≤ 1.5 metabolic equivalents (METs), such as sitting or reclining postures (CSEP, 2017; Tremblay et al., 2017). Research in the general population has shown that decreases in sedentary behaviour are associated with decreases in psychological distress (e.g. burnout) (Kilpatrick, Sanderson, Blizzard, Teale, & Venn, 2013; Sloan et al., 2013). Therefore, this link is important to investigate among medical students, who on average have higher rates of burnout than the general population (Dyrbye et al., 2014).

Another gap in this literature is that many studies have addressed predictors of mental illness in medical students in lieu of mental health. Overall, there seems to be a lack of distinction between mental health, mental illness, and burnout in this area of inquiry since most of the research that has claimed to address mental health has actually measured mental illness (Payton, 2009; Shariati, Yunesian, & Vash, 2007). Psychological distress among medical students has also been widely measured in terms of mental illness rather than burnout, further clouding this issue (Bore et al., 2016; Shariati et al., 2007). Burnout is a negative construct in which individuals typically feel overextended and disengaged (Leiter & Maslach, 2016). On the other hand, languishing mental health involves few positive emotions, low life satisfaction, and reduced functioning in one's personal or social life (Lamers et al., 2011). However, there are synergies between mental health and burnout such that they have been negatively correlated (Payton, 2009), therefore comparing these constructs can provide a more comprehensive

understanding of the psychological health of medical students. The study proposed herein is important because it will address these gaps by examining predictors of mental health and burnout and will compare the differences in predictors of these two constructs.

In accordance with each demographic section, this literature review will first present the available studies on medical student mental health, followed by studies on medical student mental illness to supplement, then medical student burnout. This review will address six demographic characteristics: gender, ethnicity, age, level of education prior to admission (e.g. undergraduate-level degree, graduate-level degree, or professional post-doctorate), year of medical school (e.g. first, second, third, or fourth), and proposed specialty (e.g. family medicine, internal medicine, surgery, pediatrics). This review will also address current state of knowledge on the links between PA, PA intensity, sedentary behaviour⁴, and burnout.

Demographic Predictors of Mental Health and Burnout in Medical Students

Gender

To date, and in line with research in the general population (Seedat et al., 2009; Yu, 2018), studies have suggested that female medical students are at a higher risk for poor mental health than male medical students (Compton, Carrera, & Frank, 2008; Dyrbye et al., 2006c); however, this research has mostly measured mental illness. Studies on the relationship between gender and mental illness or psychological distress in medical students support that female medical students have reported a significantly higher prevalence of depression, anxiety (Dyrbye et al., 2006c), and burnout (Dyrbye & Shanafelt, 2016) than male students. However, one

⁴ Upon further reading since the proposal of this thesis, the authors noticed a trend of studies examining physical activity and sedentary behaviour together. Given the state of emerging literature on sedentary behaviour, and that a measure of “sitting hours” was included in the larger study, the authors decided to include it as a variable.

Canadian study found that medical student gender was not a significant predictor of EE or DP (McLuckie et al., 2018).

Compton, Carrera, and Frank (2008) surveyed sixteen US medical schools, measuring stress, general mental health status, depressive symptoms, thoughts of suicide, and stress management. Findings indicated that female medical students were more likely to report higher degrees of stress in the past year (38% of females, 29% of males), as well as a higher mean number of poor mental health days in the past month compared to male medical students ($M = 3.8$ for females, $M = 2.7$ for males). In the Netherlands, researchers found that 51% of male medical students but only 37.5% of female medical students reported a flourishing mental health, representing the highest level of mental health (van Dijk et al., 2017). Indeed this may indicate a greater willingness to report issues with mental health or burnout among female medical students; however, this further stresses the importance of increasing awareness of these issues in the medical student population.

Concerning psychological distress, Bore, Kelly, and Nair (2016) surveyed Australian medical students ($n = 127$) and found that female medical students were significantly more distressed than male medical students, female non-medical students, and age-matched females in the general population. Psychological distress (which the authors defined in terms of mental illness) was measured via the Depression, Anxiety, and Stress Scale (DASS) Short Form and the ten-item Kessler Psychological Distress Scale (K10; Bore et al., 2016). Mean scores for depression, anxiety, stress, and psychological distress on the DASS and K10 were significantly higher for female medical students than males. Similar findings have been reported in medical students from Lebanon (Fares et al., 2016) and Iran (Shariati et al., 2007) with female medical students reporting significantly higher levels of stress than male medical students.

With regards to burnout, a study in Pakistan (Muzafar et al., 2015) found female medical students to be at an increased risk for burnout, with 60% reporting high levels of burnout compared to 39% of male medical students. In the USA, Dyrbye and Shanafelt (2016) found that female medical students were at an increased risk for EE, while male medical students were at an increased risk for DP. Two additional studies also found that male medical students reported higher DP than female medical students, suggesting that males may actually be at an increased risk for this subset of burnout (Cecil et al., 2014; Lapinski, Yost, Sexton, & Labaere, 2016). This may also suggest that male medical students are more likely to report feeling detached or cynical toward medical school rather than to report feeling emotionally exhausted, which may feel too personal (Meit, Borges, & Early, 2007). Interestingly, this points to a difference in predictors of mental health and burnout, but a direct comparison between predictors of mental health and burnout has yet to be done within a single study. This is one of the purposes of this thesis.

Ethnicity

In the literature, there is some evidence on how ethnicity relates to mental health or mental illness in medical students. Such research has primarily revealed that medical students of an ethnic minority⁵ are at an increased risk for poor mental health and burnout compared to non-minority medical students (Compton et al., 2008; Dyrbye et al., 2006b; Dyrbye et al., 2007). Interestingly, a later study found significant differences in mental health when considering race versus ethnicity⁶ of medical students (Dyrbye et al., 2012). They found no differences in mental

⁵ In these studies (Compton et al., 2008; Dyrbye et al., 2006b; Dyrbye et al., 2007), medical students were categorized as 'minority' if they self-identified as African American, Hispanic, Asian, Native American, Pacific Islander, and 'other' non-Caucasian. Ethnic minority has been defined as those with a cultural background different from that of the majority group (Verkuyten, 2018), in this case, Caucasian.

⁶ Ethnicity is a socially constructed identity based on presumed common descent, physical similarities, culture, language, and religion that can relate to a particular social position (Verkuyten, 2018). Race is a descriptive term used to refer to a group of people who are believed to be different due to biological or genetic characteristics, such as skin colour and facial features (Verkuyten, 2018). Ethnic identity can be informed by race, but can also exist separately (Verkuyten, 2018).

health between Hispanic/Latino and non-Hispanic/Latino medical students. However, they found significant differences when considering White versus non-White race, with a higher percentage of non-White medical students reporting languishing (6.2% vs. 3.9%) and moderate mental health (48% vs. 41%) and a lower percentage of non-White medical students reporting flourishing mental health (45.9% vs. 55.1%) than White medical students (Dyrbye et al., 2012). Some researchers have suggested that minority medical students in the USA reported significantly lower overall QOL and lower mental well-being than non-minority medical students. They reasoned that minority medical students reported lower overall QOL because they were more likely to report a major illness in the past year, having children, having trouble finding childcare, lacking familial support due to living out of state, and facing more academic struggles than non-minority medical students (Dyrbye et al., 2006b).

Alternatively, Dyrbye et al. (2007) found no significant differences between minority and non-minority medical students for depressive symptoms. However, minority students who felt that their race had adversely affected their education were more likely to report depression, have lower mental QOL, and have higher levels of EE, DP, and burnout compared to minority students who did not feel this way. In summary, ethnicity appears to be an important variable related to medical students' mental health, and these findings suggest that further research is required. Particularly, research on ethnicity, mental health, and burnout in Canadian medical students should be pursued.

The existing literature on these topics has emerged from the USA, and there are some known historical and political differences between the USA and Canada with regard to multiculturalism (Peach, 2005). Canada has been described as a multicultural mosaic in contrast to the melting pot USA, which has been attributed to differences in the treatment and cultural

acceptance of minority groups (Peach, 2005). One study found that Canadian immigrants wanted to gain citizenship due to Canada's level of acceptance and multinationalism while American immigrants saw US citizenship as more of a formality (Aptekar, 2016). Regarding mental and physical health inequities, research has found non-White Americans to report significantly lower self-rated health than non-White Canadians, regardless of their immigrant status (Siddiqi & Nguyen, 2010). The social climate in Canada has been more positively perceived compared to the USA as its laws are more accepting to immigrants and supportive of individual rights to religion and cultural identity (Aptekar, 2016; Peach, 2005). Moreover, these factors appear to influence mental health as having a strong sense of cultural identity has been associated with higher wellbeing and a lower risk for depression (Williams, Clark, & Lewycka, 2018). However, research among a large sample of Canadian Maritime university students ($n = 10180$) found that male students of Mixed (multiple ethnicities, discluding Aboriginal) or 'Other' ethnicities (single ethnicity, discluding Caucasian and Aboriginal) were more likely to report higher levels of depressive symptoms than Caucasian students (Steenbeek, Langille, Wilson, & Muir, 2016). No differences were found for female university students in this study (Steenbeek et al., 2016). While Canadian culture may differ from that of the USA and not all US studies may be applicable, there may still be some ethnic groups in Canada who are at an increased risk for poor mental health and burnout.

Age

The literature on medical student age and mental health is lacking. However, one study (Dyrbye et al., 2012) investigated the association between medical students' age and their mental health and found that medical students over thirty years old reported the highest proportion of languishing mental health (6.6% versus 4.4% of medical students 25-30 years old and 3.4% of

medical students < 25 years old) and the lowest proportion of flourishing mental health (50.3% versus 51.8% of medical students 25-30 years old and 54.4% of medical students < 25 years old) though these results only approached significance, with a p-value of .095 (Dyrbye et al., 2012). Other research examining mental illness (i.e. depression, anxiety, somatization, and social dysfunction) found no association with medical student age (Shariati, Yunesian, & Vash, 2007).

In other research, age approached significance in positively predicting burnout, with older medical students being at an increased risk (Muzafar et al., 2015). Finally, some research has examined the relationship between age, burnout, and attrition from medical school and found that relatively older medical students were more likely to experience burnout and to seriously consider dropping out of medical school (Dyrbye et al., 2010). Still, there is a dearth of research examining age as a predictor of medical student mental health. Age appears to be an important correlate given that mental health research has shown variance in mental health over the lifespan (Kim & Kim, 2017) and that personal and professional responsibilities (e.g. having children, buying property) increase with age (Dyrbye et al., 2010). More research needs to be done on this topic to ascertain whether different age groups need to be targeted in medical students.

Level of Education

There is no literature to our knowledge on whether level of education prior to medical school predicts mental health in medical students. One study examined differences in stress levels between Australian medical students with high school education prior to admission versus medical students with an undergraduate degree prior to admission, though no differences were found (Sandover, Jonas-Dwyer, & Marr, 2015). Further, a global meta-analysis examined the difference in depression prevalence between postgraduate (bachelor degree required prior to admission) and undergraduate (no bachelor degree required) medical students and found that

postgraduate medical students had slightly higher rates of depression (30.8%) than undergraduate students (27.0%), though this was not significant (Puthran et al., 2016).

Given that admission requirements are different for medical schools in other countries, this literature may not capture the reality for Canadian medical students. In some Canadian medical schools admission is possible with only two to three years of undergraduate level education; however, most Canadian medical schools require students to have obtained a bachelor degree prior to admission. Therefore, medical students attending a Canadian institution would have spent more years in school than medical students admitted with high school education in other countries (i.e. USA, Australia), which has both benefits and limitations. Indeed more years of schooling can provide opportunities for personal growth and greater life experience; however, higher levels of education have also been linked with greater debt and poorer health (Riemenschneider et al., 2016; Sandover et al., 2015). Another limitation is that this area of literature has not compared the mental health of medical students with undergraduate to graduate levels of education. However, research in non-medical university students has found that graduate students (i.e. master's, PhD) were nearly twice as likely to report depression than undergraduate students (Soet & Sevig, 2006). Thus, it is possible that Canadian medical students with higher levels of education prior to admission may experience poorer mental health during medical school. This is a novel contribution to the literature that this study aims to fill.

Year of Study

Research has consistently shown that medical students in their third year of study are at the highest risk for poor mental health compared to all other years (Bore et al., 2016; Compton et al., 2008; Ludwig et al., 2015). Compton, Carrera, and Frank (2008) surveyed first, third, and fourth year US medical students and found first year medical students to report the lowest mean

number of poor mental health days over the past month ($M = 2.2$) compared to third or fourth year medical students ($M = 4.3$ and $M = 3.3$ days, respectively). Third years were also most likely to report fourteen or more bad mental health days in the past month and reported depressive symptoms more frequently (34.7%) than first years (21.9%; Compton et al., 2008). Dyrbye et al. (2012) examined mental health and found a significant difference in mental health between years of study, showing a higher proportion of languishing medical students in third year (5.1%) compared to first (2.3%) and fourth (2.6%) year. Alternatively, the highest proportion of flourishing medical students was in fourth year (61.5%).

In their review, Dyrbye, Thomas, and Shanafelt (2005) reported a two- to three-fold increase in depression from first to second year of study which suggests that when medical students begin their third year they are already at a greater risk for poor mental health outcomes. Further, Kligler, Linde, and Katz (2013) qualitatively explored the perceived opportunities and challenges of third year medical students in the USA ($n = 173$) and found that the transition from the first two years to the last two years of medical school was a highly stressful time for medical students because this is when they begin to form professional identities and put their knowledge into practice during their clerkship. Altogether, the literature points to the highest risk for poor mental health in the third year of medical school.

Regarding the Canadian literature on medical student burnout, one study found that burnout significantly increased from the beginning to the end of the third year of study (Tucker et al., 2017) while another found that EE and DP increased with each year of study (McLuckie et al., 2018). Outside of Canada, much research has also revealed that third year of study positively predicts burnout (Bore et al., 2016; Erschens et al., 2018; Santen, Holt, Kemp, & Hemphill, 2010), with third year medical students reporting significantly higher EE, DP, and burnout than

medical students in other years of study. Mental health and burnout should be assessed across the four years of medical school in Canada as only two studies have looked at the relationship between burnout and year of study and have neglected to measure mental health (McLuckie et al., 2018; Tucker et al., 2017). Examining these topics in first to fourth year medical students is important as it can inform strategic prevention efforts early on in medical education.

Proposed Specialty

Medical specialties have typically been categorized into two classifications: primary care and non-primary care. Primary care refers to family medicine, internal medicine, pediatrics, and preventive medicine/public health, whereas non-primary care refers to emergency medicine, obstetrics/gynecology, surgery, anesthesia, pathology, radiology, cardiology, dermatology, gastroenterology, pediatric subspecialties, and psychiatry (Compton et al., 2008; Hojat & Zuckerman, 2008).

Compton, Carrera, and Frank (2008) looked at the relationship between medical students' intended specialty choice and their mental health ($n = 2316$). They found that medical students choosing primary care reported a higher number of bad mental health days in the past month ($M = 3.4$) than those choosing non-primary care ($M = 3.0$), but this was not a significant difference. This supports Zeldow and Daugherty (1991) who found that medical students choosing surgery (i.e. non-primary care) showed lower depression scores than those choosing internal medicine and family medicine (i.e. primary care). Medical students intending to pursue more intense fields, such as surgery, have been found to have higher impulsive sensation seeking scores than those intending to pursue primary care and to view risk more positively (Hojat & Zuckerman, 2008; Mehmood, Khan, Walsh, & Borleffs, 2013), which may help to explain these differences.

In line with this, Dyrbye and colleagues (Dyrbye et al., 2011b) found that medical students intending to pursue surgical specialties had significant lower EE scores than those intending to pursue primary or other non-primary care specialties. However, high levels of burnout were prevalent across all intended specialties. Alternatively, Bore, Kelly, and Nair (2016) reported no association between intended specialty choice and mental illness or burnout in Australian medical students. More research is needed to clarify this link.

As such, the present study will examine demographic predictors of mental health and burnout in Canadian medical students. It is important to assess a combination of demographic predictors of mental health as little research has done so. More specifically, some international studies have investigated multiple demographic predictors, and some Canadian studies have examined one or two demographic predictors. However, there remains a paucity of Canadian research examining a combination of demographic predictors of mental health and burnout. For instance, a few studies cited in this literature review investigated multiple predictors but in other countries, in which there may be differences in culture or the medical school setting. Bore et al. (2016) included five of the six demographic predictors of the present study, examining gender, age, year of study, level of education, and proposed specialty as predictors of burnout in Australian medical students. Cecil et al. (2014) examined predictors of burnout in British medical students but only included gender, year of study, and PA as predictor variables, thus overlooking other potentially important predictors such as ethnicity, age, educational background, and specialty. Most recently, van Dijk et al. (2017) examined predictors of mental health and psychological distress in Dutch medical students but neglected to include any demographic variables in their analyses. Further, Canadian medical student research is lacking as only two studies examined demographics as predictors of burnout. To remind the reader, these

studies only investigated the relationships between gender, year of study, EE, and DP in medical students, but did not look at other important demographics such as ethnicity or educational level (McLuckie et al., 2018; Tucker et al., 2017). This justifies our need to determine how the six chosen demographics predict mental health and burnout of medical students, particularly in Canada.

Behavioural Predictors of Burnout in Medical Students

Total Physical Activity

While many studies have examined the link between PA and mental health, showing that increased PA leads to increased mental health (Chekroud et al., 2018; Doré et al., 2018; White et al., 2017), few have investigated the link between PA and burnout in the general population (Naczenski et al., 2017; Tsai et al., 2013). One study administered a twelve-week exercise program with residents and fellows ($n = 245$) and found that participants had lower levels of burnout than non-participants post-intervention (Weight et al., 2013). In line with this, a study conducted among medical students (Cecil et al., 2014) found that low levels of PA was a significant predictor of high levels of EE compared to high levels of PA. In Australia, low exercise hours per week was also found to significantly predict burnout in medical students (Bore et al., 2016).

Similarly, other research has found PA to be inversely associated with burnout in medical students. For example, one study showed that medical students who achieved lower levels of PA had a significantly higher risk of decreased personal accomplishment and increased EE (Wolf & Rosenstock, 2017) whereas another study found that medical students who met nationally recommended PA guidelines were less likely to experience burnout (Dyrbye et al., 2017b). In Canada, a recent study found that lower levels of leisure time PA, that which is undertaken

during one's discretionary time rather than for work or travel (Amireault & Godin, 2015), was a significant predictor of higher levels of exhaustion in first to fourth year medical students (Babenko et al., 2018). However, this study used the Oldenburg Burnout Inventory which measures burnout via engagement and exhaustion (Babenko et al., 2018) and thus neglects the DP subscale of burnout. The present study will fill gaps in the literature by examining the relationship between PA and total burnout, measured via EE and DP, in Canadian medical students.

Physical Activity Intensity

There is a growing trend examining how different PA intensities relate to different mental health constructs in the general population. For example, two studies showed positive relationships between mild PA and well-being (Ku et al., 2016) and between mild and vigorous PA and happiness (Richards et al., 2015). However, the research examining how PA intensity (i.e. mild, moderate, and vigorous) relates to burnout is not vast, and is especially lacking in the medical student literature. Some studies have explored the links between different intensities of PA and burnout in the general population (Bernaards et al., 2006; Naczenski et al., 2017; Tsai et al., 2013) and other student populations (de Vries, van Hooff, Geurts, & Kompier, 2016; Elliot et al., 2015); however, there is a disagreement on which intensity is most beneficial for burnout.

On mild intensity PA, one intervention found higher frequencies of mild PA to be related to lower levels of burnout in banking and insurance workers (Tsai et al., 2013). These authors showed that the low intensity PA group (engaging in one hour of aerobic exercise and stretching once per week led by a trained professional) had a greater decrease in work-related burnout compared to the control group, suggesting that engaging in mild PA may improve burnout (Tsai et al., 2013). Later research assessed the effect of a six-week low intensity PA intervention on

study-related fatigue (i.e. EE, overall fatigue, and need for recovery) among insufficiently active university students (de Vries et al., 2016). Students in the exercise group engaged in low intensity running outdoors three times a week supervised by two trainers, with at least one day of rest in between sessions. From baseline to twelve-week follow-up, EE and overall fatigue reduced significantly in the exercise group compared to the control group (de Vries et al., 2016). However, these results must be interpreted cautiously as running is typically considered to be moderate or vigorous PA (Ainsworth et al., 2000). One study examined the association between moderate PA and burnout in Swiss vocational students, who attend one to two days of school and three to four days of work per week, but it was not significant (Elliot et al., 2015).

