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Article abstract

Background: Medical school involves high expectations of medical students, which may increase their risk for burnout. Physical activity (PA) and sedentary behaviour (SB) are modifiable risk factors for burnout. However, medical students are insufficiently taught about PA and SB and may therefore be less likely to meet guideline-recommended levels of these two movement behaviours or promote them in practice. Few studies have examined the relationships between medical students' PA intensity, SB, and burnout; such examination could help clarify educational needs for improving levels of movement behaviours and their promotion.

Purpose: This study investigated (1) the relationships between light, moderate, vigorous, and total PA, SB, and burnout among medical students, and (2) moderate-to-vigorous PA as a moderator of the relationship between SB and burnout, to guide future curriculum renewal.

Methods: Medical students (N = 129) at two Canadian institutions completed online validated questionnaires assessing light, moderate, vigorous, and total PA, SB, and burnout.

Results: Regression analyses indicated that light PA (β = -.191, p = .039) and SB (β=-.230, p = .013) were negatively associated with burnout. Moderate-to-vigorous PA did not significantly moderate the relationship between SB and burnout.

Conclusions: Engaging in lighter forms of PA and SB within guideline recommendations may help mitigate medical student burnout. Competencies to promote movement behaviours may dually target medical student burnout and curriculum gaps.

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Original Research

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Abstract

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Conclusions: Engaging in lighter forms of PA and SB within guideline recommendations may help mitigate medical student burnout. Competencies to promote movement behaviours may dually target medical student burnout and curriculum gaps.

Résumé

Contexte : Les études de médecine impliquent des attentes élevées de la part des étudiants, ce qui peut augmenter leur risque d'épuisement professionnel. L'activité physique (AP) et la sédentarité sont des facteurs de risque modifiables de l'épuisement professionnel. Cependant, les étudiants en médecine ne sont pas suffisamment sensibilisés à l'AP et au comportement sédentaire (SB), et sont donc moins susceptibles d'atteindre les niveaux recommandés par les lignes directrices pour ces deux types de comportement en lien avec le mouvement, ou de les promouvoir dans leur pratique. Peu d'études ont examiné les relations entre l'intensité de l'AP, le SB et l'épuisement professionnel chez les étudiants en médecine ; un tel examen pourrait aider à clarifier les besoins éducatifs pour améliorer les niveaux de comportement en lien avec le mouvement et leur promotion.

Objectif : Cette étude a évalué (1) les relations entre l'AP légère, modérée, vigoureuse et totale, le SB et l'épuisement professionnel chez les étudiants en médecine, et (2) l'AP modérée à vigoureuse en tant que modérateur de la relation entre le SB et l'épuisement professionnel, dans le but de guider le renouvellement du curriculum.

Méthodes : Des étudiants en médecine (N = 129) de deux institutions canadiennes ont complété des questionnaires en ligne validés évaluant l'AP légère, modérée, vigoureuse et totale, le SB, et l'épuisement professionnel.

Résultats : Les analyses de régression ont montré que l'AP légère (β = -.191, p = .039) et le SB (β = -.230, p = .013) étaient négativement associés à l'épuisement professionnel. L'AP modérée à vigoureuse n'a pas modéré de manière significative la relation entre le SB et l'épuisement professionnel.

Conclusions : La pratique de formes plus légères d'AP et de SB conformément aux recommandations des lignes directrices pourrait contribuer à réduire l'épuisement professionnel des étudiants en médecine. Développer des compétences pour promouvoir ces comportements en lien avec le mouvement pourrait à la fois atténuer l'épuisement professionnel et combler certaines lacunes du curriculum.

Introduction

Medical students are tasked with demonstrating a broad set of competencies (i.e., observable abilities or skills) by the time they graduate.[1] In Canada, medical curricula are designed using the CanMEDS framework, which outlines the seven roles that are required of physicians, to facilitate medical students' achievement of these broad competencies.[2] Indeed, the medical curriculum has been described as 'over-extended' as a result of educational inflation and credentialism (i.e., a growing demand for educational qualifications).[3] Further, medical school is known for placing a heavy workload, high competition, and high expectations on medical students,[4] undoubtedly to prepare them to administer optimal care in the future and meet the evolving health needs of society.[3] However, these contributing factors place medical students at an increased risk for burnout,[5] with 44.2% reporting burnout globally.[6] Burnout arises in response to ongoing workplace stressors and has three dimensions: emotional exhaustion, depersonalization, and a lack of personal accomplishment.[7] Burnout among medical students is a pressing concern as it hinders engagement with their studies and can persist into residency;[5,8] thus, timely and effective solutions are needed.

