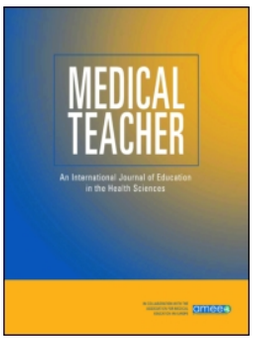

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Basic psychological needs, more than mindfulness and resilience, relate to medical student stress: A case for shifting the focus of wellness curricula

Adam Neufeld[a], Annik Mossière[b]* and Greg Malin[c]

[a]Department of Family Medicine, University of Calgary, Calgary, Canada; [b]Clinical Psychologist, Saskatchewan Health Authority, Saskatoon, Canada; [c]Department of Academic Family Medicine, College of Medicine, University of Saskatchewan, Saskatoon, Canada

ABSTRACT

Purpose: Medical student distress is an increasing concern in medical education. Addressing this issue requires a comprehensive understanding of what factors influence learners' stress in medical school. Grounded in Self-Determination Theory (SDT), this study explores the relative association between medical students' mindfulness, resilience, basic psychological needs, and perceived stress.

Materials and methods: Of all year 1–4 medical students at our institution, 197 (49%) completed an online survey, measuring satisfaction and frustration of their basic psychological needs (autonomy, competence, relatedness), mindfulness, resilience, and perceived stress. Variables were assessed in relation to perceived stress, controlling for students' gender and year.

Results: Higher mindfulness, resilience, and need satisfaction were associated with lower perceived stress. Conversely, need frustration was associated with higher perceived stress. When students' need frustration was included in the model, the association between mindfulness, resilience, and perceived stress weakened. Third years reported more autonomy frustration than all other years. Compared to males, females in second and fourth year reported higher stress, lower mindfulness and resilience, and less competence fulfilment.

Conclusions: Findings of this study suggest that, while mindfulness and resilience are important qualities for medical student well-being, their stress-protective benefits may diminish when students' basic psychological needs are frustrated in medical school. Addressing potentially need-thwarting aspects of the learning environment is therefore recommended, to help reduce student stress and promote their well-being. Preliminary suggestions on how this might be achieved are discussed, from an SDT perspective.

KEYWORDS

Medical student; basic psychological needs; stress; mindfulness; resilience

Introduction

Intrinsic motivation and psychological well-being are globally valued qualities in medical education, yet are at risk for students during medical school (Dyrbye et al. 2006; Kusurkar and Croiset 2015; Dyrbye and Shanafelt 2016). In response to disturbing prevalence statistics on medical student distress (e.g. upwards of 24% meet criteria for depressive illness) (Rotenstein et al. 2016), considerable efforts have been spent developing educational interventions that bolster medical students' resilience and mindfulness (McAllister and McKinnon 2009; Tempski et al. 2012; Dobkin and Hutchinson 2013; Farquhar et al. 2018; Daya and Hearn 2018). While these qualities themselves are known facilitators of well-being (Dyrbye et al. 2006; Ishak et al. 2013; Rahimi et al. 2014), there is little evidence that related wellness interventions are truly helping medical students' well-being (Wasson et al. 2016). Moreover, wellness interventions tend to convey to medical students that student well-being is the sole responsibility of the individual, without acknowledging the social nature of human psychological well-being and important implications between the learner and learning environment.

A key element of the social dynamic of well-being is the role of medical students' basic psychological needs for

Practice points

- While mindfulness and resilience have important stress-protective qualities for medical learners, taking basic psychological needs (autonomy, competence, and relatedness) into the equation is a particularly important consideration for understanding their well-being.
- Findings from this study suggest that need satisfaction, resilience, and mindfulness are stress-protective, but that when medical students' basic needs are frustrated, their ability to be mindful and resilient may diminish.
- Additionally, findings suggest that third year may represent a particularly autonomy-thwarting time for medical learners, and that female students, more than males, may experience higher perceived stress, lower mindfulness and resilience, and less competence fulfilment, especially in years two and four.
- Overall, this study illustrates how promoting students' need fulfilment in medical school can help reduce their perceived stress and facilitate their ability to be mindful and resilient.