In regards to vigorous intensity PA, some authors have reported a U-shaped relationship with burnout (Bernaards et al., 2006) indicating that participants who engaged in vigorous PA once or twice per week were less likely to report EE one year later than those who engaged in vigorous PA less than once per month or three or more times per week. This suggests a preventive role of moderate frequency vigorous PA. Recently, a systematic review reported that vigorous PA was effective at preventing or treating burnout in the working population (Naczenski et al., 2017). These authors found a significant negative relationship between vigorous PA and EE, with the most popular dosage of PA for the treatment and/or prevention of burnout being sixty minutes twice per week (i.e. low frequency) for twelve weeks. These studies support that low to moderate frequency high intensity PA may be used in treating and preventing burnout in some populations (Bernaards et al., 2006; Naczenski et al., 2017), though it is still unknown whether this is true for medical students.

Sedentary Behaviour

To the best of our knowledge, no research has investigated the association between sedentary behaviour and burnout in medical students. Though the definition of sedentary behaviour has been regularly stated as energy expenditure not exceeding resting level, or 1.5 METs (Tremblay et al., 2017), there are currently no Canadian guidelines recommending target levels of sedentary behaviour for adults (CSEP, 2017a; LeBlanc et al., 2015). Nevertheless, research with the general population has suggested a negative link between sedentary behaviour and both physical and psychological health (Biswas et al., 2015; Hamilton, Healy, Dunstan, Zderic, & Owen, 2008; Sloan et al., 2013) showing that more sedentary behaviour leads to worse physical and psychological health. Pertaining to psychological health, Sloan et al. (2013) examined sedentary behaviour and psychological distress among the general population in Singapore and found that high amounts of sedentary behaviour were associated with increased odds for psychological distress. Further, their results showed that those who met moderate-to-vigorous PA (MVPA) guidelines and were sedentary for five or less hours per day had the lowest odds of psychological distress (Sloan et al., 2013). However, this study was not conducted among overly busy medical students. More recent research has recommended that sedentary behaviour health outcomes be examined across low, middle, and high levels of MVPA (Biswas et al., 2015), therefore another purpose of this thesis was to examine how the relationship between sitting and burnout among medical students is moderated by levels of MVPA.

Medical Students: Why Are They Unique?

Medical students are unique to the general population as they face a curriculum that is long and emotionally draining and a culture that enforces high, sometimes unrealistic expectations and productivity above all else (Beckman, 2015; Muzafar et al., 2015). For

example, the heavy workload of the medical curriculum, examinations, competition with peers, and fear of failure have been reported as common stressors among medical students (Anuradha, Dutta, Raja, Sivaprakasam, & Patil, 2017; Matheson et al., 2016). Additionally, medical students may feel obligated to participate in a range of extra-curricular activities on top of their scholastic obligations in aims of putting forth a superior curriculum-vitae (CV) to compete for residency programs (Canadian Federation of Medical Students, 2017). In fact, there are residency application guides for medical students recommending that they tailor their CVs to eleven sections including: academic achievements, electives, publications, teaching experience, community and faculty contribution, and professional development (Student Affairs Office, 2017, pp.13). Given the expected workload of medical students, with reports of up to sixty-three hours a week of in-class and out-of-class studies (i.e. lectures, exam preparation, community-based work; Nosair & Hamdy, 2017), it is possible they may experience increases in burnout as a result of too much activity and less sitting in their time-pressed days. Thus, medical students may benefit from more breaks as not doing so may negatively impact their psychological health.

Summary

The literature has suggested that medical students who are female, minority, relatively older (i.e. > 30 years), have higher levels of education prior to admission, in third year of study, and are intending to pursue primary care are at an increased risk for poor mental health and burnout; however, there remain several gaps in the literature. First and foremost, the majority of medical student research has focused on mental illness rather than mental health (Dyrbye et al., 2006c; McLuckie et al., 2018; Puthran et al., 2016). Secondly, most studies on mental health, mental illness, and burnout have targeted non-Canadian populations (Bore et al., 2016; Erschens et al., 2018; van Dijk et al., 2017) though some Canadian medical student research has emerged

within the last two years (Babenko et al., 2018; McLuckie et al., 2018; Tucker et al., 2017). In addition, there is a need to conduct more research on age and level of education as predictors of medical student mental health. As well, no studies to our knowledge have compared demographic predictors of mental health with those of burnout, which is important because they are distinct constructs and medical students may not be similarly at risk for each. Finally, no studies to our knowledge have looked at the relationships between different intensities of PA, sedentary behaviour, and burnout in medical students. This research will address these gaps.

The Present Study

The overall purpose of this thesis was to investigate demographic and behavioural predictors of mental health and burnout in first to fourth year medical students at two Canadian universities. The primary objective of this thesis is presented first, followed by the secondary objectives. The hypotheses for each objective are also presented below.

Article 1

1. To investigate how six common demographics (gender, ethnicity, age, level of education prior to admission, year of medical school, and proposed specialty) predict mental health in medical students. Based on previous literature, it is hypothesized that:
 - a. Female medical students would have lower levels of mental health than male medical students (Compton et al., 2008; van Dijk et al., 2017).
 - b. Medical students of ethnic minority would have lower levels of mental health than non-minority medical students (Dyrbye et al., 2006b).
 - c. Relatively older medical students (i.e. > 30 years of age) would have lower levels of mental health than relatively younger medical students (Dyrbye et al., 2012; Muzafar et al., 2015).

- d. Medical students with higher levels of education prior to admission would have lower levels of mental health than medical students with lower levels of education prior to admission (Puthran et al., 2016).
 - e. Third year medical students would have lower levels of mental health compared to all other years of study (Compton et al., 2008; Tucker et al., 2017).
 - f. Medical students intending to pursue specialties in primary care (e.g. family medicine) would have worse mental health than medical students intending to pursue other specialties (Compton et al., 2008; Hojat & Zuckerman, 2008).
2. To examine whether or not predictors are similar between mental health and burnout. This is an exploratory purpose; therefore, there is no hypothesis.

Article 2

3. To investigate the relationships between mild, moderate, vigorous, and total PA, sitting, and burnout in medical students. Based on previous literature, it is hypothesized that:
- a. Total PA would have a negative relationship with burnout (Babenko et al., 2018; Dyrbye et al., 2017b).
 - b. Mild, moderate, and vigorous PA would each have a negative relationship with burnout (Naczenski et al., 2017; Tsai et al., 2013).
 - c. Sitting hours would have a negative relationship with burnout (Bernaards et al., 2006).
4. To investigate how MVPA moderates the relationship between sitting and burnout in medical students. It was hypothesized that the relationship between sitting and burnout would be the strongest among medical students who engage in higher levels of MVPA (Bernaards et al., 2006; Biswas et al., 2015).

Supplemental Results

The purpose of this section was to investigate how the demographic and behavioural variables correlated with the two subtypes of burnout: emotional exhaustion and depersonalization.

Significance

This study has many knowledge and practical contributions. First, it addresses many gaps in the literature, as previously outlined. Specifically, this research will provide knowledge on whether or not predictors of mental health are similar to predictors of burnout among medical students in a Canadian context. It will also add novel insight to the relationships between PA and burnout in Canadian medical students, and between mild, moderate, and vigorous PA, sitting and burnout among medical students in general. Importantly, this study contributes toward positive psychology research as levels of mental health were measured rather than mental illness. Overall, this study brings light to subsets of the Canadian medical student population who are at risk for poor mental health and burnout, supporting that this is a worthy area to target in research.

Knowledge from this research could advise medical stakeholders in designing interventions aimed at improving the mental health of medical students. Practical applications of this research may include: changes to the medical curriculum (e.g. more scheduled time for breaks and PA, greater focus on PA in the curriculum; Lomis, Carpenter, & Miller, 2009; Thornton et al., 2016), de-stigmatization of mental health issues (e.g. changes within medical school culture, improved access to psychological services, increased opportunities for mental health discussion groups among medical students; Johnston, 2015), and development of programs geared towards improving mental health in at risk subsets of the medical student population (e.g. meditation and mindfulness programs, PA programs, and Physical Activity

Counselling; Mascaro et al., 2018; Wild et al., 2014). Altogether, this study can inform future research in this area that could improve the mental health of medical trainees who will support the foundation of our healthcare system.

The implications of poor mental health and burnout in medical students are vast. Personal implications include: depression, substance abuse, suicidal ideation, and relationship strain (Collier, 2017). Depression may push medical students to acting on suicidal thoughts (Dyrbye, Thomas, & Shanafelt, 2005) while burnout has been suggested to increase suicidal ideation by 200% and alcohol abuse by 25% in medical students (Dyrbye et al., 2017a). Poor mental health in medical students can also affect physician health as students progress beyond the medical school years, for these mental health issues may persist if not properly cared for (Dyrbye et al., 2005; Dyrbye et al., 2006a; Tyssen, Vaglum, Grønkvold, & Ekeberg, 2001). This has economic implications including: lost productivity, requiring more tests and referrals, more medical errors, malpractice claims, and absenteeism (Dyrbye et al., 2017a). Medical students may become attuned to the distressing concerns of medical education as they become increasingly accustomed to chronic distress and begin to view it as normal (Lomis et al., 2009). Therefore, it is imperative to determine which subsets of this population are most at risk in order to shift the dialogue from one of illness to one of health.

CHAPTER III: METHODS

This research is part of a larger study titled “Health Behaviours and Prescribing Habits of First to Fourth Year Medical Students” in which one of the purposes is to examine the relationships between mental health and physical activity (PA). Therefore, for the purposes of this thesis, it was not possible to include PA variables in the mental health model and the authors decided on running two separate sets of models: one for demographics and mental health/burnout and one for behavioural variables and burnout.

The present study used a quantitative methodology with a cross-sectional design. Data were collected at two large Canadian universities using online surveys comprised of validated questionnaires, including: the Mental Health Continuum-Short Form (Appendix D), the Maslach Burnout Inventory-2-Item (Appendix E), and the Godin Leisure Time Exercise Questionnaire (Appendix G). These questionnaires have been deemed valid and reliable measures used consistently in research on mental health, burnout, and PA (Godin & Shephard, 1985; Lamers et al., 2011; Shanafelt et al., 2015) and have been used in the medical student population (Dyrbye et al., 2014; van Dijk et al., 2017; Wolf & Rosenstock, 2017). Questions on demographics (Appendix F) and a question on sitting hours per day (Appendix H) were also included. Online surveys are a commonly used method in studies among medical students assessing their mental health and burnout (Dyrbye et al., 2007, 2012, 2014; van Dijk et al., 2017). Ethical and Faculty of Medicine approval were obtained from both institutions prior to recruitment and data collection (Appendix A) and all participants provided consent (Appendix B).

The population of interest was all medical students enrolled in first to fourth year of study at McGill University and Queen’s University medical schools. Given how difficult it can be to reach the medical student population, these two universities were selected due to working

relationships the authors had with researchers at these institutions. Medical students at the University of Ottawa were not eligible for this study as the inclusion of the Mental Health Continuum-Short Form (Keyes, 2002) and the Maslach Burnout Inventory-Two-Item (Maslach et al., 1996) were not approved by the Research Ethics Board as they were considered too sensitive of topics.

The survey was administered through the online platform SurveyMonkey between November 2017 and January 2018. Links to the survey were distributed to all medical students via medical student Facebook groups, weekly e-newsletters, and one in-class announcement at McGill University where paper slips containing survey links were distributed to medical students. Announcements were not approved by the Faculty of Medicine at Queen's University. The authors chose to administer the survey in November as research among medical students has also done this (Haglund et al., 2009) and has supported that depression levels may increase from the first to second semester of medical school across all four years (Moutinho et al., 2017). Therefore, mid-semester would likely not capture medical students at their absolute lowest or highest levels of poor mental health and burnout.

As recommended by the committee at the proposal defence, additional information regarding the methods of this thesis are provided here. For the recruitment procedures, all medical students at McGill University and Queen's University were sent an initial invitation to partake in this study on November 28, 2017 via Facebook and electronic newsletters. As a follow up reminder, a second invitation was sent on December 11, 2017, two weeks after the initial invitation, and a third invitation was sent on January 14, 2018 to all medical students at both universities. At McGill University only, an in-class announcement was given on November 29, 2017 to a mandatory first year class by the primary and secondary author of this thesis.

CHAPTER IV: JOURNAL ARTICLES

ARTICLE 1: Investigating demographic predictors of mental health and burnout in first to fourth year medical students

The following article describes the demographic predictors of mental health and burnout, and provides a comparison of these predictors to show how they are similar or different between mental health and burnout in first to fourth year medical students recruited in this master's thesis. This article has been submitted to the *Journal of Mental Health*, which aims to publish thought-provoking work that will impact service provision and clinical practice, such as research that focuses on the treatment and care of mental health.

ARTICLE 2: Are medical students burning out because they do not rest? An examination of how physical activity and sitting influence burnout in medical students

The following article describes the behavioural predictors of burnout in first to fourth year medical students recruited in this master's thesis. This article has been submitted to the *Journal of Physical Activity and Health*, which aims to examine how physical activity influences health outcomes, such as the role of physical activity in the prevention or treatment of mental health.

Article Contributions: As primary author of both articles, my contributions included: mounting the online survey, participant recruitment, data collection, data analysis, and manuscript writing. Taylor McFadden's contributions included: co-project conceptualization, designing the survey, participant recruitment, data collection, and article revision. Dr. Michelle Fortier's contributions included: co-project conceptualization, study design, overall supervision of all phases, and article revisions. Dr. Jennifer Tomasone's contributions included: ethics applications and article revisions. Dr. Shane Sweet's contributions included: ethics applications and article revisions, with particular attention to guiding the data analyses.

**Investigating demographic predictors of mental health and burnout in first to fourth year
medical students**

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Abstract

Background: Medical students are at risk for poor mental health and burnout compared to the general population and age-matched peers. Research has suggested that demographics can predict mental illness and burnout in medical students; however, less is known about the link between demographics and mental health. Moreover, predictors of mental health and burnout have not been compared in general and very few studies have examined multiple demographics simultaneously. **Aims:** This research examined and compared demographic predictors (i.e., gender, ethnicity, age, level of education, year of study, proposed specialty) of mental health and burnout in first to fourth year Canadian medical students. **Method:** Medical students ($n = 129$) completed online surveys comprised of validated questionnaires. **Results:** Multiple regression indicated that third year ($\beta = -.243, p = .013$) negatively predicted mental health ($R^2 = 15.0\%$), and female gender ($\beta = .242, p = .005$), ‘other’ ethnicities ($\beta = .189, p = .028$), third year ($\beta = .391, p < .001$) and fourth year ($\beta = .212, p = .023$) positively predicted burnout ($R^2 = 32.7\%$). **Conclusion:** This research addressed gaps in the literature and can inform medical stakeholders in developing targeted programs for improving medical student mental health and burnout.

Keywords: mental health; burnout; medical student; gender; year of study; ethnicity

Introduction

There has been a growing concern regarding the increase in mental illness in the general population over recent years. By age forty, about 50% of the Canadian population will have experienced a mental illness (Canadian Mental Health Association, 2018). Rates in the U.S. are similar, with almost half the population (47.4%) experiencing a mental disorder in their lifetime (Kessler et al., 2009). Conversely, mental health is more than the absence of mental illness (Gilmour, 2015). Keyes' Complete State Model conceptualizes mental health as the combination of emotional, psychological, and social well-being, with higher levels of each representing better mental health (Keyes, 2002, 2005). Keyes' Dual Continua Model later defined mental health along one continuum, ranging from languishing, the lowest level of mental health, to flourishing, the highest level of mental health, with mental illness on a separate continuum (Keyes, 2014).

Burnout is another construct composed of high levels of emotional exhaustion (EE)¹, depersonalization (DP)², and low levels of personal accomplishment³ (Maslach & Leiter, 2016). It has been defined as an emotional response to workplace stressors, such as heavy workload (Maslach, Schaufeli, & Leiter, 2001). Medical students are one group that is at an increased risk for burnout compared to the general population (Brazeau et al., 2014; Dyrbye et al., 2014). For example, nearly 50% of medical students and 38% of early-career physicians in one American study reported burnout compared to 36% and 30% of general population peers, respectively (Dyrbye et al., 2014). Importantly, medical school burnout can persist into the physician years without proper support (Dyrbye et al., 2006a). If burnout in medical students and physicians is left untreated, problems can arise including substance abuse, depression, suicide, and poor patient care (Dyrbye et al., 2017).

Furthermore, medical students are at an increased risk for mental illness during their education relative to the general population and age-matched peers (Brazeau et al., 2014). For instance, depression prevalence in Canadian medical students has been reported at 41.5% (Matheson et al., 2016) compared to 4.7% in the general population (Statistics Canada, 2018). What is more worrisome is that consequences of mental illness have been shown to persist into physician-hood (Dyrbye, Thomas, & Shanafelt, 2005). In fact, early career physicians are over six times more likely to require treatment for a mental health problem if the issue was experienced during their education (Tyssen, Vaglum, Grønkvold, & Ekeberg, 2001).

Much research has stated that certain demographics may influence mental health, mental illness, and burnout in medical students. For instance, female medical students have reported higher rates of depression than male medical students (Dyrbye, Thomas, & Shanafelt, 2006c). Third year medical students have reported more depressive feelings and higher levels of burnout compared to other years of study (Cecil, Mchale, Hart, & Laidlaw, 2014; Tucker, Bouvette, Daly, & Grassau, 2017). Medical students who are of ethnic minorities (Dyrbye et al., 2006b), are relatively older (Dyrbye et al., 2012), have higher levels of education pre-admission (Puthran, Zhang, Tam, & Ho, 2016), and are interested in pursuing primary care specialties (Compton, Carrera, & Frank, 2008) have also reported worse mental health and higher levels of depression and burnout.

Nevertheless, research has predominantly examined the relationship between demographics and mental illness in medical students (Dyrbye et al., 2006c; Puthran et al., 2016), leaving a dearth of knowledge on predictors of mental health. Two studies examined the relationship between demographics and medical students' mental health, not mental illness; however, they did not address as many demographic variables as the

present study aims to (Dyrbye et al., 2012; van Dijk, Lucassen, van Weel, & Speckens, 2017). Additionally, research on age and education level as predictors of medical students' mental health is scarce and warrants further investigation as mental health has been shown to vary across the lifespan and levels of education (Kim & Kim, 2017); thus, they may have implications for medical student mental health. Finally, no studies have compared predictors of mental health and burnout in medical students. The present study aimed to address these gaps in the literature.

Regrettably, it is not uncommon for medical students to let mental health issues experienced during medical school go unaddressed (Lomis, Carpenter, & Miller, 2009). The culture of medicine reinforces that medical professionals are invincible, and it is frowned upon to show signs of weakness (Wallace, Lemaire, & Ghali, 2009). Indeed, research has shown a direct link between the mental well-being of physicians and patient care, making physician wellness an indicator of healthcare system quality (Wallace et al., 2009). One example of this is the association between poor physician health and increased medical errors (Shanafelt, Dyrbye, & West, 2017). Conducting research on demographic predictors of mental health and burnout in medical students can contribute toward de-stigmatizing these issues and informing preventive efforts in at-risk groups (Spiker & Hammer, 2018), thus highlighting the importance of this study. This knowledge can benefit medical stakeholders in developing targeted programs to address issues concerning mental health and burnout in medical schools in order to optimize medical student mental health. This should be imperative as the pervasiveness of mental health issues beyond medical school ultimately affects the quality of care physicians provide (Dyrbye et al., 2005).