'Movement behaviours' encompass three behaviours—physical activity (PA), sedentary behaviour (SB), and sleep—that people engage in to varying degrees each day that contribute to overall health.[9] Movement behaviours cannot be performed simultaneously, that is, someone who is being physically active is neither engaging in a sedentary activity nor sleeping. In this regard, physical *in*activity and SB—two often conflated terms—are distinct behaviours; the former refers to insufficient amounts of PA while the latter refers to any waking behaviour not exceeding resting level, such as sitting.[10,11] Studies suggest that increasing PA and decreasing SB is beneficial for burnout, stress, and mental illness among medical students. For example, Babenko and colleagues assessed the relationships between exhaustion, engagement, coping strategies (including PA), and psychological needs at one medical school in Canada and found that medical students who engaged in higher levels of PA reported lower levels of burnout.[5] Chellaiyan and colleagues assessed the relationships between SB, anxiety, stress, and depression at one medical college in India and found that medical students who engaged in higher levels of SB reported greater depressive symptoms.[12] However, Babenko et al.[5] did not investigate whether SB or specific intensities of PA related to exhaustion and did not measure the depersonalization and personal accomplishment dimensions of burnout per Maslach's conceptualization and Chellaiyan et al.[12] did not examine associations between SB and burnout. Optimizing these movement behaviours is imperative to medical students' mental wellbeing; thus, it is important to fill the abovementioned gaps by investigating links between PA intensities, SB, and overall burnout.

Lifestyle medicine initiatives in medical education have been growing, some of which have focused on movement behaviours,[13] with physical *in*activity now being the fourth leading risk factor to global mortality.[14] Despite this increasing emphasis, research has indicated that only 62% of medical students at three Canadian institutions met Canada's previous PA guidelines,[15] with 72% engaging in at least eight hours of SB per day.[16] In comparison to Canada's new 24-Hour Movement Guidelines (24HMG), which recommend 150 minutes of moderate-to-vigorous PA (MVPA) per week, several hours of light PA per day, no more than eight hours of SB per day, and seven to nine hours of good-quality sleep per day for adults ages 18-64 years,[9] these data showcase an opportunity to optimize the movement behaviours of future physicians. While 'movement behaviours' is not yet a commonly heard term in medicine, the promotion of Canada's 24HMG (which are still relatively new) in medical education initiatives may help increase familiarity with the term.

Incorporating PA and SB content into the medical curriculum is also one way to improve medical students' levels of PA and SB. Currently, PA and SB health promotion content is not generally included in medical curricula globally despite recent evidence suggesting that incorporating PA and SB content may not require a substantial amount of additional curricular time.[17–21] Further, research supports that medical students who learn about PA for health promotion in medical school have improved their own PA levels. In turn, increasing one's PA can help mitigate burnout.[22,23] Thus, incorporating PA and SB content into the curriculum could increase the likelihood of medical students engaging in optimal levels of these movement behaviours to support their physical and mental health.[22]

However, as burnout is a unique construct to mental health,[24] understanding how different PA intensities (i.e., light, moderate, or vigorous) relate to burnout would help better understand burnout prevention needs during medical education. General population intervention

research has found that vigorous PA twice a week reduced burnout.[25] Other research suggests that engaging in light PA is beneficial for medical students' mental health.[26] Given burnout is a risk factor for mental illness,[27] it is important to investigate whether light PA is also beneficial for medical students' burnout. Research on the relationships between PA duration and intensity, SB, and burnout in medical students is sparse. A meta-analysis identified a need to explore how the interaction between MVPA and SB influences health outcomes and no study to date has investigated these relationships with medical student burnout as the outcome variable.[28] Research also argues that curriculum change efforts must consider the impact on medical students' emotional wellbeing.[3] Thus, we deemed it important to investigate what influence PA and SB have on medical students' experiences of burnout, and if the relationships between PA and burnout vary at different intensities, to advance the literature and inform efforts to promote movement behaviours and mitigate burnout in the medical curriculum.