CONTACT Adam Neufeld adam.neufeld@ucalgary.ca Cumming School of Medicine, Department of Family Medicine, Foothills campus, University of Calgary, 3330 Hospital Drive NW, Calgary, Alberta T2N 4N1, Canada
*The author is currently a registered Clinical Psychologist, practicing in Calgary, Alberta.

autonomy, competence, and relatedness, which are central to Basic Psychological Needs Theory (BPNT)—a mini theory within Self-Determination Theory (SDT) (Ryan and Deci 2000). This theory is described below, followed by an explanation of its place in medical student education. We then highlight the current state of stress and wellness in medical school, the role of BPNT in well-being, as well as the influence of additional factors (i.e. student gender and year of study) on stress and wellness. Finally, the current research is described and outlined. Results and a discussion of the findings follow.

A brief overview of SDT

SDT represents a broad framework for the study of human motivation and well-being, positing that quality of motivation exists along a continuum, ranging from poorer quality extrinsic motivation (i.e. by external pressures) to higher quality intrinsic motivation (i.e. out of joy or interest) (Ryan and Deci 2000). According to SDT, peoples' intrinsic motivation and well-being are enhanced by environmental supports for three basic psychological needs—autonomy, competence, and relatedness (Ryan and Deci 2000, 2017). Autonomy is the need to experience volition in one's life, behavior, and goals (versus feeling controlled or helpless), competence is the need to feel effective in what one does (which is fueled by overcoming challenges), and relatedness is the need to feel connected and that one matters to significant others (Ryan 1995).

BPNT—a mini-theory within SDT that focuses specifically on these psychological needs—assumes that all human beings universally require satisfaction of autonomy, competence, and relatedness in order to thrive, and that conversely, frustration of any of these needs will come at significant functional costs (Vansteenkiste and Ryan 2013; Ryan and Deci 2017). Thus, when a given environment (e.g. medical school) supports these basic psychological needs, people are more likely to flourish and move towards motivational states that favor autonomous behavior and well-being, than when these needs are thwarted, which can provoke psychological distress (e.g. stress, maladjustment, burnout, etc.) (Vansteenkiste and Ryan 2013; Ryan and Deci 2017). It is important to note that, while the absence of basic need satisfaction does not necessarily imply basic need frustration (Bartholomew et al. 2011; Vansteenkiste and Ryan 2013; Ryan and Deci 2017), basic need frustration (e.g. when people feel they are a failure, or ongoingly feel isolated, pressured, or conflicted) does imply low basic need satisfaction (Vansteenkiste and Ryan 2013).

An example of where support or hindrance of autonomy, competence, and relatedness may be particularly important is in the way instructors give feedback (Mouratidis et al. 2010), which can be a real source of stress for medical learners (Bowen et al. 2017). To support autonomy, a preceptor might get the learner(s) to identify the most interesting or challenging cases to discuss and offer suggestions for how to continue in their self-directed efforts to become more proficient. To support competence, the preceptor may sit down with learners privately, inquire about their perceptions of their own performance, propose strengths and potential areas for improvement (with a specific rationale for why), and focus the evaluation on learners' intrinsic rather than extrinsic goals (e.g. career-related aspirations vs. passing the rotation). Finally, to support relatedness, the preceptor might show warmth and empathy, provide examples of their own personal experiences, and offer timely, informational, and personalized feedback. For a more comprehensive list of ways that medical teachers can support and undermine medical students' basic psychological needs, see Neufeld and Malin (2020).

SDT and BPNT in medical education

Although SDT-based research is still a growing field in medical education, numerous studies have helped shape our understanding of teaching and learning processes, and have assisted in guiding the development and reform of various aspects of curricula in medical education (Williams and Deci 1998; ten Cate et al. 2011; Kusurkar et al. 2011, 2013; Orsini et al. 2016). Research concerning motivation in medical education has shown that, when the learning environment and workplace is more supportive of their basic psychological needs, it conduces to a range of beneficial outcomes for medical learners (e.g. deeper learning, better academic performance, and increased resiliency and psychological well-being) (Williams and Deci 1998; Kusurkar et al. 2013; Neufeld and Malin 2020). Studies from the broader context of health professions education, dealing with basic psychological needs, are complimentary (Orsini et al. 2016, 2018). Despite the fact that students' basic psychological needs are critical to their motivation and well-being, research and policies that reflect these constructs are still lacking in medical education.