The present study

The aim of this study was to investigate demographic predictors of mental health and burnout in Canadian medical students. The primary objective was to examine how six common demographics (i.e., gender, ethnicity, age, level of education, year of study, and proposed specialty) predict mental health in medical students. It was hypothesized that medical students who are female, of ethnic minority, relatively older (i.e. > 30 years), have higher levels of education, are in third year of study, and are intending to pursue primary care (e.g. family medicine) would have lower levels of mental health (Compton et al., 2008; Dyrbye et al., 2012; Puthran et al., 2016; Tucker et al., 2017). A secondary objective was to examine whether or not these six predictors are similar between mental health and burnout. This was an exploratory purpose with no hypothesis.

Methodology***Research design***

The present study used a cross-sectional design. Data were collected using online surveys comprised of validated questionnaires. Approval from the Faculty of Medicine and ethical approval from X and Y University Research Ethics Boards (file reference numbers XX and YY) has been granted.

Participants and procedures

The population of interest was all medical students enrolled at two large Canadian universities. Inclusion criteria were that students must be in first to fourth year of study and comprehend English. The sample ($N = 141$) was obtained out of a possible 1140 enrolled and corresponded to a 12.4% response rate. This was expected as survey response rates are typically 10-15% for external researchers (Fryrear, 2015), such as with the present study, and is consistent with others (Blake, Stanulewicz, & McGill,

2017; Cecil et al., 2014; Wolf & Rosenstock, 2017). Further, our sample size was deemed sufficient as a power analysis indicated that 98 participants would be required to achieve a medium effect size with 80% power and six predictor variables in each regression model. Medical students in this sample ranged from 19 to 42 years of age ($M = 24.91$, $SD = 4.31$) and just over the majority were female (56.6%), which is representative of the Canadian medical student population (The Association of Faculties of Medicine of Canada, 2017). Table 1 provides additional sample characteristics.

INSERT TABLE 1

The survey was administered between November 2017 and January 2018 through the online platform SurveyMonkey, which follows recruitment methods of other mental health studies among medical students (Bore, Kelly, & Nair, 2016; Matheson et al., 2016). Survey links were distributed through medical student Facebook groups and e-newsletters as well as an in-class announcement for first year students at one university in November 2017; announcements were not approved by the Faculty of Medicine at the second university. Two follow-up reminders were sent in an effort to increase the response rate. All participants consented for their data to be used in this research.

The survey was purposefully administered mid-semester as it would give an adequate representation of medical students' usual mental health. Considering this, some students did not fill out the survey until after exams or until the next semester, thus responses were compared before and after December 25th to mark the end of term and start of holidays. This confirmed there were no differences in mental health or burnout. To promote participant safety with sensitive questions on mental health and burnout, contact information for psychological services were provided should

participants wish to access these services. Participants were given the opportunity to provide an e-mail address to enter in a prize draw to win a FitBit Alta.

Measures

Demographic measures

Six questions provided information on: gender (i.e., male, female, or other), ethnicity (i.e., White, Hispanic, Aboriginal Canadian, Black/African American, Asian, or other⁵), age, highest level of education to date (i.e., college degree, undergraduate-level degree, graduate-level degree, professional post-graduate degree, or other), year enrolled in medical school (i.e., first, second, third, or fourth), and medical specialty most likely to practice in the future (i.e., family medicine, internal medicine, surgery, pediatrics, or other). These are common categorizations of demographic variables based on previous studies with medical students (Compton et al., 2008; Dyrbye et al., 2007).

Mental health measure

The 14-item Mental Health Continuum Short Form (MHC-SF) was used to assess mental health according to three dimensions of well-being: emotional (3 items, e.g. “happy”), social (5 items, e.g. “that you belonged to a community”), and psychological (6 items, e.g. “that your life has a sense of meaning to it”) well-being (Lamers, Westerhof, Bohlmeijer, Klooster, & Keyes, 2011). Items are rated on a 6-point Likert scale assessing their frequency in the past month (0 = “never”, 1 = “once or twice”, 2 = “about once a week”, 3 = “about 2-3 times a week”, 4 = “almost everyday”, 5 = “everyday”). These items showed a very good internal consistency (Cronbach’s alpha = 0.91; Pallant, 2007). Similar to previous studies (van Dijk et al., 2017), total continuous mental health scores of 0-70 were used, with higher scores representing better mental health. Respondents were also categorized as flourishing, moderate, or languishing. Flourishing was indicated by feeling ≥ 1 emotional well-being symptom(s) “everyday”

or “almost everyday” (items 1-3) and ≥ 6 social or psychological well-being symptoms “everyday” or “almost everyday” (items 4-14). Languishing was indicated by feeling ≥ 1 emotional well-being symptom(s) “never” or “once or twice” (items 1-3) and ≥ 6 social or psychological well-being symptoms “never” or “once or twice” (items 4-14). Moderate mental health was indicated by scores that were neither flourishing nor languishing (Keyes, 2002). The MHC-SF is a highly utilized tool and has been confirmed as a valid and reliable instrument in measuring mental health (Lamers et al., 2011) and has been used in research with medical students (van Dijk et al., 2017).

Burnout measure

The two-item Maslach Burnout Inventory (MBI) has been adapted from the full 22-item MBI (Maslach, Jackson, & Leiter, 1996) and has been deemed to be valid and reliable. It is a widely utilized instrument for measuring EE, DP, and total burnout in medical students (Shanafelt et al., 2015; West, Dyrbye, Satele, Sloan, & Shanafelt, 2012). Responses for the two items, assessing EE and DP, are rated on a 7-point Likert scale (0 = “never”, 1 = “a few times a year or less”, 2 = “once a month or less”, 3 = “a few times a month”, 4 = “once a week”, 5 = “a few times a week”, 6 = “everyday”). Scores for EE and DP are added for a total burnout continuous score of 0-12; higher scores indicate higher levels of burnout. This scale showed an acceptable internal consistency (Cronbach’s $\alpha = 0.72$); however, as the number of items was small an inter-item correlation was run, which showed a strong correlation of 0.57 (Pallant, 2007). In line with previous medical student research using the two-item MBI, respondents were categorized as burned out if they responded “once a week” or more often to either of the EE and/or DP subscales (Dyrbye et al., 2014; West et al., 2012; West, Dyrbye, Sloan, & Shanafelt, 2009).

Data analysis

Data from the online surveys were downloaded from SurveyMonkey into Microsoft Excel 2013. Statistical analyses were performed using the statistical software package SPSS version 23 for Windows (IBM Inc., 2015).

Predictors of mental health in medical students

To address the first research question, correlation and multiple linear regression were used to identify predictors of mental health (continuous) ($n = 129$). As a secondary analysis multivariate logistic regression was used to assess differences according to mental health category (i.e. flourishing, moderate, and languishing). Categorical demographics were dichotomized for correlation (Table 3) and were dummy-coded for linear regression (reference groups: male gender, White ethnicity, college degree, first year of study, and family medicine). Differences were determined as significant at an alpha level of 0.05. Effect sizes for linear regression were reported using Cohen's f^2 (≥ 0.02 small effect, ≥ 0.15 medium effect, ≥ 0.35 large effect; Cohen, 1988) and for logistic regression were reported in odds ratios (OR). Post-hoc analyses to compute achieved power were run using GPower 3.1 (Erdfelder, Faul, & Buchner, 1996).

Comparing predictors of mental health and burnout in medical students

To address the second research question, all analyses were repeated using burnout in place of mental health. To test whether or not predictors of mental health and burnout were similar, standardized beta weights with 95% confidence intervals (CIs) were estimated using bias corrected bootstrapping (1000 resamples). Proportion overlap was assessed for overlapping CI arms of each pair of beta weights (Cumming, 2009). CIs with a proportion overlap of $< 50\%$ corresponded to $p < .05$ and a statistically significant difference (Cumming, 2009). Since the MBI-2-item is scored negatively (i.e.

higher scores indicate worse health) and the MHC-SF is scored positively (i.e. higher scores indicate better health), beta weights for burnout were reversed.

Results

Preliminary analyses

Preliminary analyses were performed to assess for violations of the assumptions of normality, homoscedasticity, independence of residuals, and collinearity. Outliers were removed from continuous mental health ($n = 3$) and burnout ($n = 6$) total scores. A missing values analysis was run showing that 8.64% of data were missing. Four cases were missing not at random and were removed (i.e. respondents skipped entire questionnaires). Little's MCAR test subsequently confirmed that some remaining data were missing completely at random ($X^2(106, N = 129) = 103.863, p = .541$), after which these data were imputed using Expectation-Maximization (Musil, Warner, Yobas, & Jones, 2002). There were no differences in mental health ($t = 1.037, p = .302$) or burnout ($t = 1.364, p = .175$) between those who responded before or after December 25th, indicating no response bias. A correlation matrix is presented in Table 2.

INSERT TABLE 2

Predictors of mental health in medical students

Results showed that the overall model explained 15.0% of the variance in mental health. Though this was not significant, $p = .120$, it showed a medium effect size (Cohen's $f^2 = 0.153$) with a power of 0.92. Third year of study was the only significant predictor ($\beta = -.243, p = .013$), indicating that being in third year significantly predicted lower mental health scores compared to being in first, second, or fourth year of study. Some responses were removed from the model due to elevated Mahalanobis values, including: Hispanic ($n = 1$), Aboriginal Canadian ($n = 1$), and Black/African American ethnicity

responses ($n = 4$), and 2-3 years undergraduate ($n = 3$) and post-graduate ($n = 5$) level of education responses.

Examination of demographic differences according to mental health category confirmed the first analysis. Multinomial logistic regression was run with all independent variables; however, ethnicity was removed due to singularity in multiple categories (Aboriginal Canadian and Black ethnicities). The subsequent model explained between 41.8% (Cox and Snell R^2) and 53.4% (Nagelkerke R^2) of the variance in mental health category, however it was not significant, $X^2 (64, N = 129) = 69.790, p = .289$. Year of study was the only significant predictor, with third year of study being a significant predictor of moderate compared to flourishing mental health ($p = .003$). Specifically, medical students who were in third year compared to fourth year were over thirty-nine times more likely to report moderate compared to flourishing mental health (OR = 39.200). No significant differences among any other demographics were found according to mental health categories.

Comparing predictors of mental health and burnout in medical students

Results showed three significant predictors that explained 32.7% of the variance in burnout, $p = <.001$, with a large effect size (Cohen's $f^2 = 0.366$) and a power of 0.99. Specifically, being female ($\beta = .242, p = .005$) significantly predicted higher burnout scores compared to being male (Figure 1), being in third year ($\beta = .391, p = <.001$) or fourth year ($\beta = .212, p = .023$) significantly predicted higher burnout scores compared to being in first year of study, and medical students of 'other' ethnicities⁵ ($\beta = .189, p = .028$) significantly predicted higher burnout scores compared to those of White ethnicity. Age approached significance ($\beta = -.166, p = .095$) indicating that those who were younger were more likely to have reported burnout. Congruent with the mental health regression model, Hispanic ($n = 1$), Aboriginal Canadian ($n = 1$), and

Black/African American ethnicity responses ($n = 4$) were removed due to small sample sizes and elevated Mahalanobis values. Both models are summarized in Table 3.

INSERT FIGURE 1 & TABLE 3

Examination of demographic differences according to burnout category partially confirmed the first analysis. The logistic regression model was significant, $X^2 (19, N = 129) = 35.790, p = .011$ and explained between 24.2% (Cox and Snell R^2) and 37.8% (Nagelkerke R^2) of the variance in burnout category. Third year of study significantly predicted burnout ($p = .001$), showing that medical students who were in third year compared to first year were over eleven times more likely to be burned out (OR = 11.467). Female gender approached significance ($p = .101$), indicating that female medical students were almost three times as likely to report burnout compared to male medical students (OR = 2.665). No significant differences were found according to burnout categories among any other demographics.

Proportion overlap tests using Cumming's (2009) parameters showed a significant difference for gender (proportion overlap < 0.50, $p < .05$), indicating that female gender positively predicted burnout but did not predict mental health. 'Other' ethnicity⁵ similarly predicted mental health and burnout (proportion overlap > 0.50, $p > .05$), indicating that although 'other' ethnicity positively predicted burnout, it was not statistically significantly different from its relation to mental health. Second and third year of study similarly predicted mental health and burnout (proportion overlap > 0.50, $p > .05$), indicating that mental health outcomes paralleled burnout outcomes within each year of study (i.e. higher mental health plus lower burnout scores in second year and lower mental health plus higher burnout scores in third year). Finally, a significant difference was found for fourth year of study (proportion overlap < 0.50, $p < .05$), indicating that fourth year positively predicted mental health and negatively predicted

burnout (Figure 2). Age, level of education, and proposed specialty were not significant predictors of mental health or burnout, thus comparisons were not made. Table 4 shows all calculations.

INSERT FIGURE 2 & TABLE 4

Discussion

This study was the first to examine a combination of demographic predictors of mental health in medical students in a single study, which is a strength as most have focused on predictors of mental illness using fewer demographics (Compton et al., 2008; Shariati, Yunesian, & Vash, 2007). This research was also the first to compare predictors of mental health and burnout in medical students. Importantly, this research examined mental health instead of mental illness thus supporting a positive shift from treatment to prevention (Kiziela, Viliūnienė, Friberg, & Navickas, 2018).

Confirming our hypotheses, female medical students reported greater levels of burnout than male medical students, which supports previous work (Dyrbye & Shanafelt, 2016; Fares et al., 2016). A systematic review stated that female physicians can burnout as a result of fulfilling multiple family and work roles (Azam, Khan, & Alam, 2017). Women in medicine tend to spend more time with patients (Dahrouge et al., 2016) and face more sexual harassment (Jagsi, 2018). For instance, 30% of female medical faculty have reported sexual harassment compared to 4% of male faculty (Jagsi et al., 2016). Many of these women feel trapped due to the culture of silence and fear of reporting harassment (Holroyd-Leduc & Straus, 2018). Likewise, more female medical students have reported verbal or sexual abuse than male medical students (Dyrbye et al., 2005), which can contribute to exhaustion.

Comparatively, mental health was similar between female and male medical students. While spending more time with patients contributes to burnout, it may

improve well-being via compassion, for instance. Further, it is possible to experience high levels of burnout yet still feel happy, socially competent, and psychologically fulfilled (Payton, 2009). Future qualitative research with women in medicine should investigate how more family responsibilities and more time with patients contributes to burnout compared to mental health.

Medical students of ‘other’ ethnicities⁵ reported higher burnout than medical students of White ethnicity. This corroborates other studies, where some minority medical students reported feeling that their race had negatively impacted their education due to racial discrimination and cultural dissimilarities (Dyrbye et al., 2006b; Dyrbye et al., 2007). Despite action taken toward improving multiculturalism in Canadian universities over the past two decades, there remains a need to improve cultural safety (Hunt, 2013) and multicultural sensitivity (Friesen, 2014). Future research should study differences in cultural upbringing that may impact feelings of exhaustion, detachment, and burnout within North American medical school culture.

As expected, third year of medical school significantly predicted lower mental health and higher burnout scores, which supports previous systematic reviews (Dyrbye et al., 2006c; Erschens et al., 2018). Third year of study involves transitioning from classroom to clerkship and medical students have reported greater patient responsibility and time constraints, leading to more frequent poor mental health days and higher burnout compared to other years of study (Compton et al., 2008; Kligler, Linde, & Katz, 2013). Interestingly, our findings showed that mental health was lowest in third year and highest in fourth year but that burnout was high in both third and fourth year. This suggests that medical students may learn to cope with stressors by fourth year, but that burnout symptoms may persist over the clerkship years. A review found burnout prevalence to be high among fourth year medical students, supporting that burnout

symptoms may carry from clerkship into residency (Dyrbye & Shanafelt, 2016). This is in line with Keyes' Dual Continua Model (2014) which helps to explain how medical students can be flourishing and burned out simultaneously. Lastly, moderate levels of mental health were reported by 70% of third year students, which is concerning as less than flourishing mental health can diminish psychosocial health (Keyes, 2014) and patient care (Wallace et al., 2009). Interventions (e.g. walking groups, yoga, or mindfulness programs) could be designed for second year medical students to prevent burnout in third and fourth year and changes to the medical curriculum as a whole could also be considered.

Limitations and future directions

As with any research, there were limitations. The main limitation of this study was its cross-sectional design as no causality was determined. Other limitations included generalizability as only two of the seventeen medical schools in Canada were surveyed as well as the small sample size as this can lead to bias. Future studies should follow a cohort of medical students at a larger number of Canadian medical schools to measure changes in mental health and burnout longitudinally.

Conclusion

This study investigated demographic predictors of medical student mental health and burnout, indicating that third year of study negatively predicted mental health and positively predicted burnout, and female gender, 'other' ethnicities, and fourth year of study positively predicted burnout. Practically speaking, this research can impart knowledge to medical stakeholders in targeting medical students at-risk for poor mental health and burnout. Preventive efforts should target female, minority ethnicity, and second year medical students, while treatment efforts should target third and fourth year medical students (Daya & Hearn, 2018). This study will inform future research on

improving mental health and burnout in future physicians who are a crucial piece to our healthcare system.

Declaration of interest statement

No potential conflict of interest was reported.

Footnotes

1. Emotional exhaustion is characterized by increased fatigue, or feeling worn out as a result of one's work (Maslach & Leiter, 2016).
2. Depersonalization is characterized by withdrawal, and negative attitudes toward patients (Maslach & Leiter, 2016).
3. Lack of personal accomplishment is characterized by reduced productivity and confidence in one's work (Maslach & Leiter, 2016).
4. Gender was used dichotomously (male, female) as one participant identified as transgender female-to-male.
5. 'Other' ethnicities included: South Asian, Jewish, Sri Lankan, Iranian, North African, Arab, European, Bengali Canadian, Mediterranean, Han, and Asian-Caucasian.

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List of TablesTable 1. Mental health, burnout, and demographic characteristics of first to fourth year medical students ($n = 129$).

		<i>n</i>	<i>(%)</i>
Mental health	Languishing	3	(2.3)
	Moderate	48	(37.5)
	Flourishing	77	(60.2)
Burnout	Burnout out	27	(20.9)
	Not burned out	102	(79.1)
Demographics			
Gender	Male	55	(42.6)
	Female	73	(56.6)
	Other	1	(0.8)
Ethnicity	White	75	(58.1)
	Hispanic	1	(0.8)
	Aboriginal Canadian	1	(0.8)
	Black or African American	4	(3.1)
	Asian	33	(25.6)
	Other ⁵	14	(10.9)
	NR	1	(0.8)
Age	19-24	76	(58.9)
	25-30	40	(31.0)
	31-36	9	(6.9)
	≥37	4	(3.1)
Level of Education	College degree	17	(13.2)
	Bachelor's degree	63	(48.8)
	Graduate level degree	35	(27.1)
	Post-graduate level degree	5	(3.9)
	Some university (2-3 years undergraduate)	3	(2.3)
	Other	6	(4.7)
Year of Study	First	62	(48.1)
	Second	31	(24.0)
	Third	20	(15.5)
	Fourth	16	(12.4)
Proposed Specialty	Family medicine	31	(24.0)
	Internal medicine	27	(20.9)
	Surgery	23	(17.8)
	Pediatrics	14	(10.9)
	Other	34	(26.4)

NR = non-response

Table 2. Correlations between demographics, mental health, and burnout in medical students ($n = 129$).

Demographics¹	<i>N</i>	Mental Health		Burnout	
		<i>r</i>	<i>p</i>-value	<i>r</i>	<i>p</i>-value
Gender	128	-.009	.924	.252	.005**
Ethnicity	128	-.072	.423	.007	.943
Age	129	.051	.573	-.070	.440
Level of Education	129	-.010	.915	.078	.393
Year of Study	129	-.028	.755	.332	.000**
Proposed Specialty	129	.075	.414	-.012	.899

** $p < .01$

¹ Categorical demographics with ≥ 3 groups were collapsed into two categories for bivariate correlation as follows: ethnicity (White, non-White), year of study (first and second year, third and fourth year), level of education ($\leq$ bachelor's degree, $\geq$ master's degree), and proposed specialty (primary care, non-primary care)².

² Primary care includes: family medicine, internal medicine, and pediatrics. Non-primary care includes: surgery and other. Typed responses in the 'other' category were examined to ensure they did not fall into any other response choice.

Table 3. Results from multiple linear regression of predictors of mental health and burnout.