The primary aim of this study was to examine the relationships between light, moderate, vigorous, and total PA, SB, and burnout in first- to fourth-year medical students at two Canadian universities. A secondary aim was to direct future curriculum renewal based on our findings. Three considerations we explored were: (1) the relationship between total PA and burnout; (2) the relationships between light, moderate, and vigorous PA, SB, and burnout; and (3) whether MVPA moderates the relationship between SB and burnout. Respective hypotheses were that (1) total PA would have a negative relationship with burnout, (2) light, moderate, and vigorous PA, and SB would each have a negative relationship with burnout, and (3) the relationship between SB and burnout would be stronger among medical students who engaged in insufficient or excessive levels of MVPA. Given the heavy workload of medical school, it was expected that more medical students would report burnout if they reported lower levels of SB per day, and even higher levels if they also reported insufficient levels of MVPA or very high levels of MVPA per week.

Methods

Study design

The methodological approach is described in line with reporting guidelines for survey research.[29] This study was cross-sectional, using an online survey of administered on the platform SurveyMonkey. Given that medical students can be challenging to recruit, and that online surveys have been used in other PA and burnout research among medical students as a relatively quick and accessible method,[23] surveys were deemed the best method for data collection in this study. Surveys were also deemed appropriate given the quantitative approach of the study. The survey was developed by the second author in consultation with the third author based on validated questionnaires for assessing PA and burnout (see Measures section). The survey began with questions on self-identification (e.g., gender) and academic (e.g., year of study) characteristics before asking medical students to self-report levels of PA, SB, and feelings of burnout. Prior to data collection, the survey was piloted by the first author to ensure understandability and operability. Approval from the Faculties of Medicine at Queen's University and McGill University was obtained prior to commencing this study.

Participants and setting

The target population included all medical students enrolled at two Canadian universities. Eligible participants were medical students enrolled in any year of the undergraduate medical program (first, second, third, or fourth year) and who comprehended English. Medical students who could not comprehend English were excluded. Links to the online survey were distributed to all medical students through medical student Facebook groups and weekly e-newsletters, and through an in-person announcement in a mandatory first-year class at one university. Opportunity sampling methods were used to obtain the final sample from a cohort of 1,140 enrolled medical students at the two universities. Efforts to mitigate nonresponse bias included using the short-forms of questionnaires to reduce survey burden and sending reminder invitations to complete the survey. Informed consent was obtained from all participants through a yes/no checkbox on page one of the survey. All survey responses were anonymous.

The survey was available for three months, beginning mid-semester as this was deemed to be the most representative of medical students' typical PA, SB, and feelings of burnout. Some medical students completed the survey after the end of the semester. Given the sensitivity of questions on burnout, contact information for local psychological services was provided. While participation was strictly voluntary, participants were incentivized with the choice to provide their e-mail address in a separate, unlinked survey for a draw to win a FitBit Alta.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study received ethical clearance from the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board (HSREB) (REB number: ROMEO/TRAQ: #6022151, Department code: PHE-172-17) and the McGill Research Ethics Board II (REB File: #177-0917)

Measures

Physical activity (PA). The Godin Leisure Time Exercise Questionnaire was used to assess the frequency, duration, and intensity of leisure time PA as it has been validated for use among medical students.[30,31] Participants reported how many "times per week" (i.e. frequency) and "average minutes per session" (i.e. duration) they engaged in light, moderate, and vigorous PA over a typical seven-day period. Each frequency is multiplied by its respective Metabolic Equivalent Task value [i.e. (3 x light); (5 x moderate); (9 x vigorous)], resulting in a weighted, summed leisure score index (LSI) for each intensity (light, moderate, and vigorous). Total LSI is the sum of the three LSI values. MVPA in minutes per week is the sum of the (frequency x duration) for moderate and vigorous PA.