Student wellness in medical school

Regarding medical student well-being, the benefits of mindfulness (non-judgmental awareness and attention to the present moment) and resilience (the ability to withstand stressful experiences) are well-documented (Dunn et al. 2008; Ishak et al. 2013; Daya and Hearn 2018). In view of this, to help combat medical student distress, considerable efforts have been made researching the utility of various wellness initiatives or interventions in medical education (i.e. programs that aim to foster student well-being and self-care, and promote a culture of resilience within the learning environment) (Velez et al. 2019). While these types of initiatives show some potential in helping medical students maintain their wellness (Pidgeon and Keye 2014; Tempski et al. 2015; Slonim et al. 2015), it is important to point out what they convey to students—that adapting to the rigors of medical school is primarily their responsibility and less a shared one, on the part of medical educators. Evidence shows this can negatively affect learner satisfaction and engagement (Aherne et al. 2016) and actually add to feelings of distress and burnout for medical learners (Squiers et al. 2017).

In addition, wellness initiatives in medical education tend to be formalized and mandatory for learners (Aherne et al. 2016), which, by default, is controlling and undermines autonomous motivation (Williams and Deci 1998; White 2007; Baldwin et al. 2012). Moreover, research on wellness initiatives has largely been outcome-focused (versus person-focused), neglecting the role of basic

psychological needs, and how need frustration influences medical students' ability to be mindful and resilient in the first place (i.e. within the learning environment). From an SDT perspective, these oversights are critical, given the barriers and affordances to need satisfaction that medical students face in the learning environment are considered ultimate sources of stress and obstacles to wellness (Weinstein and Ryan 2011).

Basic psychological needs in stress and coping

Research grounded in SDT shows that environments that support people's basic psychological needs are associated with less stress incursion (Weinstein and Ryan 2011). These need-supportive environments have also been shown to increase resilience, adaptive coping, and mindfulness (Weinstein et al. 2009; Weinstein and Ryan 2011), likely reflecting the fact that mindfulness facilitates more autonomous functioning and psychological need satisfaction, and thus promotes well-being (Deci and Ryan 1980; Weinstein and Ryan 2011). The current study aims to extend such research to the study of medical students, where similar findings are expected, but have not yet been assessed. This exploration is relevant, given the potential for highly controlling (and thus need-thwarting) learning environments in medical school (Williams and Deci 1998; Baldwin et al. 2012). We define *learning environment* as the physical and psychosocial contexts in which students learn (e.g. in the classroom or in clinical settings, such as in a hospital), which is influenced by their interactions with peers, faculty and teachers, curriculum, and program infrastructure (Genn 2001a). We define a *need-supportive learning environment* as one that promote learners' basic psychological needs (autonomy, competence, and relatedness) for intrinsic motivation (e.g. by actively involving learners in education and care decisions, providing supportive feedback and setting optimal levels of challenge, and engaging in empathic connections with learners, where they feel part of a team) and avoids controlling tactics to motivate learners (e.g. micromanaging, introducing external controls, and/or using evaluations that center around rewards and punishments, which undermines intrinsic motivation) (Niemiec and Ryan 2009).

Additional factors influencing student wellness in medical school

While many demographic and structural/environmental factors (e.g. socioeconomic status, race/ethnicity, mental health, etc.) could have an impact on medical students' experience in medical school and their overall wellbeing (e.g. Ishak et al. 2013; Dunham et al. 2017; Tackett et al. 2017), gender and year of study are two areas that have garnered much attention in the literature. These are briefly reviewed, in turn, below.

The medical literature seems mixed when it comes to gender differences in medical student well-being. While some studies have found no effects of gender on well-being (Hojat et al. 1999; Tempski et al. 2015), others have demonstrated important differences, such as in mindfulness (and effects of mindfulness interventions) (De Vibe et al. 2013). Indeed, many studies show that, despite performing equally well to (or better than) male medical students, females report higher stress (Shah et al. 2010), lower resilience (Rahimi et al. 2014), and less self-confidence in medical school (Blanch et al. 2008). From an SDT perspective, chronic feelings of stress or low self-confidence are considered a by-product of psychological need deprivation (Ryan and Brown 2003). In other words, whether needs are fulfilled or thwarted may be key underlying factors that contribute to females' feelings of stress in medical school. While gender differences in medical student motivation have been explored under an SDT lens (e.g. strength of motivation and reasons for going to medical school) (Kusurkar et al. 2011), gender differences in medical students' basic psychological need fulfilment (and their association with aspects of well-being in medical school, such as resilience, mindfulness, and perceived stress) remain relatively unexplored (Neufeld and Malin 2019).