	Mental health			Burnout		
	<i>F</i> -value	<i>df</i>	<i>p</i> -value	<i>F</i> -value	<i>df</i>	<i>p</i> -value
Full model	1.523	13, 112	.120	4.078	13, 109	< .001**
Demographics (in the full model)						
		<i>β</i>	<i>p</i> -value		<i>β</i>	<i>p</i> -value
Gender (female)		.040	.667		.242	.005**
Ethnicity						
White		-	(reference)			(reference)
Asian		-.035	.708		-.087	.306
Other		.007	.939		.189	.028*
Age		.057	.605		-.166	.095†
Level of education						
Bachelor degree		.134	.234		-.142	.162
Graduate level degree		-.037	.760		.165	.136
Year of study						
1st year		-	(reference)			(reference)
2nd year		.015	.879		.043	.629
3rd year		-.243	.013*		.391	.000**
4th year		.152	.138		.212	.023*
Proposed specialty						
Internal medicine		.161	.149		-.025	.803
Surgery		.163	.140		-.016	.870
Pediatrics		-.012	.910		-.025	.795
Other		-.003	.979		-.010	.918

* $p < .05$ ** $p < .01$ † approached significance at $p < .10$

Table 4. Results from testing the difference between 95% confidence intervals (CI) of two beta (β) weights.

Demographic		Lower bound CI	Standardized β	Upper bound CI
Female gender	Mental health	-.145	.040	.226
	Burnout	-.409	-.242	-.074
	Calculations:	$.226 - .040 = .186$ $-.242 - (-.409) = .166$ $M = (.186 + .166)/2$ $= .177$ <i>POL of 0.5:</i> $= .177(0.5)$ $= .0885$ $-.145 + .0885 = -.057$ $-.074 < -.057 \therefore POL < 50\%$ at $p < .05^*$ (predictors are different)		
'Other' ethnicity	Mental health	-.180	.007	.194
	Burnout	-.358	-.189	-.020
	Calculations:	$.194 - .007 = .187$ $-.189 - (-.358) = .169$ $M = (.187 + .169)/2$ $= .178$ <i>POL of 0.5:</i> $= .178(0.5)$ $= .089$ $-.180 + .089 = -.091$ $-.020 > -.091 \therefore POL > 50\%^{\ddagger}$ (predictors are similar)		
2 nd vs. 1 st year	Mental health	-.179	.015	.209
	Burnout	-.218	-.043	.132
	Calculations:	$.209 - .015 = .194$ $-.043 - (-.218) = .175$ $M = (.194 + .175)/2$ $= .1845$ <i>POL of 0.5:</i> $= .1845(0.5)$ $= .09225$ $-.179 + .09225 = -.08675$ $.132 > -.08675 \therefore POL > 50\%^{\ddagger}$ (predictors are similar)		
3 rd vs 1 st year	Mental health	-.435	-.243	-.052
	Burnout	-.564	-.391	-.218
	Calculations:	$-.052 - (-.243) = .191$ $-.391 - (-.564) = .173$ $M = (.191 + .173)/2$ $= .182$ <i>POL of 0.5:</i> $= .182(0.5)$ $= .091$		

$-.435 + .091 = -.344$
 $-.218 > -.344 \therefore POL > 50\%^{\ddagger}$ (predictors are similar)

4 th vs 1 st year	Mental health	-.049	.152	.353
	Burnout	-.393	-.212	-.030
Calculations:				
		$.353 - .152 = .201$		
		$-.212 - (-.393) = .181$		
		$M = (.201 + .181)/2$		
		$= .191$		
		$POL \text{ of } 0.5:$		
		$= .191(0.5)$		
		$= .0955$		
		$-.049 + .0955 = .0465$		
		$-.030 > .0465 \therefore POL < 50\%^{*}$ (predictors are different)		

* $p < .05$ (POL of $< 50\%$ indicating one beta weight was significantly larger than the other)

$\ddagger$ Not statistically significant ($p > .05$), thus confirming that the predictor variable similarly predicted mental health and burnout.

POL = proportion overlap (Cumming, 2009).

List of Figures

Figure 1. Differences in medical student burnout based on gender (*n* = 129).

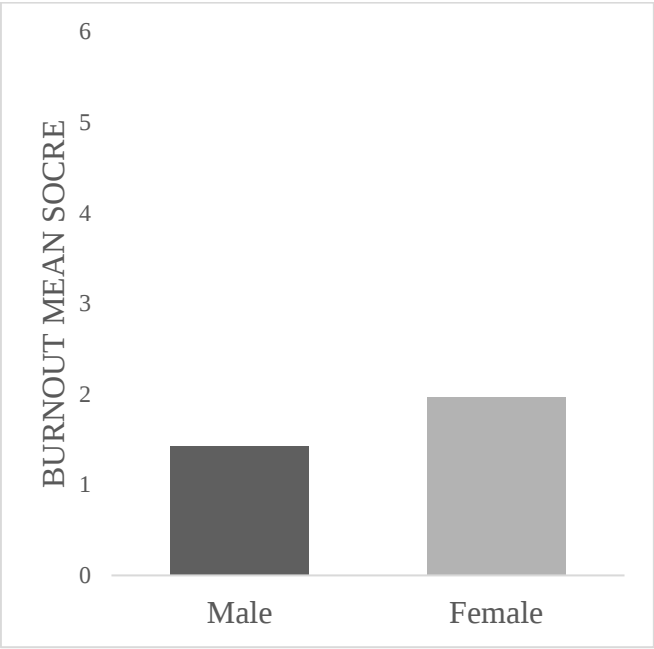
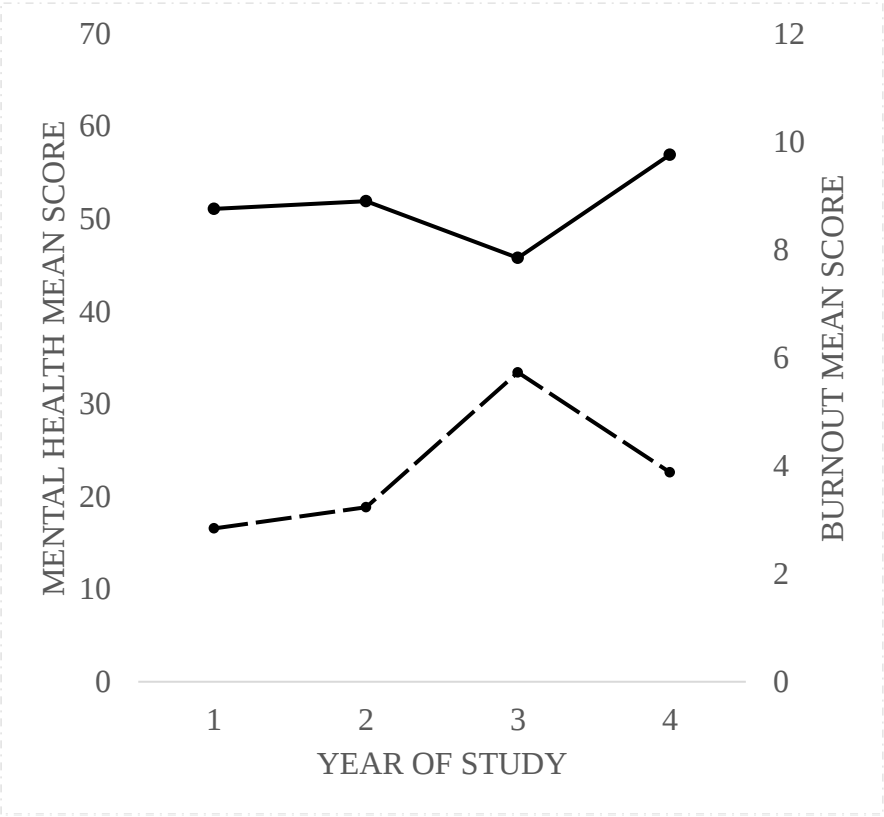


Figure 2. Differences in mental health and burnout between years of study in medical students (*n* = 123).



Legend: — Mental health
- - - Burnout

**Are medical students burning out because they do not rest? An examination of how
physical activity and sitting influence burnout in medical students**

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Abstract

Background: Medical school is a challenging endeavour involving heavy workload, high expectations, and a competitive residency application process. These contributing factors put some medical students at-risk for burnout. Physical activity and sedentary behaviour are two modifiable risk factors; however, there is a paucity of research assessing how they relate to burnout in medical students. Specifically, less is known regarding the relationships between different intensities of physical activity (mild, moderate, and vigorous), sitting, and burnout in medical students, who may actually benefit from a break in the many activities they participate in. **Objective:** This study aimed to investigate how mild, moderate, vigorous, and total physical activity, and sitting predicted medical student burnout, and how moderate-to-vigorous physical activity moderated the relationship between sitting and burnout. **Methods:** Medical students ($N = 129$) completed online validated questionnaires assessing physical activity, sitting, and burnout. **Results:** Regression analyses indicated that mild physical activity ($\beta = -.191, p = .039$) and sitting ($\beta = -.230, p = .013$) negatively predicted burnout. Moderate-to-vigorous physical activity did not significantly moderate the relationship between sitting and burnout. **Conclusions:** Results of this study contrasted previous literature and can inform stress management and wellness programs for medical students aimed at preventing burnout.

Word Count: 200 words

Medical school is a challenging endeavour involving heavy workload, high competition, and high expectations.¹ As such, medical students participate in many activities in aims of matching to their preferred residency program. These contributing factors put medical students at high risk for psychological distress, such as burnout. Burnout is a psychological syndrome that arises in response to the ongoing stressors of a workplace environment.² It has three dimensions: emotional exhaustion (EE), characterized by feeling emotionally drained; depersonalization (DP), characterized by feelings of cynicism; and a lack of personal accomplishment, characterized by feelings of inaptitude.² Concerning medical students, burnout prevalence is higher than age- and education-matched peers in the general population (50% versus 36%).³

Given its consistent links with mental health,^{4,5} physical activity (PA) is one factor that may impact medical student burnout. One study found that medical students who met American nationally recommended PA guidelines of 150 minutes of moderate or 60 minutes of vigorous PA per week reported lower levels of burnout, suggesting that PA is a modifiable risk factor for burnout.⁶ Moreover, research with the general population has reported associations between different intensities of PA (i.e. mild, moderate, and vigorous) and burnout.⁷⁻⁹ For instance, studies have found the frequency of high (e.g. vigorous) and low (e.g. mild) intensity PA to be negatively associated with burnout in working adults.^{8,9} In comparison, another study reported a U-shaped relationship between frequency of high intensity PA and burnout, with high intensity PA once or twice a week being associated with lower levels of burnout in sedentary working adults compared to higher (i.e. more than twice a week) or lower (i.e. once a month) frequencies.⁷ This demonstrates that vigorous PA no more than one to two times per week, and mild PA overall may reduce burnout, but that insufficient or excessive amounts of PA may increase burnout.⁸ Still, it is still unclear which PA intensity is best for burnout. Further, none of

these studies were conducted in medical students who may show different relationships between PA intensities and burnout given the many demands of medical school. One of the purposes of this study is to examine these relationships.

The impact of sedentary behaviour on health appears to be gaining equal recognition to that of PA.^{10,11} Sedentary behaviour has been defined as any waking behaviour in which energy expenditure does not exceed resting level,¹⁰ such as sitting during class, studying for an exam, or watching television. Canadian sedentary behaviour guidelines for adults are currently in development, as part of the new 24-Hour Movement Guidelines.^{12,13} Thus, clear recommendations for defining low and high sedentary behaviour for adults have not yet been established, unlike the Canadian PA guidelines of 150 minutes of moderate-to-vigorous PA (MVPA) per week.¹² Nonetheless, research has predominantly found that risk for ill health, such as cardiovascular disease or psychological distress, increases as sedentary behaviour increases.^{11,14,15} In regards to burnout, one study found that decreases in sedentary behaviour were associated with lower levels of psychological distress (i.e. burnout).¹⁴ However, this study was not conducted in medical students, who are unique to the general population.

Medical students often become involved in extra-curricular activities in addition to their substantial workload to improve their curriculum vitae (CV) and increase their chances of matching to their preferred residency program.¹⁶ For instance, a recent residency application guide recommended that medical students should include eleven key areas on their residency application CV, such as research, teaching, and community involvement.¹⁷ Medical students may be spreading themselves too thin by trying to fulfill these expectations. As such, and pertaining to their increased risk for burnout, medical students may actually benefit from a break to rest amid the many activities they participate in. This study is innovative in its investigation of sitting

hours, the most common form of sedentary behaviour,¹⁵ and burnout in medical students as no studies to our knowledge have examined this and it could inform sitting recommendations for medical students. Moreover, it is important to assess whether or not the strength of the association between sitting and burnout differs across MVPA levels as a recent meta-analysis identified a need to explore this interaction, specifically at higher levels of MVPA.¹¹ Considering Canada's 24-Hour Movement Guidelines,¹³ this study takes a forward-thinking approach by examining the interaction of MVPA and sedentary behaviour on medical student burnout.

Ample research, including meta-analyses, has shown the positive link between PA and mental health in clinical and nonclinical populations^{18,19}; however, less is known about the relationship between PA and burnout, particularly in medical students. Further, no study that we could identify has examined the relationships between different intensities of PA (i.e. mild, moderate, and vigorous), sitting, and burnout in medical students and no research has looked at how the interaction between MVPA and sitting influences medical student burnout. The present study will address these key gaps so we may better understand these contributing factors, which can have consequences for medical students during medical school and as they move into residency and physician-hood.

Without proper support, burnout experienced during medical school has been found to persist into medical practice.²⁰ Consequences of physician burnout include an increased likelihood of medical errors and decreased productivity.^{21,22} Regarding personal implications, burnout has been shown to lead to more severe outcomes like substance abuse and suicidal ideation,²⁰ and have economic implications on the health system. For example, the estimated cost of lost productivity and early retirement from burnout in Canadian physicians is \$213 million per year.²³

This study aimed to examine the relationships between mild, moderate, vigorous, and total PA, sitting hours and burnout in first to fourth year medical students. The first purpose was to assess the relationship between total PA and burnout in medical students. Our hypothesis was that total PA would have a negative relationship with burnout.⁶ The second purpose was to examine the relationships between mild, moderate, and vigorous PA, sitting, and burnout in medical students. Our second hypothesis was that mild, moderate, and vigorous PA, and sitting hours would have negative relationships with burnout.^{8,9} The third purpose was to investigate how MVPA moderates the relationship between sitting and burnout in medical students. Our third hypothesis was that the relationship between sitting and burnout would be stronger among medical students who engage in higher levels of MVPA.^{7,11}

Methods

Study Design

This research is part of a larger study titled “Health Behaviours and Prescribing Habits of First to Fourth Year Medical Students” (unpublished data, 2018). Therefore, this study aimed to examine the links between medical students’ PA (mild, moderate, vigorous, and total PA) and burnout. Mental health, as well as demographic variables not listed in the current study, have been presented in another manuscript (unpublished data, 2019). The present study was cross-sectional, using a survey of validated questionnaires. Data were collected via an online survey using the platform SurveyMonkey.

Participants and Recruitment

The target population included all medical students enrolled at two large Canadian universities, whereby eligible participants were medical students who were enrolled in first to fourth year and comprehended English. There were no exclusion criteria. Following ethical approval from X and

Y Universities and from the Faculty of Medicine, links to the online survey were distributed to all medical students through medical student Facebook groups and weekly e-newsletters, and an announcement was made during a mandatory class. The response rate was 12.4% (141 medical students responded to the survey out of a possible 1140). Given that the researchers were not medical students and were not affiliated with either institution, this response rate was expected.²⁴ Informed consent was obtained from all participants included in the study.

Procedures

The survey was conducted between November 2017 and January 2018. It was initiated mid-semester as it would be more indicative of medical students' typical PA habits or feelings of burnout than the beginning or end of the semester. However, two follow-up reminders were sent mid-December and mid-January to increase the response rate; thus, some responses were collected over the exam period and at the start of the winter semester. To ensure no response bias, early (before December 25th) and late responders (after December 25th) were compared, yielding no significant differences in burnout ($t = 1.364, p = .175$), PA levels ($t = 1.265, p = .208$), or sitting ($t = -.608, p = .545$). December 25th was chosen as a cut-off date as it signified the end of classes and exams and the start of holidays. Given the sensitivity of questions related to burnout, contact information for urgent or non-urgent psychological services was provided. Participation was strictly voluntary; however, participants were incentivized with the choice to provide their e-mail address for eligibility in a prize draw to win a FitBit Alta.

Measures

Physical Activity Measure

The Godin Leisure Time Exercise Questionnaire (LTEQ) was used to assess the frequency, duration, and intensity of leisure time PA.²⁵ This scale has been thoroughly validated²⁵ and has

been used with medical students.^{26,27} Participants reported how many “times per week” (i.e. frequency) and “average minutes per session” (i.e. duration) they engaged in mild, moderate, and vigorous PA over a typical seven-day period. Each frequency is multiplied by its respective Metabolic Equivalent Task (MET) value [i.e. (3 x mild); (5 x moderate); (9 x vigorous)] giving a weighted, summed leisure score index (LSI) for each intensity (mild, moderate, and vigorous).²⁸ Total PA is the total sum of the three LSI values. MVPA is the sum of the (frequency x duration) for moderate PA and vigorous PA.

Sitting Measure

Participants were asked, “how many hours per day do you spend sitting on a typical weekday?” This question has been used to assess sedentary behaviour in prior research.¹⁴ Possible responses ranged from 0-24 hours for a continuous score.

Burnout Measure

The two-item Maslach Burnout Inventory (MBI) was used to assess burnout. It is a widely utilised tool in burnout research among medical professionals, including medical students.^{3,29} It was adapted from the 22-item MBI and has been deemed a valid and reliable instrument for measuring EE, DP, and total burnout in medical students.^{30,31} The two responses assess EE and DP and are scored on a 7-point Likert scale (“never” to “everyday”) for a continuous score of 0-6 per item. Total burnout is the sum of these two scores, giving a continuous score of 0-12 with higher scores indicating higher levels of burnout. This measure showed a good internal consistency (Cronbach’s alpha = 0.72) and the inter-item correlation was strong at 0.57.³²

Statistical Analysis

All data from the online surveys were downloaded from SurveyMonkey into Microsoft Excel 2013 and analyses were performed using the statistical software package SPSS 23 for

Windows.³³ Preliminary analyses showed no violation of any of the assumptions of normality, linearity, homoscedasticity, collinearity, or homogeneity of variances.³² Correlation analyses were run to determine the strength and direction of relationships between continuous variables. Relationships were deemed significant at an alpha level of 0.05. Effect sizes are reported as Cohen's f^2 (≥ 0.02 small effect, ≥ 0.15 medium effect, ≥ 0.35 large effect)³⁴. To determine achieved power, post-hoc analyses were run using GPower 3.1.³⁵

Total Physical Activity as a Predictor of Burnout

To address the first research question, a linear regression was run to assess the predictive strength of total PA per week (total LSI value; continuous independent variable) on burnout (continuous dependent variable).

Mild, Moderate, and Vigorous Physical Activity, and Sitting as Predictors of Burnout

To address the second research question, a multivariate linear regression was conducted to assess the predictive strength of minutes of mild, moderate, and vigorous PA per week, and sitting hours per day (continuous independent variables) on burnout (continuous dependent variable). Some responses ($n = 11$) for sitting hours were reported in minutes per day rather than hours per day and were converted (e.g. 540 minutes = 9 hours).

Moderate-to-Vigorous Physical Activity as a Moderator between Sitting and Burnout

To address the second research question, a moderated linear regression was performed to examine how total MVPA minutes per week moderated the relationship between sitting hours per day (continuous independent variables) and burnout (continuous dependent variable).

Results

Less than nine percent (8.22%) of data were missing from the full sample. Cases with entire questionnaires missing were removed ($n = 12$), giving the final sample ($n = 129$). A power

analysis was run showing that a sample size of 85 would be needed to achieve 80% power with a medium effect size and four predictor variables, thus our sample size was deemed sufficient for all models. Some data were found to be missing completely at random using Little's MCAR test ($X^2 = 394.126$, $p = .056$), thus Expectation-Maximization was chosen as an imputation method.³⁶ Outliers were removed for the following variables: MVPA ($n = 7$), mild PA ($n = 8$), moderate PA ($n = 7$), vigorous PA ($n = 4$), sitting ($n = 6$), and burnout ($n = 6$).