Sedentary behaviour (SB). Participants were asked, "How many hours per day do you spend sitting on a typical weekday?" While there are many postures other than sitting that are sedentary (i.e., reclining and lying postures[10]), sitting was deemed a reasonable proxy for SB for this population as medical students are most often sedentary via seated positions. This question has been used to assess SB in prior research.[12,32] Possible responses ranged from 0-24 hours for a continuous score.

***Burnout*.** The 2-item Maslach Burnout Inventory (MBI) was used to assess burnout.[7] It is a widely utilised tool in burnout research among medical students and physicians.[33] It is a valid and reliable instrument for measuring emotional exhaustion, depersonalization, and total burnout in medical students.[34] The 2-item MBI has been adapted from the original 22-item questionnaire, and both items (i.e. emotional exhaustion and depersonalization) correlate strongly with their respective domains in the full MBI.[33] Both responses 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. Individuals are classified as burned out if they score ≥ 4 on one or both items, which indicates high emotional exhaustion and/or depersonalization "once a week" or more frequently.[34] This measure has shown good internal consistency (Cronbach's $\alpha = 0.72$) and a strong inter-item correlation at 0.57 in previous work.[34]

Data analysis

Survey data downloaded from SurveyMonkey were imported into the statistical software package SPSS 23.[35] Preliminary analyses showed no violation of assumptions of normality, linearity, homoscedasticity, collinearity, or homogeneity of variances.[36] Correlations were conducted to determine the strength and direction of relationships between variables. Significance was set to an alpha level of 0.05. Effect sizes are reported as Cohen's f^2 (i.e., (≥ 0.02 small effect, ≥ 0.15 medium effect, ≥ 0.35 large effect).[37] Post-hoc analyses were run using GPower 3.1 to assess achieved power.[38]

A linear regression analysis was run to assess the predictive strength of total PA per week (total LSI value) on burnout. To assess the predictive strength of minutes of light, moderate, and vigorous PA per week (frequency x duration for each PA intensity), and hours of sitting per day on burnout, a multivariate linear regression was conducted. Finally, a moderated linear regression was performed to examine how total MVPA per week [$(\text{frequency}_{\text{moderate}} \times \text{duration}_{\text{moderate}}) + (\text{frequency}_{\text{vigorous}} \times \text{duration}_{\text{vigorous}})$] moderated the relationship between sitting hours per day and burnout.

Results

Preliminary data analysis

In total, 141 medical students completed the survey (12.4% response rate). Although low, the response rate reflects those of other online medical student survey research supporting the challenges of seeking participation in research among time-pressed medical professionals/trainees.[31,39] To ensure no response bias, levels of PA and burnout were compared between early and late responders (i.e., before and after December 25th, respectively, to mark the end of the exam period), yielding no significant differences. Our power analyses indicated that a minimum of 85 participants would be needed to achieve 80% power with a medium effect size and four predictor variables, in terms of our largest regression model. Therefore, the sample size was satisfactory for all regression models. Missing values analyses indicated that

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). Little's MCAR test revealed data that were missing completely at random (X^2 = 394.126, p = .056), thus expectation-maximization was chosen as an imputation method.[40] Outliers were removed for MVPA (n = 7), light PA (n = 8), moderate PA (n = 7), vigorous PA (n = 4), SB (n = 6), and burnout (n = 6) prior to imputation. No response bias was found, as individuals who responded before and after December 25th showed no significant differences in PA (t = 1.265, p = .208), SB (t = -.608, p = .545), or burnout (t = 1.364, p = .175).

Table 1. Frequencies of demographics, physical activity and sitting in medical students (N = 129).

		n (%)
Gender	Male	55 (42.6)
	Female	73 (56.6.)
	Other	1 (0.8)
Year of study	First	66 (48.1)
	Second	31 (24.0)
	Third	20 (15.5.)
	Fourth	16 (12.4)
Ethnicity[a]	White	75 (58.1)
	Indigenous Peoples of Canada	1 (0.8)
	Hispanic	1 (0.8)
	Black/African American	4 (3.1)
	Asian	33 (25.6)
	'Other'[b]	14 (10.9)
	NR	*1 (0.8)*

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

[a] The term "ethnicity" is reported in place of the correct term "race", as pertaining to the response options provided in the survey, as the former is the term that was included in the question stem that participants responded to in the survey, which was conducted in 2018. The author team acknowledges the incorrect use of the term "ethnicity" and includes it herein merely to accurately reflect how participants were asked about ethnicity and how this may have influenced their responses.