Another factor that seems an important determinant of medical students' mental health is the stage of training in their medical education. For instance, in a longitudinal study on medical students' changing perceptions of the learning environment, throughout their four-year medical training, it was found that students' perceptions (which differed by gender) worsened during third year, before improving again after 'match day' in fourth year (when students match to residency programs) (Dunham et al. 2017). Similarly, other studies also point to the third year in medical school as being the most stressful for students (Hojat et al. 2009), presumably due to its demanding nature and higher degree of responsibility and supervision (e.g. mandatory clinical duties, longer work hours, challenging board examinations, etc.) (Crockett et al. 2019). To our knowledge, how controlling (and thus autonomy-frustrating) medical students perceive their clerkship is in third and fourth year (i.e. compared to pre-clerkship years) has not been studied but may help understand the nature of their stress.

In sum, there is a paucity of research accounting for medical students' interactions with their medical program, with respect to how their perceptions of the psychological need-supportiveness or hindrance in their learning environment are associated with their motivation and psychological well-being. This can shed light on potential ways to help medical students cultivate and sustain their own self-determination (from within), without imposing or adding to their stress, through interventions. In previous work, we examined basic psychological needs in the context of medical students' resilience and psychological well-being (Neufeld and Malin 2019) and in their perceptions of instructor autonomy-support in the learning environment (Neufeld and Malin 2020). The current study expands on this work, with a focus on students' perceived stress in medical school.

Current study

The learning environment in medical school and students' perceptions of it are known determinants of medical students' mental health (Genn 2001b; Miles and Leinster 2007; Lai et al. 2009; Dyrbye et al. 2009). The literature also highlights that medical students' resilience (Tempski et al. 2015; McKenna et al. 2016), mindfulness (Slonim et al. 2015; Aherne et al. 2016), and basic psychological needs (Neufeld

Table 1. Measurement tools and scoring.

Instrument	Items	Measures	Scoring
Mindful Attention & Awareness Scale (MAAS)	15	Mindfulness	1 (*almost always*) to 6 (*almost never*)
Connor Davidson Resilience Scale (CD-RISC)	10	Resilience	0 (*not true at all*) to 4 (*true nearly all the time*)
Basic Psychological Needs Satisfaction & Frustration Scale (BPNSF)	24	Needs satisfaction and frustration (autonomy, competence, relatedness)	*1 (not true at all) to 5 (completely true)*
Perceived Stress Scale (PSS)	10	Perceived stress	*0 (never) to 4 (very often)*

and Malin 2019, 2020) are each important considerations in this regard. Less evident, however, is how these qualities collectively relate to students' perceived stress in medical school. Without considering medical students' perceptions of how need-supportive or thwarting they feel the learning environment is in medical school, medical programs and curriculum designers may overestimate the stress-protective benefits of wellness initiatives that target mindfulness and resilience. This study aims to fill this gap in the literature and additionally explores the role of demographics (i.e. gender and year of study in the MD program) in medical students' basic psychological need satisfaction and frustration, resilience, mindfulness, and perceived stress. Based on previous research, the hypotheses are as follows:

1. Higher mindfulness, resilience, and need satisfaction will relate to lower ratings of perceived stress, whereas need frustration will relate to lower mindfulness and resilience, and higher perceived stress (Weinstein et al. 2009; Weinstein and Ryan 2011; Vansteenkiste and Ryan 2013).
2. As basic psychological needs are essential for optimal functioning and well-being (Ryan and Deci 2000, 2017), need frustration will account for more of the variance in perceived stress than either mindfulness or resilience. Moreover, when students' basic need frustration is considered, the association between mindfulness, resilience, and perceived stress will weaken.
3. Given the 4-year structure of this medical program (see description below), it was anticipated that clerkship students in years 3 and 4 (especially year 3's) will experience higher stress (Hojat et al. 2009; Crockett et al. 2019) and basic need frustration (particularly autonomy) compared to pre-clerkship students (in years 1 and 2).
4. Female medical students will report higher perceived stress, lower resilience and mindfulness, and greater need frustration (particularly competence) compared to male students (Blanch et al. 2008; Shah et al. 2010; Rahimi et al. 2014).