INSERT TABLE 1

Sample Characteristics

Table 1 describes the characteristics of medical students in this sample. Medical students in this sample were 25 years old on average ($M = 24.91$, $SD = 4.31$) and just over half were female (56.6%), which is consistent with national medical student data.³⁷ Descriptive statistics indicated that 21% of medical students had high levels of burnout. Table 2 shows a comparison of minutes of mild, moderate, vigorous and total PA per week and sitting hours per day according to medical students who were burned out versus not burned out.

INSERT TABLE 2

Total Physical Activity as a Predictor of Burnout

The full regression model was not significant, $F(1, 121) = 1.372$, $p = .244$, and explained 1.1% of the variance in burnout, showing a negligible effect size (Cohen's $f^2 = 0.011$) and low power (0.21). Nevertheless, and in line with the hypothesis, the relationship between total PA and burnout was negative ($\beta = -.106$), with medical students achieving higher levels of PA reporting lower levels of burnout.

Mild, Moderate, and Vigorous Physical Activity, and Sitting as Predictors of Burnout

The full model was significant, $F(4, 110) = 3.604, p = .008$, and explained 11.6% of the variance in burnout, approaching a medium effect size (Cohen's $f^2 = 0.118$) and showing a power of 0.88. Minutes of mild PA and sitting hours were identified as two significant predictors. Sitting hours was the strongest negative predictor of burnout ($\beta = -.226, p = .015$), indicating that medical students who spent fewer hours sitting per day reported higher levels of burnout. Minutes of mild PA per week was also a negative predictor of burnout ($\beta = -.191, p = .040$), indicating that medical students who engaged in fewer minutes of mild PA per week reported higher levels of burnout. Furthermore, minutes of moderate PA per week approached significance ($\beta = .161, p = .080$), suggesting that medical students who engaged in more minutes of moderate PA per week tended to report higher burnout, though not significantly. Minutes of vigorous PA per week was not a significant predictor in the model ($\beta = -.004, p = .967$). A correlation matrix is presented in Table 3.

INSERT TABLE 3

Moderate-to-Vigorous Physical Activity as a Moderator between Sitting and Burnout

Results from the moderated regression showed that the full model, with interaction, was significant, $F(3, 112) = 2.842, p = .041$, and accounted for 7.1% of the variance in burnout, showing a small effect size (Cohen's $f^2 = 0.071$) and an adequate power (0.77). This explained an additional 0.2% in burnout variance compared to the model without interaction ($R^2 = 6.9\%$). There was a non-significant main effect for MVPA ($p = .459$) but a significant main effect for sitting hours ($\beta = -.247, p = .008$). MVPA did not significantly moderate the relationship between sitting hours and burnout ($p = .689$). Visual inspection of regression slopes across low, moderate, and high levels of MVPA indicated that the relationship between sitting and burnout

was the strongest among medical students who engaged in high levels of MVPA (> 300 mins/week), while this relationship was the weakest among medical students who engaged in moderate levels of MVPA (150 to 300 mins/week; Figure 1).

INSERT FIGURE 1

Discussion

This study examined how mild, moderate, vigorous, and total PA, and sitting predicted burnout and examined the interaction of MVPA and sitting on burnout in medical students. Interestingly, findings pointed to a benefit of gentler PA and taking breaks on medical student burnout, supporting a progressive viewpoint relating PA and rest to medical students' psychological functioning. This study has many contributions as it provided novel insight on the relationship between PA intensity and medical student burnout, and offered key knowledge on sedentary behaviour and medical student burnout. These contributions are important as previous studies have only examined PA intensity in the general population, finding mixed results,^{7,8} and research on sedentary behaviour and psychological distress has not targeted medical students.¹⁴

The relationship between total PA and burnout was not significant, therefore our first hypothesis was not confirmed. However, descriptive statistics showed that burned out medical students reported more minutes of PA per week than those who were not burned out, which is supported by previous work.²⁶ While it is clear that all types of PA can benefit physical health,³⁸ the literature related to PA and burnout is less clear and warrants further research.

Our second hypothesis was that mild, moderate, and vigorous PA, and sitting would each be inversely related to burnout, and it was partially supported. Aligning with our hypothesis, minutes of mild PA per week was the only PA intensity that significantly predicted burnout, showing that engaging in more mild PA was associated with less burnout. In line with this,

Jonsdottir et al.³⁹ found that adults who engaged in mild PA at least two hours per week were at a lower risk for burnout at two-year follow up compared to both those who engaged in MVPA and those who were sedentary. Similarly, research has found an inverse relationship between yoga and state anxiety,⁴⁰ indicating that mild forms of PA are at least equally important for psychological health compared to higher intensities. Further, our findings that mild PA was a significant predictor of burnout, whereas vigorous PA was not, may be attributed to the high activity levels of medical students in this sample (64.4% met the Canadian guidelines for MVPA¹²). Thus, engaging in mild PA on top of sufficient MVPA may have provided unique benefits to burnout for these medical students.

Moderate PA approached significance as a positive predictor of burnout, supporting that medical students who are engaging in too much higher intensity PA may be at an increased risk for burnout; however, this was not significant. It is possible that medical students who are more active at moderate intensities may be sitting less throughout the day, or may be engaging in these intense forms of PA in place of mild PA or rest. For instance, going for a run may displace intentions to relax or to go for a walk later in the day, in which that latter may actually provide greater psychological benefit. In line with this, Ekkekakis et al.⁴¹ found that more vigorous forms of PA were associated with lower levels of positive affect and pleasure and higher levels of negative affect and displeasure. Indeed, medical students with higher levels of burnout may already be expressing negative affect, and thus higher intensity PA may accentuate these feelings. Consequently, engaging in mild PA would allow medical students to be more active without furthering negative affect. Future experimental studies should examine the effects of PA intensity on affect among medical students who reported burnout.

A large cross-sectional study reported that individuals engaging in high volumes of exercise may be at-risk for obsessive characteristics, such as perfectionism.⁵ Perfectionism is common among medical students,⁴² shown by exceptional levels of dedication and the need to control one's environment, and is associated with medical student burnout.⁴³ Indeed, it has been reported that medical students who engage in PA tend to do so in more vigorous forms,⁴⁴ which was the case with our sample (Table 2), and could be seen as a way to attain perfection in PA. This was supported by a significant negative correlation between moderate and vigorous PA (Table 3). One limitation must be recognized here, which is the potential overlap in which PA intensities medical students reported engaging in. For instance, medical students may have reported vigorous PA as moderate PA. Nevertheless, the possibility of medical students displacing mild or moderate PA for vigorous PA upholds our inclination that medical students may be aiming for perfection in multiple areas and are spreading themselves too thin. Future research should consider perfectionism as a moderator of the relationship between PA and medical student burnout and should examine the effects of different PA intensities objectively. It is possible that milder forms of PA may benefit medical student burnout.

In line with our second hypothesis, sitting fewer hours per day significantly predicted higher levels of burnout. This was a novel finding, since there is no published literature reporting associations between sedentary behaviour and burnout in medical students. Sitting had a negative correlation with vigorous PA that approached significance, further suggesting that medical students may be overextending themselves by becoming involved in many endeavours. One study measured sedentary behaviour in residents⁴⁵ but did not include it in their regression analysis. Two thirds of these residents reported being sedentary for 14.4 hours/day,⁴⁵ which suggests they were sedentary for 6.4 hours or less on an average day, subtracting eight hours for

sleep. In comparison, approximately two thirds of our sample reported sitting nine hours or less per day, not including sleep. This is logical, as 72% of our sample were first and second year medical students who are in class-based learning, compared to third and fourth years who are in their clerkships. One study found a positive association between leisure time sedentary behaviour (e.g. socializing) and well-being in older adults,⁴⁶ suggesting a benefit of certain sedentary activities for psychological health. However, in the larger body of literature findings have almost exclusively reported that increasing sedentary behaviour negatively affects health.^{11,14,47} In contrast to this literature, our findings suggest that this may not be the case for medical trainees who are high-achieving and work in a culture that favours productivity over rest.

Finally, our third hypothesis was not confirmed as MVPA did not significantly moderate the relationship between sitting and medical student burnout. It may be that, since medical students were already highly active (Table 1), MVPA did not have a significant influence, but since medical students are a high-achieving and busy group, sitting less was more likely to influence their burnout. So, while PA is important for medical student burnout,⁶ it may be more beneficial for medical students to rest amidst their many academic and extra-curricular activities.

Investigation of moderated regression slopes across MVPA levels suggested a protective effect of MVPA against burnout in medical students who may not be taking needed breaks. Unlike previous research reporting that the harmful effects of high sedentariness on physical health (e.g. cardiovascular disease) may be mitigated by higher levels of PA,¹¹ we are proposing that the harmfulness of low sitting hours on medical student burnout may be attenuated with recommended levels of MVPA. Still, this finding was not significant and must be interpreted with caution. The associations between sitting, PA, and physical health in the general population

are well-known,^{11,47} but more research is needed to clarify the links between sitting, PA, and burnout in medical students.

Medical school culture is competitive and expects students to be well-rounded, empathetic, and to thrive academically.¹ Accordingly, they spend much time studying and may feel compelled to participate in clubs and other activities in aims of making the best impression. The residency matching process is a growing issue as the number of unmatched medical graduates remains high. Specifically, the proportion of unmatched Canadian medical graduates in the past decade has nearly increased fivefold.⁴⁸ This may drive medical students to partake in extra activities to enhance their CVs and, resultantly, why such low levels of sitting were found among some medical students in this study. Compared to a recent study among undergraduate university students where the average sitting time per day was ten hours,⁴⁹ the average sitting time among medical students in this study was found to be lower, at eight hours per day. By trying to do everything, medical students are putting themselves at risk for burnout as they are not giving themselves a break or time to recharge. Future qualitative research should explore how high expectations and the abundance of duties medical students face contribute to high PA, low sedentary behaviour, and burnout.

Limitations and Future Directions

While this research covered several novel topics, there were some limitations including the cross-sectional design, which cannot determine causal relationships, and the small sample size, which can lead to bias. Over-reporting of vigorous PA and under-reporting of total PA and sedentary behaviour have been found among university students,⁵⁰ which could be attributed to social desirability. Similar trends may have occurred in our sample as medical students' age ($M = 24.9$) was similar to that of Loney et al.'s⁵⁰ study ($M = 21.8$). Moreover, medical students who

enjoy PA may have been more inclined to participate, especially as the prize draw was for an activity tracking device (i.e. FitBit Alta). Our sample was highly active, engaging in a median of 5.5 hours of PA per week relative to a median of four hours per week in another sample of medical students.⁴⁴ However, high activity levels are common among medical students and the present sample was representative of the larger Canadian medical student population.³⁷ Another limitation was that we were unable to define how medical students spent their time sitting given the measure we used. Participants were asked about ‘sitting on weekdays’ and may have reported academic sitting (e.g. attending class, studying) rather than leisure (e.g. socializing). Future research should assess how mild, moderate, vigorous, and total PA, using objective measures (i.e. accelerometers), and different forms of sedentary behaviour influence burnout in the other fifteen medical schools in Canada, to improve generalizability.

Conclusion

The present study showed that mild PA and sitting negatively predicted burnout and that moderate PA approached significance in positively predicting burnout. Practically, this research can be applied in proactively targeting medical students through gentle PA programs in aims of preventing burnout, such as peer walking groups. This knowledge can inform program design, such as yoga, meditation, or mindfulness programs,^{51,52} to encourage medical students to take needed breaks and to promote a slower pace conducive to stress management. Preventing medical student burnout can reduce the economic burden on the health system⁵³ and can help to prevent physician burnout,²⁰ in turn promoting the well-being of physicians who will give better quality care to patients.

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Table 1. Frequencies of Demographics, Physical Activity, and Sitting in Medical Students ($N = 129$).

		<i>n (%)</i>
Gender	Male	55 (42.6)
	Female	73 (56.6.)
	Other	1 (0.8)
Year of study	1 st year	66 (48.1)
	2 nd year	31 (24.0)
	3 rd year	20 (15.5.)
	4 th year	16 (12.4)
Ethnicity	White	75 (58.1)
	Aboriginal Canadian	1 (0.8)
	Hispanic	1 (0.8)
	Black/African American	4 (3.1)
	Asian	33 (25.6)
	‘Other’ ^a	14 (10.9)
	<i>NR</i>	1 (0.8)
MVPA mins/week^b	< 150 mins/week	46 (35.7)
	150 to 300 mins/week	50 (38.8)
	> 300 mins/week	33 (25.6)
Sitting hours/day^c	0 to 5 hours/day	16 (12.4)
	6 to 9 hours/day	72 (55.8)
	≥ 10 hours/day	41 (31.8)

Abbreviations: PA = physical activity; *NR* = non-response; MVPA = moderate-to-vigorous physical activity

^a Ethnicities in the ‘other’ category included: South Asian, Jewish, Sri Lankan, Iranian, North African, Arab, European, Bengali Canadian, Mediterranean, Han, and Asian-Caucasian.

^b As per Canada’s PA guidelines recommending at least 150 minutes of MVPA per week,¹¹ respondents were categorized into insufficiently active (< 150 minutes of MVPA/week) and sufficiently active (≥ 150 minutes of MVPA/week), which previous work has validated.²⁶ As respondents were found to be very active, an additional cut-off of > 300 minutes of MVPA per week was used to classify respondents as “highly active”.

^c As per previous literature,¹² respondents were categorized into low (0-5 hours/day), moderate (6-9 hours/day), and high SB (≥ 10 hours/day).

Table 2. Mild, Moderate, Vigorous, and Total Physical Activity, Moderate-to-Vigorous Physical Activity, and Sitting in Medical Students According to Burnout Category ($N = 129$).

	Not burned out^a <i>n</i> = 102 (79.1%)	Burned out^a <i>n</i> = 27 (20.9%)	Total sample
	<i>M</i> (SD)	<i>M</i> (SD)	<i>M</i> (SD)
Total PA (LSI)	57.14 (26.02)	60.96 (24.83)	57.94 (25.73)
MVPA^b	198.64 (119.24)	239.20 (132.02)	206.95 (122.51)
Mild PA^b	139.50 (120.30)	149.81 (173.01)	116.52 (84.38)
Moderate PA^b	99.20 (114.28)	99.26 (81.41)	80.11 (63.12)
Vigorous PA^b	124.20 (116.12)	163.89 (135.08)	120.91 (102.51)
Sitting hours^c	8.36 (2.51)	6.70 (2.81)	8.01 (2.65)

Abbreviations: PA = physical activity; MVPA = moderate-to-vigorous physical activity; LSI = leisure score index: the frequency of each physical activity intensity multiplied by its respective Metabolic Equivalent Task (MET) value, whereby total LSI is the sum of these values [(vigorous x 9) + (moderate x 5) + (mild x 3)].²⁶

^a In the two-item MBI, burnout is categorized by a score on one or both items of ≥ 4 indicating experiencing emotional exhaustion and/or depersonalization “once a week” or more frequently.²⁹

^b Reported in minutes per week

^c Reported in hours per day

Table 3. Relationships between Mild, Moderate, Vigorous, and Total Physical Activity, Sitting, and Burnout in Medical Students ($N = 129$).

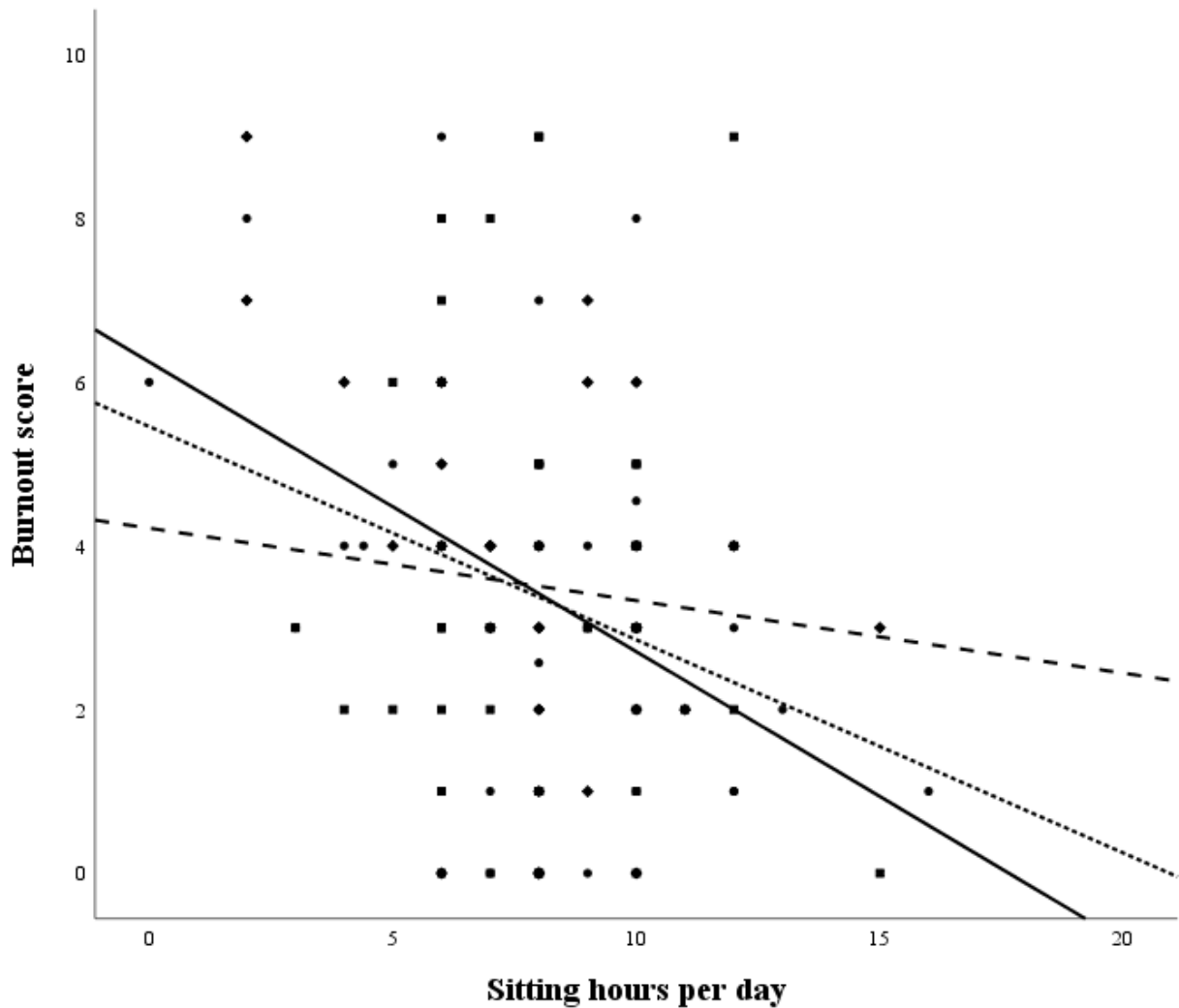
Scale	1	2	3	4	5	6	7	8	9	10
(1) Total LSI	-	.54**	.42**	.43**	.52**	.45**	.57**	.40**	.07	-.11
(2) Total MVPA		-	-.02	.04	.22*	.47**	.65**	.75**	-.13	.12
(3) Mild LSI			-	.67**	.23*	.16 [†]	-.08	-.14	.14	-.09
(4) Mild mins/wk				-	.06	.16 [†]	.06	-.05	.12	-.19*
(5) Mod. LSI					-	.68**	-.19*	-.16 [†]	.10	-.06
(6) Mod. mins/wk						-	-.002	-.01	-.02	.13
(7) Vig. LSI							-	.84**	-.14	.01
(8) Vig. mins/wk								-	-.16 [†]	.04
(9) Sitting hrs/day									-	-.26**
(10) Total burnout										-

* $p < .05$; ** $p < .01$; [†] approached significance at $p < .10$

Abbreviations: LSI = Leisure Score Index: the frequency of each physical activity intensity multiplied by its respective Metabolic Equivalent Task (MET) value, whereby total LSI is the sum of these values [(vigorous x 9) + (moderate x 5) + (mild x 3)].²⁶

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Figure 1. The Relationship between Sitting and Burnout across Levels of Moderate-to-Vigorous Physical Activity in Medical Students.