[b] 'Other' ethnicities self-reported by participants in the open text box included: South Asian, Jewish, Sri Lankan, Iranian, North African, Arab, European, Bengali Canadian, Mediterranean, Han, and Asian-Caucasian.

Participant characteristics

Medical students in this sample were 25 years old on average (M = 24.91, SD = 4.31) and just over half (56.6%) self-identified as female (Table 1). These characteristics are representative of the medical student population at the time of the study according to national data.[41] Table 2 compares minutes of light, moderate, vigorous and total PA per week and sitting hours per day according to medical students whose reported levels of burnout were categorized as 'burned out' or 'not burned out' based on established cut-points.[34]

Table 2. Descriptive statistics of minutes of light, moderate, vigorous, and total physical activity, moderate-to-vigorous physical activity, and hours of sitting in medical students according to burnout category (N = 129).

	Not burned out	Burned out	Total sample
	n = 102 (79.1%)	*n* = 27 (20.9%)	
	M (SD)	*M* (SD)	*M* (SD)
Total PA (LSI)	57.14 (26.02)	60.96 (24.83)	57.94 (25.73)
MVPA[a]	198.64 (119.24)	239.20 (132.02)	206.95 (122.51)
Light PA[a]	139.50 (120.30)	149.81 (173.01)	116.52 (84.38)
Moderate PA[a]	99.20 (114.28)	99.26 (81.41)	80.11 (63.12)
Vigorous PA[a]	124.20 (116.12)	163.89 (135.08)	120.91 (102.51)
Sitting hours[b]	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) + (light x 3)].

[a]Minutes per week; [b]Hours per day

Relationship between total physical activity and burnout

The full regression model was not significant, F (1, 121) = 1.372, p = .244, and explained 1.1% of the variance in burnout. The effect size was negligible (Cohen's f^2 = 0.01) with low power (0.21). Nevertheless, and in line with the hypothesis, the relationship between total PA and burnout was negative (β = -.106, p > .05), with medical students who achieved higher levels of MVPA more often reporting lower levels of burnout.

Relationships between light, moderate, and vigorous PA, SB, and burnout

The full model was significant, F (4, 110) = 3.645, p = .008, and explained 11.7% of the variance in burnout, approaching a medium effect size (Cohen's f^2 = 0.12) with high power (0.88). The strongest negative predictor of burnout was SB (β = -.230, p = .013), indicating that medical students who reported spending more hours sitting per day reported lower levels of burnout. Light PA was also a negative predictor of burnout (β = -.191, p = .039), indicating that medical students who reported engaging in more minutes of light PA per week reported lower levels of burnout. Minutes of moderate PA per week approached significance as a positive predictor (β = .161, p = .079), suggesting that medical students who reported engaging in more moderate PA per week tended to report higher burnout. Minutes of vigorous PA per week was not a significant predictor in the model (β = -.002, p = .984). A correlation matrix is presented in Table 3.

Table 3. Relationships between light, 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 mins/week		-	-.02	.04	.22*	.47**	.65**	.75**	-.13	.12
(3) Light LSI			-	.67**	.23*	.16┼	-.08	-.14	.14	-.09
(4) Light mins/week				-	.06	.16┼	.06	-.05	.12	-.19*
(5) Mod. LSI					-	.68**	-.19*	-.16┼	.10	-.06
(6) Mod. mins/week						-	-.002	-.01	-.02	.13
(7) Vig. LSI							-	.84**	-.14	.01
(8) Vig. mins/week								-	-.16┼	.04
(9) Sitting hours/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) + (light x 3)].

MVPA as a moderator between SB and burnout

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 = 0.07) and adequate power (0.77). There was a non-significant main effect for MVPA (p = .459) but a significant main effect for sitting hours (β = -.247, p = .008). MVPA did not significantly moderate the relationship between sitting 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), suggesting that medical students who sat fewer hours per day and engaged in more minutes of MVPA per week had the highest levels of burnout (Figure 1).