Methods

Participants

A total of 400 students from all four years of the medical program in a prairie province in Canada were invited to complete an anonymous internet-based questionnaire. Of note, this is a four-year medical program that employs a 2 + 2 curriculum—consisting of two pre-clinical years (largely classroom-based systems modules, with clinical skills training and patient exposures mixed in) and two clinical years (primarily hospital and clinic-based, with 6-week clinical rotations and call shifts, in each specialty area). The questionnaire was open for 8 weeks at the end of the academic year, and asked students about their perceptions of the need-supportiveness or need-hindrance (i.e. autonomy, competence, and relatedness) of the learning environment, their mindful attention and awareness, resilience, and perceived stress. A convenience sample was obtained (i.e. no specific recruitment beyond email invitations/reminders to participate). Data was collected in aggregate form to prevent participant identification, maintain confidentiality, and mitigate any response bias (i.e. pressure or motivation to respond in a particular way).

Ethical approval

This research received ethical approval from the University Research Ethics Board. All participants provided written informed consent prior to taking part in the study.

Measures

The internet-based questionnaire contained demographic questions (i.e. year of study and gender identification) and four previously validated scales. See Table 1 below for summary of scales.

Basic Psychological Needs Satisfaction and Frustration Scale (BPNSF – Chen *et al. 2015*)

The original 24-item scale measures satisfaction and frustration of peoples' three basic psychological needs (autonomy, competence, and relatedness) based on SDT. It has been cross-culturally validated and shown to have strong reliability and construct validity (Chen et al. 2015). The scale poses questions about the kinds of experiences people currently have in their lives, and participants rate how true various statements are for them on a 5-point Likert scale (1 = *not true at all* to 5 = *completely true*). Example statements include: 'I feel a sense of choice and freedom in the things I undertake', 'I feel confident that I can do things well', and 'I feel that the people I care about also care about me'. For the purpose of this study, the wording of the stem was modified slightly, to reflect students' experiences 'over the past year in medical school'. As has been done in prior research using this measure, we conducted analyses using the individual needs subscales, and on a composite score of total need satisfaction and total need frustration (Chen et al. 2015).

Mindfulness Attention Awareness Scale (MAAS – Brown and Ryan *2003)*

The 15-item MAAS inventory has been validated and measures peoples' dispositional and state mindfulness. It

provides a collection of statements about everyday experiences, and asks participants to indicate how frequently or infrequently they currently have each experience, on a 6-point Likert scale (1 = *almost always*, 2 = *very frequently*, 3 = *somewhat frequently*, 4 = *somewhat infrequently*, 5 = *very infrequently*, and 6 = *almost never*). Example statements include: 'I could be experiencing some emotion and not be conscious of it until sometime later', 'I break or spills things because of carelessness, not paying attention, or thinking of something else', and 'I forget a person's name almost as soon as I've been told it for the first time'. For the purpose of this study, the original wording of the stem was modified to cue students to their every-day experiences in medical school.

Connor Davidson Resilience Scale (CD-RISC – Campbell-Sills and Stein *2007*)

The 10-item CD-RISC has been validated in health sciences research (Campbell-Sills and Stein 2007) and measures peoples' resilience. It includes a series of statements that deal with overcoming adversity, which is a common theme in medical school and relevant to our research questions. With each statement, participants are asked to select the option that indicates their level of agreement, as it applies to them over the past month, on a 5-point Likert scale (0 = *not true at all, 1 = rarely true, 2 = sometimes true, 3 = often true,* 4 = *true nearly all the time*). Example statements include: 'I am able to adapt when changes occur', 'I try to see the humorous side of things when I am faced with problems', 'I am able to handle unpleasant or painful feelings, like sadness, fear, and anger'. The original stem was modified slightly, to reflect how true students felt each statement applied to them during the last year in medical school.

Perceived Stress Scale (PSS – Cohen *1994*)

The 10-item PSS is a widely used tool for measuring perceived stress (the degree to which situations in one's life are appraised as stressful). It has been shown to have strong reliability and construct validity (Cohen 1994). Items ask how unpredictable, uncontrollable, and overloaded respondents find their lives. The scale includes direct queries about current levels of experienced stress, and participants are asked to rate each item on a 5-point Likert scale (*0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often*). Example questions include: 'How often have you been upset because of something that happened unexpectedly?' and 'How often have you found that you could not cope with all the things that you had to do?'. The original questions in the PSS ask about feelings and thoughts during the last month. These were modified to reflect students' experiences during the last year in medical school.