Legend: < 150 mins/week of MVPA; — — — 150-300 mins/week of MVPA; ——— > 300 mins/week of MVPA; ● < 150 mins/week of MVPA; ■ 150-300 mins/week of MVPA; ◆ > 300 mins/week of MVPA

CHAPTER V: SUPPLEMENTAL ANALYSIS

Leading research on burnout has reported different models of burnout since the 1980's, with some models proposing that emotional exhaustion (EE) precedes depersonalization (DP) in the manifestation of burnout, and other models proposing the opposite (Leiter & Maslach, 2016). It is a common misconception that burnout is predominantly measured as only EE, which neglects to show the full picture as DP provides unique information to the burnout experience (Leiter & Maslach, 2016). Thus, the purpose of the supplemental analysis was to examine the relationships between the six demographic variables (gender, ethnicity, age, year of study, level of education, and proposed specialty), the six behavioural variables (mild, moderate, vigorous, and total physical activity, sitting hours, and moderate-to-vigorous physical activity), and the two subscales of burnout (EE and DP), thereby complementing the findings of *Articles 1* and *2*.

Data were analysed through bivariate correlations. Results revealed some novel relationships (Table 1). Medical students who were in their third year, engaged in more minutes of moderate PA, and sat less reported higher levels of EE while medical students who were in their first year and had obtained a college degree reported lower levels of EE. Those who were of 'other' ethnicities, were in their third year, and sat less per day reported higher levels of DP while those who were of Asian ethnicity, were in their first year, and had a post-doctoral degree reported lower levels of DP. The associations between other demographic and behavioural variables, EE, and DP were non-significant. These findings will be discussed in greater detail in the General Discussion that follows.

Table 1. Correlations among demographic variables, behavioural variables, emotional exhaustion, and depersonalization.

Demographic variables (dichotomous) (dummy coded)	EE		DP	
	<i>r</i>	<i>p</i> -value	<i>r</i>	<i>p</i> -value
Gender (Male as reference group)	.136	.130	.050	.580
Ethnicity (White as reference group)	-.112	.216	-.105	.248
<i>White</i>	.106	.239	.113	.212
<i>Hispanic</i>	.049	.585	-.086	.345
<i>Aboriginal Canadian</i>	-.071	.428	-.086	.345
<i>Black/African American</i>	-.084	.354	-.051	.573
<i>Asian</i>	-.171	.056	-.238**	.008
<i>'Other' ethnicity</i>	.110	.224	.251**	.005
Age (continuous)	.001	.995	-.069	.451
Year of study (Year 1-2 as reference group)	.270**	.002	.332**	<.001
<i>First year</i>	-.289**	.001	-.225*	.012
<i>Second year</i>	.053	.554	-.083	.360
<i>Third year</i>	.367**	<.001	.352**	<.001
<i>Fourth year</i>	-.031	.729	.065	.475
Level of education (Undergraduate as reference group)	.017	.854	.002	.982
<i>College degree</i>	-.211*	.018	-.105	.246
<i>Bachelors degree</i>	.062	.491	.038	.674
<i>Graduate level degree</i>	.079	.384	.094	.300
<i>Post-doctoral degree</i>	-.135	.133	-.195*	.031
<i>'Some' undergraduate school (2-3 years)</i>	-.019	.830	-.051	.573
Specialty (Primary care as reference group)	-.024	.793	.004	.965
<i>Family medicine</i>	.066	.465	-.007	.937
<i>Internal medicine</i>	.040	.661	.048	.595
<i>Surgical specialties</i>	-.070	.438	-.039	.665
<i>Pediatric specialties</i>	-.022	.807	-.084	.356
<i>'Other' specialties</i>	-.027	.763	.049	.592
Behavioural variables (continuous)				
Total PA (LSI value)	.129	.152	-.016	.856
Mild PA mins/week	.034	.717	-.003	.976
Moderate PA mins/week	.194*	.035	.012	.898
Vigorous PA mins/week	-.027	.766	.024	.797
Sitting hours/day	-.197*	.028	-.235**	.005
MVPA mins/week	.092	.322	.089	.342

* $p < .05$ ** $p < .01$

PA = physical activity

CHAPTER VI: GENERAL DISCUSSION

The overarching purpose of this thesis was to investigate demographic predictors of mental health and burnout and behavioural predictors of burnout in first to fourth year medical students. *Article 1* examined and compared how six demographics (gender, ethnicity, age, year of study, level of education, and proposed specialty) predicted mental health and burnout in medical students. *Article 2* examined how mild, moderate, vigorous, and total physical activity (PA), and sitting predicted burnout in medical students and how moderate-to-vigorous PA (MVPA) moderated the relationship between sitting and burnout. This research utilised the Dual Continua Model (Keyes, 2014) and Maslach's burnout model (Maslach, Jackson, & Leiter, 1996) as guiding psychological frameworks. This chapter will discuss in detail the key findings, knowledge and practical implications, limitations, and future directions.

Summary and Implications

Investigating Demographic Predictors of Mental Health and Burnout

The first purpose was to investigate how six demographics (gender, ethnicity, age, year of study, level of education, and proposed specialty) predicted medical student mental health. Confirming our hypotheses, medical students in third year reported the lowest levels of mental health. The second purpose was to examine whether predictors were similar between mental health and burnout. In line with our hypotheses, medical students who were female, of 'other' ethnicities, and in third year reported the highest levels of burnout. As stated on pages 39 to 41, similar predictors were ethnicity, and second and third year and different predictors were gender and fourth year. Supplemental results showed that medical students who were: in third year reported higher emotional exhaustion (EE); in first year and had a college degree reported lower

EE; of 'other' ethnicities and were in third year reported higher depersonalization (DP), and; of Asian ethnicity, were in first year, and had a post-doctoral degree reported lower levels of DP.

Gender

While systematic reviews have shown female medical students to have higher levels of depression and anxiety (Dyrbye et al., 2006c; Hope & Henderson, 2014), no prior research had assessed gender as a predictor of mental health in Canadian medical students. We did not find mental health to be significantly different between male and female medical students. However, we found that female medical students reported higher burnout. In general it has been found that women are more likely to report a mental health problem while men have been shown to underreport these issues (National Institute of Mental Health, 2016). Perhaps, when questions were phrased positively for mental health, as opposed to negatively for burnout, male medical students reported more honestly and thus were more similar to female medical students in this regard. Along this line, male medical students have been found to be more private than female medical students, suggesting they may be less likely to share about their negative emotions (Meit, Borges, & Early, 2007).

Our finding of self-reported burnout levels being significantly higher among female medical students supports previous research (Dyrbye & Shanafelt, 2016; Muzafar et al., 2015); however, gender was not significantly associated with EE or DP. This was surprising given that it was a significant predictor of total burnout. One explanation could be that female medical students felt only slightly higher levels of EE and DP separately, but that this gap became significant when EE and DP were grouped. A recent study also found no significant links between medical student gender and EE or DP (McLuckie et al., 2018).

The higher levels of burnout reported by female medical students could be due to many contributing factors, one of these being personality. Compared to male medical students, female medical students have been found to be more sensitive, self-doubting, self-critical, perfectionistic, and driven (Meit et al., 2007), and less resilient (Peng et al., 2012), pointing to how some may over-strive and incur greater vulnerability to hardship. More recently, female medical students with maladaptive perfectionism were found to frequently self-criticize and negatively compare themselves to others, most often in the areas of academic performance and social interactions (Chand, Chibnall, & Slavin, 2018). Notably, these perfectionistic tendencies can be a means to avoid career failure and negative judgement and may contribute toward female medical students raising their standards and over-achieving in multiple life domains (Chand et al., 2018), which may explain why their burnout scores were higher than male medical students.

Another factor that might explain these differences in burnout levels is that women in medicine face more sexual harassment than male peers (Dyrbye, Thomas, & Shanafelt, 2005; Jaggi, 2018). This year, a national Canadian survey found that female medical students experienced a ‘double disadvantage’ as females and as students regarding their risk for being a victim of sexual remarks and inappropriate touching by patients and superiors (Phillips et al., 2019). Female medical students have also reported a greater challenge in finding mentors in medicine, who play an important role in their professional development (Sambunjak, Straus, & Marušić, 2006) and can help reduce self-critical tendencies through supportive role modelling behaviour. Given the persisting climate of gender inequities in medicine (Bates et al., 2016; Jaggi et al., 2011, 2016) perhaps female medical students found it harder to cope, which could have contributed toward feelings of cynicism about medical culture or feelings of exhaustion about having to adapt and work within this culture. Future qualitative research could target these areas

through exploring female medical students' perceptions of medical culture, as well as the influence of programs to encourage networking, access to role models, and continuous education (Lewis et al., 2018). Interventions could also aim to increase self-compassion in female medical students to target the negative effect of perfectionism, as recent work has shown that self-compassion in non-medical female students was protective factor against burnout (Beaumont, Durkin, Hollins Martin, & Carson, 2016). Given that male medical students may be less willing to report mental health issues (National Institute of Mental Health, 2016), future work in this area should continue efforts to increase awareness and support for these issues among all medical students.

Ethnicity

Medical student ethnicity was not a significant predictor of mental health; however, 'other'¹ ethnicity was a positive predictor of burnout and was significantly and positively associated with DP. Some researchers support that minority² medical students face greater academic struggle and be more likely to have children, have trouble finding childcare, and lack family support due to living out of state, which likely influence burnout (Dyrbye et al., 2006b) and could explain greater feelings of detachment from medical school. Moreover, 'other' ethnicity was associated with higher DP and Asian ethnicity was associated with lower DP. Nearly 26% of this sample identified as Asian compared to 11% who identified as 'other'. Given this, it is possible that 'other' ethnicity medical students felt less cultural or social relatedness or

¹ 'Other' ethnicities included: South Asian, Jewish, Sri Lankan, Iranian, North African, Arab, European, Bengali Canadian, Mediterranean, Han, and Asian-Caucasian.

² Ethnicity is a socially constructed identity based on presumed common descent, physical similarities, culture, language, and religion that can relate to a particular social position (Verkuyten, 2018). In Dyrbye et al.'s research (Dyrbye et al., 2007; Dyrbye et al., 2006b), medical students were categorized as 'minority' if they self-identified as African American, Hispanic, Asian, Native American, Pacific Islander, and 'other' non-Caucasian. Here, these authors are referring to an ethnic minority, which has been defined as those with a cultural background different from that of the majority group (Verkuyten, 2018), in this case, Caucasian.

felt like an outsider, whereas Asian medical students felt a greater sense of belonging to a group. In line with this, one study found that minority students who felt that race had adversely affected their education were more likely to have high EE and DP compared to minority students who did not feel this way (Dyrbye et al., 2007).

Research outside of medical students has found that having to cope with cultures different from one's own in an educational or work setting may contribute toward higher burnout, a term called "diversity-related burnout" (pp. 399; Tatar & Horenczyk, 2003). Some medical students in the present study who self-selected 'other' ethnicity reported ethnicities similar to other categories (e.g. "South Asian" versus Asian), suggesting that perceptions of cultural dissimilarity were related to burnout rather than ethnicity itself. It is also possible that medical students of 'other' ethnicities were international students and thus were less acculturated. Thus, it appears that multiple underlying factors that are related to ethnicity (e.g. culture, SES, immigration) could be drivers behind burnout in this group and should be measured in future studies.

The connectedness among people of similar age or ethnicity, known as homophily, is common in medical students and may explain why the 'other' ethnicity participants in this study may have felt like an outsider (Isba, Woolf, & Hanneman, 2017). In contrast, connectedness with other social groups is known as bridging social capital, which can increase access to resources not available within one's own social network (Vaughan, Sanders, Crossley, O'Neill, & Wass, 2015). Fostering bridging social capital in ethnic minority medical students via peer mentorship initiatives may benefit them by equalizing some of the advantages other ethnic groups may have in medical education. Drawing on our earlier points, peer mentorship programs could also help

female medical students reduce their over-achieving behaviours and mitigate burnout, given that they have shown greater difficulty in accessing female mentors (Sambunjak et al., 2006).

Year of Study

Third year of study was a significant predictor of lower mental health and higher burnout than all other years, a relationship which was also significant with EE and DP. This was not surprising as it aligns with a growing number of studies (Compton et al., 2008; Dyrbye et al., 2006c; Santen et al., 2010). Moreover, this finding has been explained as being due to the curricular shift where third year medical students transition to their clerkships and adapt to new responsibilities, apply skills in a practical setting, and interact with patients, each producing novel stressors (Kligler, Linde, & Katz, 2013). Pertaining to burnout, our results support those of previous cross-sectional (Bore, Kelly, & Nair, 2016; McLuckie et al., 2018; Wolf & Rosenstock, 2017) and longitudinal studies (Tucker, Bouvette, Daly, & Grassau, 2017), showing that the transition from didactic to practical learning that occurs in third year may increase burnout. Indeed, burnout in third year has been attributed to changes in scheduling, teaching methods, professional responsibilities, and training environment (El-Masry, Ghreiz, Helal, Audeh, & Shams, 2013).

In comparing mental health and burnout, second year medical students reported favourable outcomes for both constructs while third years reported worse outcomes for both. Interestingly, fourth years reported favourable mental health outcomes yet worse burnout outcomes. In general, the literature has shown that medical students are at the highest risk for poor mental health and burnout in their third year (Bore et al., 2016; Erschens et al., 2018), but that they have higher levels of resilience in their fourth year as they become more experienced and improve their capacity to cope with stress (Houpy, Lee, Woodruff, & Pincavage, 2017).

Indeed, resilient medical students have been found to report fewer mental health problems (Haglund et al., 2009; Peng et al., 2012); however, it is nonetheless concerning that burnout might persist into fourth year. It is possible for burnout to accompany high levels of mental health and resilience, as a national survey among Canadian physicians found that 60% had flourishing mental health and 82% had high levels of resilience, but that 30% were burned out (Vogel, 2018). This suggests that the presence of coping skills or resilience does not guarantee protection from burnout. Additional studies are needed to determine whether improvements in coping and resilience over the third year of medical school can explain the link between year of study and mental health outcomes.

Finally, supplemental results showing that first year was associated with lower EE and DP and third year was associated with higher EE and DP supports past research (McLuckie et al., 2018; Santen et al., 2010). As such, it seems that intervening prior to third year may be the most proactive strategy in preventing mental health issues and burnout in medical students so we may equip them with effective coping habits that will benefit them in future years (Mascaro et al., 2018; Mazurkiewicz, Korenstein, Fallar, & Ripp, 2012). Various forms of PA and meditation have been shown to improve mental health and burnout in general (Govindaraj, Karmani, Varambally, & Gangadhar, 2016; Goyal et al., 2014) and in medical students (Dyrbye et al., 2017b; Wild et al., 2014). Therefore, future intervention research could implement a wellness practicum for second year medical students where they would choose a type of PA (e.g. martial arts, running groups, or intramural soccer) and a form of meditation (e.g. guided meditation in a class) to practice twice weekly over the academic year. Courses to help ease the transition into clerkship can also be implemented in first and second year medical students to teach them stress management skills, to allow them to practice clinical procedures, and to pair them with third and

fourth year medical students who can provide insight on common challenges to clerkship (Poncelet & O'Brien, 2008).

Age, Level of Education, and Proposed Specialty

The remaining three demographics were not found to be significant predictors of mental health or burnout and are therefore discussed in the same section. These findings were not surprising, as the prevalence of mental health and burnout were similar across all ages, educational backgrounds, and proposed specialties in this study. However, age approached significance as a negative predictor of burnout indicating that younger medical students reported marginally higher burnout levels. This must be interpreted cautiously, yet it supports that age may be an important variable to further study given that one study found significantly lower levels of DP among older medical students in osteopathic medicine (aged 36-45 years old; Lapinski et al., 2016). Moreover, there may be a positive influence of more life experience on burnout. Future research could explore how both age and life experience influence burnout through a qualitative lens. No significant associations were found between medical student age, EE, and DP.

Research examining how educational level relates to mental health, burnout, EE, and DP in medical students is sparse. However, some studies have found a positive association between financial strain and psychological distress in medical students (Bore et al., 2016; Shariati, Yunesian, & Vash, 2007). Financial concerns are common in graduate-entry medical students who have paid for more schooling and have higher levels of education (Sandover, Jonas-Dwyer, & Marr, 2015) and these concerns have been likened with poor health (Riemenschneider et al., 2016). However, having a post-doctoral degree was associated with lower DP. This could be attributed to these medical students having more years of experience, which enabled them feel

more engaged in their studies. Further, having a college degree was associated with lower EE, which might be due to the hands-on experience typically undertaken in college education. This type of training may have been related to the ability to cope with the emotionally draining workload of medical school and thus was associated with lower EE. Given this, it seems that certain educational backgrounds uniquely influence burnout during medical school, which is a topic that should be further studied.

Regarding specialty, we found no differences in mental health or burnout of medical students whereas other studies have found that burnout was higher among medical students intending to pursue primary care (family medicine, internal medicine, and pediatrics; Compton et al., 2008; Enoch, Chibnall, Schindler, & Slavin, 2013). It may have been that it was too early to see the effects of medical students' intended specialties on their mental health or burnout as they would have not yet experienced the challenges inherent to certain fields. For instance, pediatricians may exhibit higher EE due to witnessing child death more often, but medical students intending to pursue pediatrics may not have witnessed this yet. Alternatively, research has shown that medical students' personality influences their specialty choice (Mehmood, Khan, Walsh, & Borleffs, 2013; Peng et al., 2012), which may explain differences in burnout. For example, medical students selecting surgery tend to seek out more thrilling and social experiences (Mehmood et al., 2013) and may have greater social support to help with burnout. More research is needed to clarify the links between proposed specialty and medical students' mental health and burnout.

Investigating Physical Activity and Sitting as Predictors of Burnout

Another purpose of this thesis was to examine how mild, moderate, vigorous, and total PA, and sitting predicted burnout in medical students. Mild PA and sitting were significant,

negative predictors of burnout, showing that medical students who reported engaging in less mild PA per week or who reported sitting fewer hours per day indicated higher levels of burnout. Sitting was also significantly and negative associated with EE and DP. Moderate, vigorous, and total PA were not significant predictors of burnout, though moderate PA was significantly and positively associated with EE. The fourth purpose was to examine how MVPA moderated the relationship between sitting and burnout. MVPA was not a significant moderator of this relationship; however, the main effect of sitting was significant, supporting its negative relationship with burnout.

In contrast to previous studies in the general population (Biswas et al., 2015; Sloan et al., 2013), higher burnout was found among medical students who reported sitting less. This could be partially attributed to the heavy clinical workload where medical students are likely walking or standing most of the day and thus accrue higher levels of exhaustion. Indeed, third and fourth year medical students in our study showed the highest levels of burnout and the lowest levels of sitting (Figure 1). However, stressors related to medical education could have also influenced lower levels of sitting such that medical students across all four years of study were sitting less as a result of trying to outperform their peers in multiple domains.

Akin to our discussion on gender differences, high-achieving behaviour in medical students may be influenced by personality. Self-oriented perfectionism (i.e. high expectations from oneself, about oneself) has been shown to be highly prevalent among medical students (Seeliger & Harendza, 2017), and when paired with institutional pressures to excel (McLuckie et al., 2018; Muzafar et al., 2015) may exacerbate feelings of inadequacy, leading to less resting and more burnout. Medical students are faced with a residency match rate that continues to decrease (The Association of Faculties of Medicine of Canada, 2018) and this adds stress

throughout medical school. Prior to 2011, only ten to twenty Canadian medical graduates were unmatched per year, but in 2017 this increased to sixty-eight (AFMC, 2018). Due to the culture of competition and scarcity of residency positions, medical students are advised to engage in many activities (i.e. research, clubs, athletics) to improve their curriculum vitae (Student Affairs Office, 2017), thus it is not surprising that some are sitting so little.