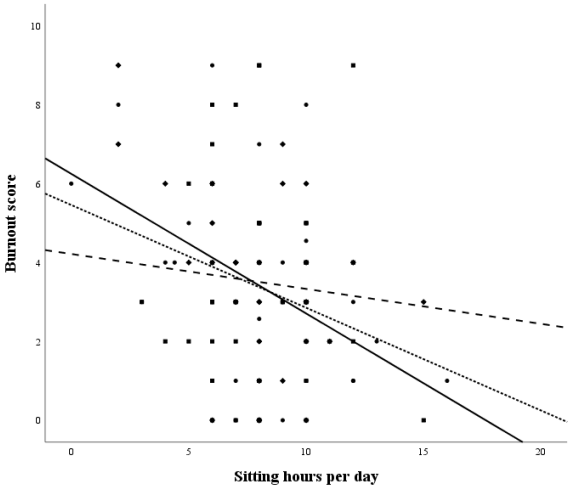

Figure 1. The relationship between sitting and burnout across levels of moderate-to-vigorous physical activity in medical students.

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

Discussion

This study aimed to investigate whether PA duration, intensity, and SB related to burnout among a sample of medical students at two Canadian medical schools. Results suggested that lighter intensities of PA and levels of SB in proximity with guideline recommendations may be beneficial to reducing levels of burnout. With the advent of Canada's 24-Hour Movement Guidelines for Adults, which specify recommendations for PA, SB, and sleep for health benefits,[9] medical schools have the opportunity to help mitigate burnout among medical trainees by promoting healthy movement behaviours to better support the next generation of health professionals.

The relationship between total PA and burnout was not significant; however, the negative direction of this relationship is supported by prior work.[5] While research supports that all types of PA can be beneficial to physical health,[42] further research is needed to examine the relationships between total PA and burnout in a larger sample of medical students in Canada in addition to exploring interactions with sedentary and sleep behaviours. Doing so may better assess medical students' considerations and preferences for learning how to improve their movement behaviours in line with Canada's 24-Hour Movement Guidelines, which can inform more targeted curriculum initiatives.

Minutes of light PA per week significantly and negatively predicted burnout, showing that more minutes of light PA was associated with lower burnout. Intervention research among medical interns and residents has found light PA to reduce burnout.[43] However, given our study was cross-sectional, it is possible that lower levels of burnout predicted higher levels of light PA. Medical students who were not burned out may have felt more relaxed and thus

primed for less intense forms of PA. The results of the present study suggest that light PA may support psychological health among medical students. As evidenced by Canada's 24-Hour Movement Guidelines (24HMG),[9] several hours of light PA per day is recommended to promote optimal health. Communicating this to medical students may improve their awareness of how light PA can benefit their health and wellbeing.

Interestingly, sitting fewer hours per day was significantly and negatively related to burnout. This finding, in combination with our finding on the benefit of light PA for burnout, suggests that medical students who are not allotting enough time for restful activities may be at an increased risk of burnout. Important to note is that medical students who reported burnout engaged in an average of 6.70 hours/day of SB, compared to the 8.36 hours/day of SB that medical students who did not report burnout engaged in. Those in the latter group were only slightly higher than the overall average of 8.01 hours/day of SB, which notably is also the recommended level of daily SB per the 24HMG recommendations.[9] Thus, our findings suggest that medical students may be less likely to experience burnout if they remain within proximity to the guideline recommendations for SB and replace any excessive MVPA with light PA. Indeed, medical students in a past study reported 'exercise' and 'taking days off' as the top two strategies they have used to prevent burnout.[44]

Another explanation for the negative relationship between sitting and burnout could be the fact that medical students in first and second year, who typically experience lower rates of burnout, have more classes and down time, and sit more, compared to third and fourth years who are in clerkship and report consistently higher rates of burnout.[45] To explore this further, we calculated the mean levels of sitting per each year of study and found that that pre-clerkship medical students did engage in higher SB than those in clerkship (first year, *M* = 8.98 hours/day; second year, *M* = 8.75 hours/day; third year, *M* = 5.10 hours/day; fourth year, *M* = 6.44 hours/day). Overall, medical culture can favour productivity over rest and contribute to burnout; thus, medical students may benefit from incorporating light movement or rest breaks.