Statistical analyses

All outliers and submitted surveys with insufficient data (i.e. less than two completed scales) were removed prior to carrying out our basic statistical analyses, using SPSS version 24.0. All data were assessed and met the statistical assumptions of normality, homoscedasticity, and multicollinearity, prior to proceeding with our statistical analyses. Reliability tests for all measurement instruments were performed using Cronbach's alpha coefficients, which were each considered satisfactory (all α's $>$ .78). Correlational analyses were conducted to assess the relationships between all variables. The collinearity statistics were all within acceptable limits (VIF $<$ 5). Hierarchical regression was utilized to assess the extent that the demographic, mindfulness, resilience, and basic psychological needs variables (total need satisfaction and need frustration of autonomy, competence, and relatedness) contributed to changes in the criterion, perceived stress. We put medical students' basic psychological needs as the final step in the regression, to determine the extent that students' basic needs contributed to their perceived stress in medical school, over and above the contributions of mindfulness and resilience. For the regression analyses, squared semi-partial correlation values (sr^2) assessed the unique contributions of each predictor variable to the variance in the criterion. To further assess the effects of our categorical demographic variables (i.e. gender and year of study) on the variables of interest, multivariate one-way analysis of variance (MANOVA) was utilized. Unpaired *t*-tests (or pairwise comparisons where there exceeded two subgroups) with Bonferroni's *p*-value correction were then conducted, to unpack the significant effects. Levene's test of equal variances was used for all subgroup comparisons. Cohen's *d* was included to provide effect sizes (where values of 0.2, 0.5, and 0.8 are considered small, medium, or large, respectively).

Results

Demographics

The response rate of the medical students was 54% (214/400) and 197 cases were analyzed. The sample consisted of 92 males (47%) and 105 females (53%). There were 71 (36%) 1st years, 58 (29%) 2nd years, 36 (18%) 3rd years, and 36 (18%) 4th years. The sample mean age was 25.9 years (*SD* = 3.7).

Factors contributing to medical students' perceived stress

Correlational analyses (see Table 2) conducted on the overall basic need scores revealed that basic need satisfaction, mindfulness, and resilience positively correlated with one another and negatively correlated with perceived stress. In addition, the opposite was true for basic need frustration, which negatively correlated with mindfulness and resilience and positively correlated with perceived stress. Finally, a strong negative relationship was evident between basic need satisfaction and basic need frustration.

A hierarchical regression was conducted to examine the association between medical students' mindfulness, resilience, overall basic need satisfaction (incorporating autonomy, competence, and relatedness), and perceived stress, while controlling for gender and year of study. Students' overall need satisfaction was added in the final step of the regression model, to determine how it influenced perceived stress, above and beyond mindfulness

Table 2. Correlations among demographics, basic psychological needs, mindfulness, resilience, and perceived stress.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Gender	—												
2. Year	0.03	—											
3. AS	−0.12	−0.05	—										
4. CS	−0.22**	−0.03	0.67**	—									
5. RS	0.02	−0.05	0.53**	0.54**	—								
6. AF	0.02	0.15*	−0.70**	−0.55**	−0.41**	—							
7. CF	0.17**	0.06	−0.54**	−0.79**	−0.43**	0.50**	—						
8. RF	0.03	0.01	−0.49**	−0.52**	−0.67**	0.42**	0.53**	—					
9. BNS	−0.12	−0.05	0.86**	0.87**	0.81**	−0.65**	−0.69**	−0.66**	—				
10. BNF	0.10	0.09	−0.71**	−0.77**	−0.61**	0.81**	0.84**	0.77**	−0.82**	—			
11. PS	0.23**	0.06	−0.64**	−0.71**	−0.46**	0.59**	0.75**	0.52**	−0.71**	0.77**	—		
12. M	−0.25**	0.01	0.57**	0.59**	0.36**	−0.44**	−0.51**	−0.40**	0.60**	−0.56**	−0.62**	—	
13. R	−0.20**	0.09	0.63**	0.70**	0.44**	−0.38**	−0.65**	−0.44**	0.70**	−0.61**	−0.71**	0.53**	—