Indeed, too many activities and time constraints are antecedents to not resting (Helvig, Wade, & Hunter-Eades, 2016) and these antecedents are both common for medical students and are known contributors to their burnout (Kligler et al., 2013; Santen et al., 2010). Regarding this, research has shown that resting improves mental health (Helvig et al., 2016), and meta-analyses have found that relaxation practices (e.g. meditation) improved anxiety in the general population (Manzoni, Pagnini, Castelnuovo, & Molinari, 2008). Thus, promoting rest and relaxation for medical students may reduce feelings of burnout that arise from the exhaustion and/or detachment they feel from over-extending themselves. This can include green spaces or silent rooms made available to medical students that encourage them to pause, reflect, and recharge. Moreover, reducing burnout through awareness campaigns and peer support groups may in turn influence better PA and rest habits in medical students. Future research should look at bi-directional relationships between burnout and multiple behavioural variables (e.g. PA, sedentary behaviour, sleep, diet).

Mild PA was negatively related to burnout, indicating that medical students who engaged in more mild PA reported lower levels of burnout, and vice versa. Perhaps medical students found mild PA more enjoyable as gentler forms of activity typically do not cause shortness of breath (e.g. dog-walking; CSEP, 2017b). In this respect, mild forms of PA are also more conducive to socializing, which may have allowed medical students to feel like they were taking

a break while engaging in mild PA compared to more intense forms of PA. Mild PA has been associated with higher levels of positive affect than vigorous PA (Ekkekakis, Parfitt, & Petruzzello, 2011) and may be more pleasurable for medical students. This supports past research showing that social support and talking with friends were facilitators to medical students' engagement in PA (Wattanapisit, Funghongcharoen, Saengow, & Vijitpongjinda, 2016). Another consideration is that burnout could have influenced levels of mild PA and sitting in medical students such that those who were not burned out were more easily able to relax and engage in mild forms of PA, or that those who were burned out were overly busy and had less time for mild PA or resting or saw these as less important.

Moderate PA approached significance as a positive predictor of burnout. Supplemental results showed that minutes of moderate PA per week were associated with higher EE, further suggesting that some medical students may be over-extending themselves. Prior research has not examined the associations between PA intensity and EE. However, in contrast to our result, one study found total PA to be a significantly and negatively associated with medical student exhaustion (Babenko, Mosewich, Abraham, & Lai, 2018). This suggests that PA could have a positive or negative influence on medical student burnout, but that burnout may also influence levels or perceptions of PA. For instance, feelings of exhaustion could alter medical students' perceptions of how much PA they are doing. Still, it appears that medical students might be over-committing themselves and aiming for perfection in multiple areas, thereby contributing to increased mental and physical fatigue. This may explain why we found that doing more moderate PA was related to higher levels of EE in our participants.

We did not find significant relationships between vigorous or total PA and EE, DP, or overall burnout. Past research has found a U-shaped relationship between EE and frequency of

vigorous PA, suggesting a preventive role of moderate frequency vigorous PA (i.e. once to twice a week; Benaards et al., 2006). But, this also shows that the link between vigorous PA and burnout may not be linear, may depend on individuals' fitness levels. In *Article 2*, we found that vigorous PA approached significance in negatively correlating with sitting. This suggests that medical students who were more vigorously active also spent less time sitting and supports the issue of not enough rest contributing to burnout. It is clear that medical students have a plethora of reasons to be high-achieving. However, as evidence suggests, this is not beneficial for their psychological health. Further exploration of the links between PA intensity, sitting, and burnout in medical students is warranted as these factors appear highly relevant to burnout in this population.

It is possible that MVPA did not largely influence the relationship between sitting and burnout as medical students in this sample were already fairly active ($M_{MVPA} = 206.95$ mins/week, $SD = 122.51$). However, since medical students are a time-pressed group, differences in sitting had a larger influence on burnout, EE, and DP. This supports research in a sufficiently active general population, which found that MVPA did not attenuate the negative effects of sedentary behaviour on depression and anxiety (Blough & Loprinzi, 2018). Overall, it appears that the challenges of medical school result in unique interactions between PA, sitting, and medical students' psychological health, compared to the general population.

Knowledge and Theoretical Contributions

Many novel contributions to the literature were provided in this thesis, including new knowledge on predictors of mental health and burnout among Canadian medical students. Moreover, age and level of education were included as predictors of medical student mental health, which to our knowledge has not been done before. Important gaps were filled regarding

the relationships between PA intensity, sitting, and medical student burnout, providing key information on these phenomenon. Furthermore, this thesis supported Keyes' (2014) Dual Continua Model and Maslach's theorization of burnout (Maslach et al., 1996).

This thesis has several notable strengths. First, it involved a multi-institutional study conducted in a demographically representative sample (AFMC, 2017). Second, it examined predictors of medical student mental health, rather than mental illness, which supports that these constructs exist on separate continua (Keyes, 2002, 2014). Research in medical students has typically conflated mental health and mental illness by labelling disorder (e.g. depression, anxiety) as 'mental health' and this has been the prevailing dialogue in the literature for decades (Dyrbye et al., 2006c; Lucchetti et al., 2018; Shariati et al., 2007). Researching medical student mental health adopts a positive psychology perspective and supports a paradigmatic shift from treatment to prevention, which can contribute toward a stronger emphasis on prevention of poor mental health and burnout in medical students. We found that levels of mental health differed from levels of burnout in some medical students (e.g. fourth year medical students showed higher levels of mental health yet higher levels of burnout) which upholds that these are also two separate constructs. This demonstrates that interventions targeting medical students' mental health should be designed to instill positive emotions, life satisfaction, and healthy relationships, and should be informed separately from those targeting their burnout (Lamers, Westerhof, Bohlmeijer, Klooster, & Keyes, 2011).

Third, this study investigated a combination of demographic predictors, which few studies have done (Bore et al., 2016; Cecil, Mchale, Hart, & Laidlaw, 2014). Another strongpoint to this study was examining the influence of PA intensity and sitting on medical student burnout, which no prior research has targeted. Indeed, 24-hour Movement Guidelines for PA and

sedentary behaviour among adults are forthcoming (Tremblay, Carson, & Chaput, 2016), and this study supported that medical students' PA and sitting habits should be considered collectively in regards to their burnout. This was accomplished through our examination of the interaction between medical students' MVPA and sitting levels on their burnout.

Finally, the Canadian setting was a strength as most research on medical student health has been conducted in the USA and elsewhere (Cecil et al., 2014; Frank, Carrera, Elon, & Hertzberg, 2006; van Dijk, Lucassen, van Weel, & Speckens, 2017). There are some unique aspects to medical education in Canada that may influence the types of students these schools attract. Canadian medical schools tend to have stricter acceptance rates, at 7% overall, with students applying to three medical schools on average out of the seventeen in Canada (AFMC, 2017). In contrast, the overall acceptance rate for the 179 medical schools in the USA is 41% with an average of sixteen applications per student (Association of American Medical Colleges, 2018). Canadian medical students appear to face unique concerns that may affect mental health, thus justifying the target population of this study.

Practical Contributions

From an applied stance, the relationships between demographics, PA, sitting, mental health, and EE and DP found in this dissertation may inform efforts to address distinct profiles of mental health and burnout in demographic groups of medical students who appear to be most at risk. For example, based on recommendations from leading burnout researchers (Leiter & Maslach, 2016) and from the results found here, interventions for 'other' ethnicity medical students could focus on improving social relationships as this would target feelings of disengagement common to high DP. Moreover, interventions for medical students with high EE and DP, such as those in third year with low levels of sitting, should target both the workload and

social atmosphere (Leiter & Maslach, 2016). This may include seated breaks (e.g. over lunch or coffee) for ‘other’ ethnicity and third year medical students to rest and socialize as a respite from their clerkship and to connect with peers. This could be a key avenue to strengthen social support in medical students, which can subsequently improve their levels of stress, coping abilities (Dieser, Edginton, & Ziemer, 2017), and their mental health (Helvig et al., 2016). Alternatively, improving mental health and burnout in medical students may affect their behaviours (e.g. PA, coping, self-care) as research among medical students has suggested a negative bi-directional relationship between resilience and anxiety (Tempski et al., 2015) and has found sleep dysfunctions to be reciprocally associated with EE (Pagnin et al., 2014).

Curricular changes would likely also benefit medical student mental health and burnout. Designing a mandatory wellness course to teach medical students life skills could help to prevent burnout and improve mental health. This course should allow students to choose which wellness topics they want to learn (Evans & Boucher, 2015) and should focus on teaching malleable health behaviours in an active, hands-on approach (Koles, Stolfi, Borges, Nelson, & Parmelee, 2010; C. J. Miller & Metz, 2014). One of these topics could be mindful compassion-based meditation, which has been shown to decrease depressive symptoms and increase compassion in medical students (Mascaro et al., 2018). Other topics could include nature-based PA and yoga, which have each been found to be effective at improving mental health in adults (Hendriks, de Jong, & Cramer, 2017; Thompson Coon et al., 2011). In medical students, yoga and meditation have been shown to decrease stress and increase happiness and positivity (Prasad, Varrey, & Sisti, 2016). Therefore, this course could give medical students the choice of practicing seated meditation, yoga, or nature-based PA (e.g. mild nature walks, trail runs) twice per week with other medical students. Additionally, this course could be informed by the Healthy Mind Platter

(Rock, Siegel, Poelmans, & Payne, 2012). This is a model that has been used to support mental health (R. Miller, Gallo, & Moore, 2018), and has been recommended for medical students (Ungerleider, Ungerleider, & Ungerleider, 2017), focusing on seven neurocognitive activities, including “physical time”, “downtime”, and “connecting time”. Overall, it has been presented that mild forms of PA, restorative activities, peer support, and mentorship opportunities are key wellness areas to target in medical students.

Moreover, researching sensitive topics like mental health and burnout may help medical students to feel more comfortable with these concepts, potentially reducing their associated stigma and increasing help seeking. Mental health stigma is high in medical culture (Johnston, 2015; Schwenk, Davis, & Wimsatt, 2010), which frowns upon signs of weakness and prioritizes work above health and family (Beckman, 2015). In aims of breaking down this stigma, strategies to influence medical culture should be debated. For instance, conducting a panel discussion with representatives from the Association of Faculties of Medicine Canada (AFMC), the Canadian Federation of Medical Students (CFMS), and the Canadian Medical Association (CMA) could help bring attention to issues concerning mental health and burnout in medical students at a national level. Moreover, medical stakeholders could be involved in designing a peer mentorship program to help new or struggling medical students receive quality support, such as from a Wellness Ambassador (CMA Ambassador Program; CMA, 2019).

Limitations and Future Directions

Certain limitations have been discussed in *Articles 1* and *2*. These included: the cross-sectional study design, the possibility for over- or under-reporting of PA and a social desirability bias, and the measure used to quantify sitting hours. Additional limitations are discussed here, with further attention given to drawbacks of the research design.

Cross-sectional research is limited as it can neither determine causal relationships nor relationships over time. Indeed, the term ‘predictors’ is commonly used in longitudinal research, but it has also been extensively used in cross-sectional studies in medical students that use regression analysis (Babenko et al., 2018; Bore et al., 2016; McLuckie et al., 2018). ‘Predictors’ is also a statistical term used to identify independent variables in regression analyses (Pallant, 2007). Nevertheless, the independent variables in this study were hypothesized to influence the dependent variables; however, there may be bi-directionality to these relationships. For instance, increases in sitting could have influenced decreases in burnout and/or decreases in burnout could have influenced increases in sitting. Further, we acknowledge that the small, self-selecting sample size and low response rate (12.4%) can lead to bias due to a greater chance of higher variability in the data. Ideally a larger sample would have been obtained; however, other surveys among medical students have reported similar response rates (Blake, Stanulewicz, & McGill, 2017; Cecil et al., 2014; Wolf & Rosenstock, 2017).

The demographic measure used to assess ethnicity allowed for elaboration in the form of a text box, but only in the ‘other’ ethnicity category. Thus, it was not possible to identify medical students’ level of integration in Canadian culture for other ethnicity responses. For example, medical students of ‘Asian’ ethnicity may be first, second, or third generation Canadian, or may be an international student. Furthermore, Franco-Ontarians could be considered a minority category within Ontario culture who may be unique to other cultures. Here, however, ‘minority’ may not translate to ‘ethnic minority’ as discussed in this dissertation, as Franco-Ontarians could be of African American descent, European descent, and so on. Nevertheless, this group was not considered as there were no ‘Franco-Ontarian’ responses within the ‘other’ ethnicity category.

Regarding this measure, some improvements can be made. The methods used to measure ethnicity in medical students have come from research conducted in the ‘melting pot’ ethnic context of the USA, which is not representative of the multicultural mosaic of ethnicities in Canada. Future quantitative research could update ethnicity measures to be able to analyze different ethnic groups of Canadian medical students, rather than measures that combine ethnicity and race such as the one used in this thesis. These future studies could also include questions on medical students’ generational, immigrant, and international status in addition to their self-reported ethnicity. Additionally, future qualitative research could ask how these variables may or may not impact medical students’ experiences of burnout and poor mental health.

Likewise, the PA measure used (Godin & Shephard, 1985) did not describe the type of activity participants engaged in. Examples for each item indicated what forms of mild, moderate, and vigorous PA may look like (e.g. “fast walking”, “easy bicycling”, or “badminton” for moderate PA; Appendix G), which may have helped respondents to select the correct intensity; however, overlap between intensities is likely as certain activities (e.g. running) may have been perceived as moderate PA to some but as vigorous PA to others (Loney, Standage, Thompson, Sebire, & Cumming, 2011). As an alternative, future research could classify types of PA according to Ainsworth’s Compendium of Physical Activities (Ainsworth et al., 2000) to improve consistency of results across studies.

Lastly, our measure of sitting could not determine how medical students spent their time sitting. For instance, time sitting could be spent in class, studying, watching television, or playing an instrument, where each may have varying positive and negative influences on burnout (Ku, Fox, & Chen, 2016). Moving forward, it would be interesting to examine how different

forms of sedentary behaviour impact burnout, as medical students who have higher levels of burnout may be engaging in more stressful, work-oriented forms of sitting and could benefit from taking more time to relax and disengage from their studies. Another topic for future studies would be to investigate how medical students' sleep habits influence their mental health and burnout in combination with PA and sitting.

Examining both positive and negative psychological outcomes (i.e. mental health and burnout) should be continued in future research. Other salient constructs should be assessed too, including mental illness, engagement, and resilience. Engagement has been defined as an intrinsic component of professional fulfillment that involves a meaningful contribution to one's work (Trockel et al., 2018). It is said to be a positive state that mirrors burnout, including a lack of exhaustion and cynicism, and high levels of efficacy (Leiter & Maslach, 2016). Resilience is the ability to cope with and rebound from adversity (Houpy et al., 2017) and has been negatively correlated with burnout (Skodova, Lajciakova, & Banovcinova, 2016). Furthermore, medical students with low levels of mental health or high levels of burnout are at an increased risk for developing a mental illness (Keyes, Dhingra, & Simoes, 2010; Payton, 2009) and have also shown lower levels of resilience (Houpy et al., 2017). Therefore, it would be highly relevant for longitudinal studies to compare predictors of mental health, mental illness, burnout, engagement, and resilience over the four years of medical school. Knowledge of the interplay between these constructs may then inform preventive measures to target low mental health, engagement, and resilience, and high mental illness and burnout in medical students via tailored approaches.

Future studies should also examine perfectionism as a predictor variable, as it is a contributing factor to medical student burnout (J. H. Yu, Chae, & Chang, 2016). It is a trait often rewarded in medical students despite being shown to increase their burnout (Yu et al., 2016).

Medical students typically exhibit high levels of perfectionism as a result others' and their own high expectations of themselves (Yu et al., 2016). This may be seen in medical students' high-achieving behaviours, such as engaging in vigorous forms of PA (Frank et al., 2006) or extreme durations of PA, such as ultramarathons, as a way of achieving perfection in other domains. Moving forward, studies could examine how perfectionism influences the relationships between mild, moderate, vigorous, and total PA, sitting and burnout.

Mixed methods investigation of other variables, including social support, sleep, and nutrition, could also be considered as these have been negatively associated with burnout in medical students (Moczko, Bugaj, Herzog, & Nikendei, 2016), with sleep disorders being reciprocally related to medical student burnout (Pagnin et al., 2014). Particularly with PA, future research should use objective measures of PA, given that accelerometer-based PA was recently found to have a significant bi-directional relationship with major depressive disorder while self-reported PA was not (Choi et al., 2019). Moreover, social capital (i.e. having access to social networks) and socio-economic status have shown positive links with academic performance and negative links with depression in ethnic minority medical students (Vaughan et al., 2015; Woolf, Mcmanus, Potts, & Dacre, 2013). Exploring these variables could offer a deeper understanding of the mechanisms associated with mental health and burnout outcomes linked to medical student demographics, such as ethnicity.

Conclusion

The central purpose of this thesis was to investigate demographic and behavioural predictors of mental health and burnout in first to fourth year medical students, and to compare demographic predictors of mental health and burnout. Findings supported that medical students who were in their third year of study showed the lowest levels of mental health and medical

students who were female, of 'other' ethnicity, in third year of study, who engaged in fewer minutes of mild PA per week, and who sat fewer hours per day reported the highest burnout. These results align with previous research, though multiple novel relationships emerged, specifically regarding sitting as a negative predictor of medical student burnout. Moving forward, research should investigate other important contributors to medical student mental health and burnout such as personality, social relationships, and over-achieving behaviours. This knowledge supports the inclusion of wellness courses in the medical school curriculum, including PA and relaxation, and may inform best practices for the health of our future medical professionals who will provide better quality care to patients (Dyrbye et al., 2017a).

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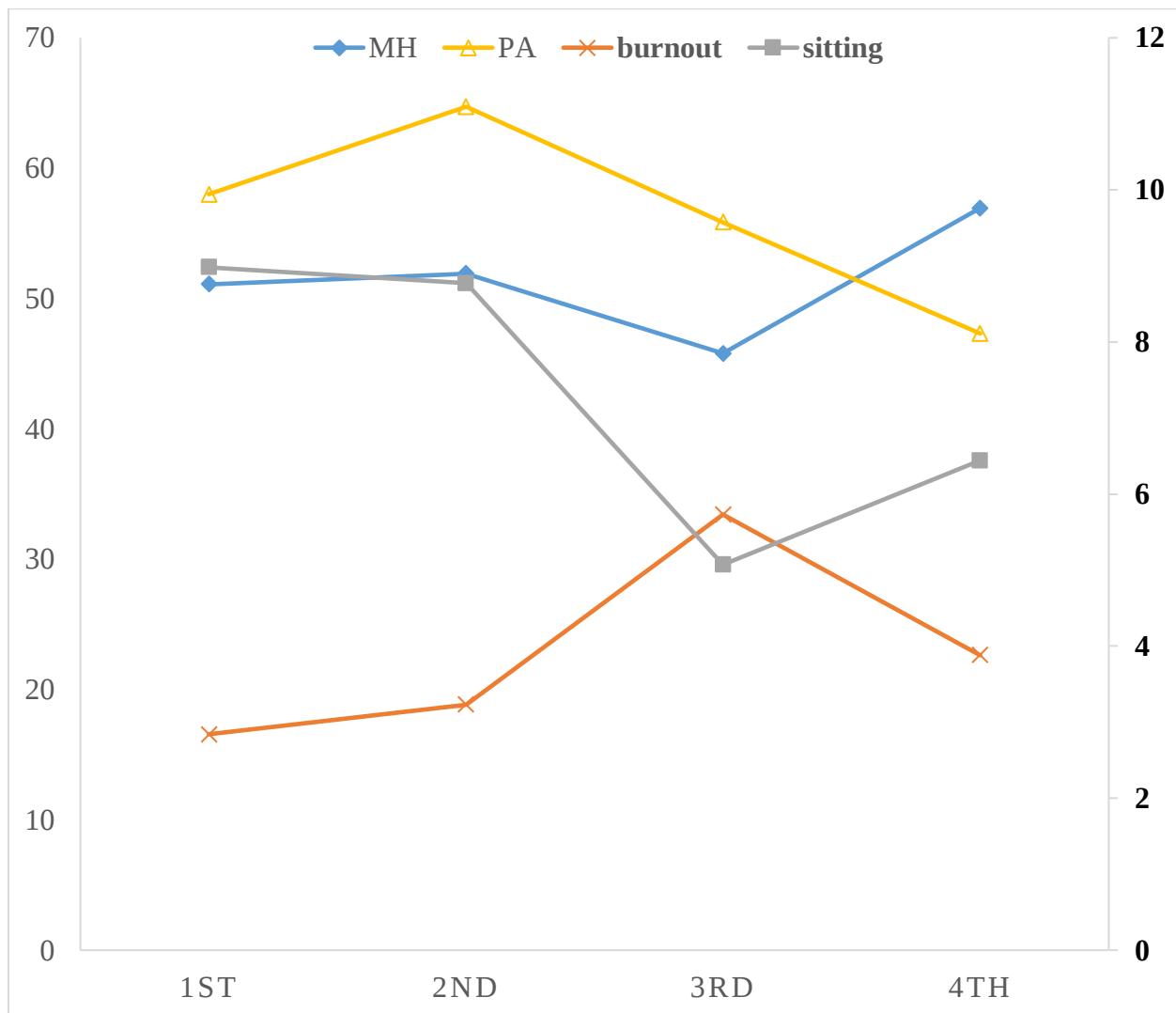
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Figure 1. Mental health, burnout, total physical activity, and sitting across first to fourth year medical students ($N = 129$).