Further, MVPA did not significantly moderate the relationship between sitting and burnout. Perhaps since medical students were already highly active (see Table 1), MVPA did not have a large influence on burnout. While overall PA was negatively related to burnout in our regression models, light and restorative forms of PA (e.g., nature walks) may be more beneficial to medical students as they may feel less depleting than structured, higher-intensity PA.[46] Medical students who reported sitting fewer hours per day in our sample may have been more prone to burnout due to insufficient restful activities to break up their intense studies or higher-intensity PA. Thus, when teaching about SB, it could be worth noting that both excessive amounts (i.e., far over 8 hours/day[47]) and extremely low amounts of SB may not be conducive to medical students' physical or psychological health if they are also engaging in too much MVPA in place of too little light PA.

There is a key opportunity to take a holistic approach to integrating PA and SB content into the medical curriculum and endorsing healthy movement behaviours. From a Competency Based Medical Education perspective,[1] which focuses on the progression of outcomes, supporting medical students to engage in healthy movement behaviours should start with teaching the 24HMG recommendations and the health risks or health benefits of meeting or not meeting those recommendations, respectively, before progressing to teaching evidence-based strategies for changing their movement behaviours. In turn, supporting changes in medical students' movement behaviours can help build important self-care skills that are useful in preventing and managing burnout.[23] Moreover, optimizing medical students' movement behaviours can help them promote movement behaviours in future practice as health professionals who meet guideline-recommended levels of PA have been shown to provide PA counselling more frequently and confidently.[48] Efforts to renew medical curricula should be cognizant of curricular inflation and aim to add little to no additional curricular time, such as through embedding PA prescription in existing classes or providing brief endorsements of light PA (e.g., active transport) or restful activities (e.g., self-care) for personal wellness.[21]

Additionally, any renewal that is initiated from individuals external to a medical school (e.g., researchers) should be done in collaboration with those internal to the medical school, rather than enforcing mandatory changes.[21] Similarly, medical students should be encouraged and offered opportunities to practice engaging in healthy levels of PA and SB, with options to include various ability levels, rather than be forced to change their PA or SB as part of the curriculum. Finally, focusing on the full movement continuum,[49] it would be salient to include content on healthy sleep duration, quality, hygiene, consistency, and

timing in addition to PA and SB in the curriculum.[21] Overall, minimally burdensome, co-produced renewal efforts should lead to more feasible and implementable curriculum changes, resulting in more medical students learning effective strategies to mitigate burnout.

Study limitations and future directions

Limitations to this research included the convenience sampling method and low response rate, which may have reflected a non-response bias and a sample that lacked representativeness of the full eligible population. Attempts were made to mitigate bias, including using validated survey measures that were brief to reduce participant burden. However, it should be noted that the validity and reliability of the question to assess SB has not been assessed in research among medical students and is thus this data may be limited in its accuracy. Further, sitting was used as a proxy for SB, which made it impossible to determine the effects of different types of SB (e.g., studying, socializing) on burnout. Lastly, there is the potential for over- or under-reporting of PA and SB in research among students, which could reflect social desirability.[50] Medical students who enjoy PA may have been more inclined to participate as the prize draw was an activity tracking device. Future research should use objective measures (i.e. accelerometers) to assess how light, moderate, vigorous, and total PA, and different types of SB influence burnout in a larger number of Canadian medical schools, to improve generalizability. Findings from this study may inform efforts to incorporate a greater focus on movement behaviours in the curriculum to improve medical students' movement behaviours, burnout, and skills for future practice.

Conclusion

In this study, negative associations between light PA and burnout and between SB and burnout, and a positive association (approaching significance) between moderate PA and burnout among medical students, point toward potential benefits engaging in gentler forms of PA and amounts of SB within guideline recommendations for medical student burnout. This research may inform future explorations of relationships between PA duration and intensity, SB, and burnout among a larger sample or in other Canadian medical schools. Our findings may also guide initiatives to support medical student wellbeing within the high-achieving culture of medicine, such as by medical educators striving to incorporate PA and SB content into the curriculum or encouraging medical students to take needed breaks, move well, and manage feelings of burnout.

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