Left y-axis: Mental health mean score, total physical activity Leisure Score Index (LSI)

Right y-axis: Burnout mean score, sitting hours per day

APPENDICES

Appendix A. Ethics Approval



Research Ethics Board Office
James Administration Bldg.
845 Sherbrooke Street West, Rm 325
Montreal, QC H3A 0G4

Tel: (514) 398-6831

Website: www.mcgill.ca/research/researchers/compliance/human/

Research Ethics Board II
Certificate of Ethical Acceptability of Research Involving Humans

REB File #: 177-0917

Project Title: Health Behaviours and Prescribing Habits of First to Fourth Year Medical Students

Lead Investigator: Prof. Shane Sweet

Department: Kinesiology & Physical Education

Co- Investigators: Jennifer Tomasone, Queen's University; Michelle Fortier, University of Ottawa; Taylor McFadden, University of Ottawa; Ryan McGinn, University of Ottawa; Brendan Levac, University of Ottawa; Brendan Swift, McGill University

Approval Period: October 24, 2017 to October 23, 2018

The REB-II reviewed and approved this project by full board review in accordance with the requirements of the McGill University Policy on the Ethical Conduct of Research Involving Human Participants and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans.

Deanna Collin
Ethics Review Administrator, REB I & II

* Approval is granted only for the research and purposes described.

* Modifications to the approved research must be reviewed and approved by the REB before they can be implemented.

* A Request for Renewal form must be submitted before the above expiry date. Research cannot be conducted without a current ethics approval. Submit 2-3 weeks ahead of the expiry date.

* When a project has been completed or terminated, a Study Closure form must be submitted.

* Unanticipated issues that may increase the risk level to participants or that may have other ethical implications must be promptly reported to the REB. Serious adverse events experienced by a participant in conjunction with the research must be reported to the REB without delay.

* The REB must be promptly notified of any new information that may affect the welfare or consent of participants.

* The REB must be notified of any suspension or cancellation imposed by a funding agency or regulatory body that is related to this study.

* The REB must be notified of any findings that may have ethical implications or may affect the decision of the REB.



**QUEEN'S UNIVERSITY HEALTH SCIENCES & AFFILIATED TEACHING HOSPITALS
RESEARCH ETHICS BOARD (HSREB)**

HSREB Initial Ethics Clearance

October 31, 2017

Dr. Jennifer Tomasone
School of Kinesiology and Health Studies
Queen's University

ROMEO/TRAQ: #6022151

Department Code: PHE-172-17

Study Title: PHE-172-17 Health Behaviours and Prescribing Habits of First to Fourth Year Medical Students

Co-Investigators: Dr. M. Fortier, Dr. S. Sweet, Ms. T. McFadden

Review Type: Delegated

Date Ethics Clearance Issued: October 31, 2017

Ethics Clearance Expiry Date: October 31, 2018

Dear Dr. Tomasone,

The Queen's University Health Sciences & Affiliated Teaching Hospitals Research Ethics Board (HSREB) has reviewed the application and granted ethics clearance for the documents listed below. Ethics clearance is granted until the expiration date noted above.

- Survey – Version 2
- Recruitment Text – Version 2
- Information/Consent Form – Version 2

Documents Acknowledged:

- University of Ottawa HSREB Approval Letter – February 7, 2017
- Queen's UGME Clearance – October 10, 2017

Amendments: No deviations from, or changes to the protocol should be initiated without prior written clearance of an appropriate amendment from the HSREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

Renewals: Prior to the expiration of your ethics clearance you will be reminded to submit your renewal report through ROMEO. Any lapses in ethical clearance will be documented on the renewal form.

Completion/Termination: The HSREB must be notified of the completion or termination of this study through the completion of a renewal report in ROMEO.

Reporting of Serious Adverse Events: Any unexpected serious adverse event occurring locally must be reported within 2 working days or earlier if required by the study sponsor. All other serious adverse events

must be reported within 15 days after becoming aware of the information.

Reporting of Complaints: Any complaints made by participants or persons acting on behalf of participants must be reported to the Research Ethics Board within 7 days of becoming aware of the complaint.

Note: All documents supplied to participants must have the contact information for the Research Ethics Board.

Investigators please note that if your trial is registered by the sponsor, you must take responsibility to ensure that the registration information is accurate and complete.

Yours sincerely,

Chair, Health Sciences Research Ethics Board

The HSREB operates in compliance with, and is constituted in accordance with, the requirements of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations, Canadian General Standards Board, and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is qualified through the CTO REB Qualification Program and is registered with the U.S. Department of Health and Human Services (DHHS) Office for Human Research Protection (OHRP). Federalwide Assurance Number: FWA#:00004184, IRB#:00001173

HSREB members involved in the research project do not participate in the review, discussion or decision.

Appendix B. Participant Consent Forms**Health Behaviours and Prescribing Habits of First to Fourth Year Medical Students**

Name: Shane Sweet
Status: Assistant Professor
Affiliation: Department of Kinesiology and Physical Education, Faculty of Education, McGill University
Contact:

Name: Jennifer Tomasone
Status: Assistant Professor
Affiliation: Faculty of Arts and Science, School of Kinesiology and Health Studies, Queen's University
Contact:

Name: Michelle Fortier
Status: Professor
Affiliation: Department of Human Kinetics, Faculty of Health Sciences, University of Ottawa
Contact:

Name: Ms. Taylor McFadden
Status: PhD Student

Affiliation: Department of Human Kinetics, Faculty of Health Sciences, University of Ottawa
Contact:

Name: Ryan McGinn
Status: Medical Student
Affiliation: Department of Medicine, Faculty of Medicine, University of Ottawa
Contact:

Name: Brendan Levac
Status: Medical Student
Affiliation: Department of Medicine, Faculty of Medicine, University of Ottawa
Contact:

Name: Brendan Swift
Status: Medical Student
Affiliation: Department of Medicine, Faculty of Medicine, McGill University
Contact:

Purpose of the Study: Physical activity stands to be one of the largest returns on investment for health. This study is conducted by the McGill on campus chapter of Exercise is Medicine Canada. Our purpose is to determine whether the curriculum in the Faculty of Medicine is effective in providing the necessary tools for future physicians to prescribe physical activity in a preventative and therapeutic context. In addition, we will assess some of your own personal health measures. Ultimately, your responses may allow us to propose a change in the curriculum to ensure that future physicians possess the necessary tools to prescribe physical activity.

Study Procedures: If you volunteer to participate in this study, you will be asked to fill out a survey that takes up to 15 minutes to complete. The surveys will be administered electronically in November 2017 to first, second, third and fourth year medical students. The survey will involve questions pertaining to basic demographics (age, sex, academic background, etc.), your knowledge of the Canadian Physical Activity Guidelines, your confidence, motivation and frequency in prescribing physical activity, your perceived importance of prescribing physical activity, and your own physical activity behaviors. Psychological variables, including mental health, resiliency and burnout will also be assessed.

Voluntary Participation: Your participation in this study is completely voluntary. If you choose to participate, you can withdraw from the study at any point in time without consequence. Also, you can refuse to answer any questions if you do not feel comfortable, and still remain in the study. You may suspend the survey at any time or

withdraw without consequence. You will no longer be able to withdraw once you have submitted your answers to the study questionnaire because the data are anonymous. This means that we will not be able to identify your specific questionnaire responses, making it impossible to remove your answers from the study data.

Potential Risks: While filling out the online surveys, you may experience minor psychological or emotional discomfort related to the questions. You do not have to answer any questions that you do not feel comfortable answering, and you do not have to give the reason why you chose to not answer a particular question. Your data will be included in the study if you do not answer all the questions. You can withdraw from the study at any time without penalty. You may take as many breaks as you require while filling out the questionnaires.

Potential Benefits: By participating in this study you are providing valuable information, which may lead to improvements in medical education. In addition, your participation will provide important data on the physical and mental health of medical students. This information is important for the development of evidence-based policies aimed at improving the health of medical students. While you may not receive many immediate tangible benefits, you will be contributing to the education and health of your future peers.

Compensation: To thank you for your contribution to the research project, you will be given the option to enter your name and email address in a draw to win a Fitbit Alta fitness tracker valued at \$170. The draw is open to all research participants who enter their name in the draw, regardless of whether they decide to withdraw from further participating in the research project.

Upon completion of the study, a name will be randomly selected amongst those who have entered and the person whose name is drawn will be informed by email. To win the prize, the person must correctly answer a skill testing question. If the person cannot be reached within 14 days from the date of the draw, the prize will be awarded to the second name that is randomly selected and so on until the prize has been awarded. The odds of winning a prize will depend on the number of eligible entries received. The prize must be accepted as awarded or forfeited and cannot be redeemed for cash. Your name and email address that you provide when you enter the draw is collected for the purposes of contacting you if your name is selected in the draw.

While the online survey itself will be anonymous, we are collecting identifiable information for the purposes of compensation. Should you choose to provide your email address, your contact information and survey responses will be separated by the researcher when downloading your submission. Your contact information and survey responses will be saved in separate data files with no link between them, in order to restore anonymity. Only the principle and co-investigators will know the password to access the file containing identifiable information. Your name and the contact information you provide will be kept confidential and then destroyed once the prizes have been awarded.

We reserve the right to cancel the draw or cancel the awarding of the prize if the integrity of the draw or the research or the confidentiality of participants is compromised. The draw is governed by the applicable laws of Canada.

Confidentiality: This survey is completely anonymous. We guarantee that your identity will be protected. Results will be presented at conferences and published in peer-reviewed journals in pooled format. Your name will not be revealed in any future documents or publications. The information obtained in this study will remain strictly confidential. Electronic copies of the surveys will be kept in a secure database in Taylor McFadden's laboratory (co-investigator) at the University of Ottawa in Ottawa, Ontario. The only people who will have access to the surveys are the principal and co-investigators. A blind identification number, not your name, will identify your surveys and data so that no one, not even the researchers, will know how you responded. Once data collection is complete, the code linking your number to your name will be destroyed. In order to minimize the risk of security breaches and to help ensure your confidentiality, we recommend that you use standard safety measures such as signing out of your account, closing your browser and locking your screen or device when you are no longer using them / when you have completed the study. Please note that the online survey tool used in this study (SurveyMonkey) is hosted by a server located in the United States and is thus subject to the U.S. Patriot Act. In view of this, we cannot absolutely guarantee the full confidentiality and anonymity of the data.

Questions: If you have any questions or need more information about the study itself, please contact Taylor McFadden at _____ or Shane Sweet at _____.

If you have any ethical concerns or complaints about your participation in this study, and want to speak with someone not on the research team, please contact the McGill Ethics Manager at 514-398-6831.

Agreeing to participate in this study does not waive any of your rights or release the researchers from their responsibilities.

If you understand and accept these conditions, please indicate your electronic consent by selecting yes or no. Before indicating your consent, please save or print a copy of this document to keep for your own reference.

Yes
I consent to participate.

No
I do not consent to participate.

You may voluntarily enter your name and email address below, to be entered into the prize draw.



Health Behaviours of First to Fourth Year Medical Students

Name: Jennifer Tomasone

Status: Professor

Affiliation: Faculty of Arts and Science,
School of Kinesiology and Health Studies,
Queen's University

Contact:

Name: Shane Sweet

Status: Professor

Affiliation: Department of Kinesiology and
Physical Education, Faculty of Education,
McGill University

Contact:

Name: Michelle Fortier

Status: Professor

Affiliation: Department of Human Kinetics,
Faculty of Health Sciences, University of
Ottawa

Contact:

Name: Ms. Taylor McFadden

Status: Ph.D. Student

Affiliation: Department of Human Kinetics,
Faculty of Health Sciences, University of
Ottawa

Contact:

Name: Ms. Tamara Morgan

Status: M.A. Student

Affiliation: Department of Human Kinetics,
Faculty of Health Sciences, University of
Ottawa

Contact:

Purpose of the Study: Physical activity stands to be one of the largest returns on investment for health. This study is conducted by the Queen's on campus chapter of Exercise is Medicine Canada. Our purpose is to explore the individual experiences and health behaviours of first to fourth year medical students who reported experiencing indicators of burnout during medical school.

Study Procedures: Interviews will be conducted with approximately 15-20 medical students (1st – 4th year) at Queen's University and McGill University in 2018. Students will be contacted via the emails they provided for the prize draw in a recent survey titled "Health Behaviours of First to Fourth Year Medical Students". If you volunteer to participate in this study, you will be invited to partake in one individual telephone interview lasting approximately 45 to 60 minutes. The interview will involve questions related to your experience with burnout, including contributing factors to burnout, as well as your own physical activity behaviours, and extracurricular endeavours.

Your voice will be recorded during the interview in order for the researchers to collect your responses. The transcription of your interview will be returned to you by email in order to verify the accuracy of your responses. You will have two weeks to make revisions/clarifications to your transcripts. The transcription will be protected by a password.

Voluntary Participation: You are under no obligation to participate and if you choose to participate, you can withdraw from the study at any time and/or refuse to answer any questions without consequence. If you choose to withdraw from the study, you will have the option to withdraw your data from the interview. Deciding not to participate or withdrawing participation will have no impact on your academic standing.

Potential Risks: During the interview, you may experience minor psychological or emotional discomfort related to the questions. You do not have to answer any questions that you do not feel comfortable answering, and you do not have to give the reason why you chose to not answer a particular question. Your data will be included in the study if you do not answer all the questions. You can withdraw from the study at any time without penalty. You may take as much time as you need to answer questions. If you experience distress while participating in this interview, please contact your local **Physician Health Program** at 800-851-6606 or any of the following services:

Urgent Care

Queen's 24-hr Emergency Line

Tel.: 613-533-6111

Non-Urgent Care

Student Wellness Services

Tel.: 613-533- 3196

Potential Benefits: By participating in this study you are providing valuable information, which may lead to improvements in medical education. In addition, your participation will provide important data on the physical and mental health of medical students. This information is important for the development of evidence-based policies aimed at improving the health of medical students. While you may not receive many immediate tangible benefits, you will be contributing to the education and health of your future peers.

Compensation: No compensation will be given for participating in this study.

Confidentiality: I have been assured by the researcher that the information I share during my interview will remain strictly confidential. The information I share during the interviews might be cited or quoted in the analysis; however, my name will not be linked to any text and will not be revealed in any future documents or publications. I have been guaranteed that my identity will be protected through the use of blind ID number codes to identify your interview transcript. Audio recordings and electronic transcriptions of the interviews will be kept in a secure database in Taylor McFadden's laboratory (co-investigator) at the University of Ottawa in Ottawa, Ontario. The only people who will have access to the interview transcripts are the principal and co-investigators. Once data collection is complete, the ID code linking your number to your name will be destroyed.

Questions: If you have any questions or need more information about the study itself, please contact Tamara Morgan at _____ or Taylor McFadden at _____.

If you have any concerns about your rights as a research participant please contact Dr. Albert Clark, Chair of the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board at 1-844-535-2988.

Acceptance: Agreeing to participate in this study does not waive any of your rights or release the researchers from their responsibilities. Please save or print a copy of this document to keep for your own reference.

I, _____, verify that I have read the explanation of the study, and that I consent to participate in the abovementioned research.

Appendix C. Recruitment Text

The following recruitment text will be included in the online survey prior to the consent form: You are invited to participate in a research study titled “Health Behaviours and Prescribing Habits of First to Fourth Year Medical Students”. This study has received approval from the University of Ottawa’s Research Ethics Board and from the Faculty of Medicine.

It will take less than 15 minutes to complete the survey.

By filling out the survey, you will have the option of entering into a draw to win a Fitbit Alta fitness tracker (an approximate value of \$170). Should you choose to provide your name and contact information, you will be entered into the draw upon submission of the survey. If you choose to withdraw from the study at any time, you will still be eligible to win the FitBit Alta fitness tracker.

The researchers would like to thank you for your participation.

Appendix D. Mental Health Continuum-Short Form

1. How often in the past month did you feel...

	Every day	Almost every day	About 2 or 3 times a week	About once a week	Once or twice	Never
Happy?						
Interested in life?						
Satisfied with your life?						
That you had something important to contribute to society?						
That you belonged to a community (like a social group, your neighbourhood, your city, your school)						
That our society is becoming a better place for people like you?						
That people are basically good?						
That the way our society works makes sense to you?						
That you liked most part of your personality?						
Good at managing the responsibilities of your daily life?						
That you had warm and trusting relationships with others?						
That you had experiences that challenged you to grow and become a better person?						
Confident to think or express your own ideas and opinions?						
That your life has a sense of direction or meaning to it?						

Appendix E. 2-item Maslach Burnout Inventory

1. Please read each statement carefully and decide if you ever feel this way about your medical school training. If you never had this feeling, mark “Never”. If you have had this feeling, indicate how often you feel it by marking the response that best describes how frequently you felt that way. You may skip questions that you feel are inappropriate to your situation or you are unable to answer.

	Everyday	A few times a week	Once a week	A few times a month	Once a month or less	A few times a year or less	Never
“I feel burned out from medical school”							
“I have become more callous toward people since I started medical school”							

Appendix F. Demographic Measures

1. Gender (please check):
 - Male
 - Female
 - Other (please specify) _____
2. What is your age? _____ years
3. Which of the following describes your ethnicity? (please check)
 - White
 - Hispanic
 - Aboriginal Canadian
 - Black or African American
 - Asian
 - Other (please specify): _____

Academics:

1. Highest level of education to date (please check):
 - College Degree
 - University- Bachelor-level Degree (BA, BSc, etc.)
 - University- Master-level Degree (PhD, DPhil, EdD, etc.)
 - University- Professional Post-Graduate
 - Other (Please Specify): _____
2. What year are you currently enrolled in?
 - First year
 - Second year
 - Third year
 - Fourth year
3. What area of medicine are you currently most likely to practice in the future?
 - Family Medicine
 - Internal Medicine
 - Surgery
 - Pediatrics
 - Other (please specify) _____

Appendix G. Godin Leisure Time Exercise Questionnaire

Physical activity is any bodily movement produced by your muscles that use energy to occur. The following questions will ask you about the time you spent being physically active in a typical **7-Day period**. Please answer each question even if you do not consider yourself to be an active person. Please think about all activities you do at work, at school, as part of your house and yard work at home, to get from place to place and in your time for recreation, exercise or sport.

1. During a typical **7-Day period**, how many times on average do you engage in **strenuous** exercise (heart beats rapidly) (e.g. long distance bicycling, running, hockey, football, soccer, basketball)?
_____ Times per week
_____ Average minutes per session
2. During a typical **7-Day period**, how many times on average do you engage in **moderate** exercise (not exhausting) (e.g. fast walking, baseball, easy bicycling, volleyball, badminton, dancing)?
_____ Times per week
_____ Average minutes per session
3. During a typical **7-Day period**, how many times on average do you engage in **mild** exercise (minimal effort) (e.g. yoga, golf, bowling, easy walking, fishing)?
_____ Times per week
_____ Average minutes per session

Appendix H. Sitting Measure

1. During a typical **7-Day period**, how many times on average do you spend **sitting** on a **weekday?**

_____ **Hours** per day