Gender (1 = male, 2 = female); Year (1–4); AS: autonomy satisfaction; CS: competence satisfaction; RS: relatedness satisfaction; AF: autonomy frustration; CF: competence frustration; RF: relatedness frustration; BNS: basic psychological need satisfaction (autonomy, competence, and relatedness); BNF: basic psychological need frustration (autonomy, competence, and relatedness); PS: perceived stress; M: mindful attention and awareness; R: resilience.
*Statistically significant at $p < 0.05$ and ** at $p < 0.01$ level (two-tailed).

Table 3. Hierarchical regression of demographics, mindfulness, resilience, and basic need satisfaction on perceived stress among medical students.

Variable	B	*SE.B*	*β*	95% CI sr^2	sr^2
Step 1					
Year	0.297	0.409	0.052	[−0.509, 1.103]	0.003
Gender	2.967	0.896	0.236**	[1.199, 4.734]	0.056
Step 2					
Year	0.596	0.271	0.104*	[0.062, 1.131]	0.011
Gender	0.642	0.613	0.051	[−0.566, 1.851]	0.002
M	−2.594	0.447	−0.330**	[−3.475, −1.712]	0.075
R	−0.510	0.055	−0.525**	[−0.618, −0.402]	0.193
Step 3					
Year	0.416	0.260	0.073	[−0.098, 0.929]	0.005
Gender	0.908	0.584	0.072	[−0.245, 2.061]	0.005
M	−1.785	0.459	−0.227**	[−2.691, −0.879]	0.030
R	−0.347	0.063	−0.357**	[−0.471, −0.223]	0.061
BNS	−0.254	0.055	−0.312**	[−0.363, −0.145]	0.042

$R^2 = 0.059$ for step 1 ($p < 0.005$); $\Delta R^2 = 0.535$ for step 2 ($p < 0.001$); $\Delta R^2 = 0.042$ for step 3 ($p < 0.001$); Overall $R^2 = 0.636$.
Year (1–4); Gender (1 = male, 2 = female); BNS: basic psychological need satisfaction (autonomy, competence, and relatedness); M: mindful attention and awareness; R: resilience; B: unstandardized beta; *SE.*B: standardized error for the unstandardized beta; *β*: standardized beta; CI: confidence interval; sr^2: semi-partial correlation squared; R^2: coefficient of determination; ΔR^2: change in coefficient of determination.
*Statistically significant at $p < 0.05$ and ** at $p < 0.01$ level (two-tailed).

and resilience, and how the variance that mindfulness and resilience accounted for in perceived stress, changed accordingly (see Table 3).

As was hypothesized, higher scores in mindfulness and resilience were associated with lower ratings of perceived stress. As seen in Table 3, with all five variables entered sequentially, the model accounted for 63.6% of the variance in students' perceived stress, where each variable added incrementally to the overall variance of perceived stress at each step. In the final model, only students' mindfulness, resilience, and overall need satisfaction (and not their gender or year), contributed uniquely to the variance in perceived stress.

Next, a second hierarchical regression was conducted, this time looking at the association between mindfulness, resilience, overall basic need frustration (incorporating autonomy, competence, and relatedness), and perceived stress, while controlling for gender and year. As seen in Table 4, when all five variables were entered sequentially, the overall model accounted for 71.4% of the variance in perceived stress. Again, each variable added incrementally to the overall variance of perceived stress at each step. As was hypothesized, once students' overall need frustration was included in the model, the contributions of the other factors were reduced, with basic need frustration accounting for the most unique variance (12.2%) in perceived stress.

Effects of year on perceived stress and basic need frustration

As was expected, the MANOVA revealed a significant main effect of year on perceived stress [F (3, 184) = 2.83, $p = 0.040$]. However, while the planned pairwise comparisons between years approached statistical significance and had medium Cohen's effect sizes, they did not yield statistically significant relationships (see Table 5).

For frustration of students' three basic needs, the MANOVA found a significant effect of year on autonomy [F (3, 184) = 5.166, $p = 0.002$], but not on competence [F (3, 184) = 2.459, $p = 0.064$] or relatedness [F (3, 184) = 1.368, $p = 0.254$]. In keeping with a priori hypotheses, pairwise comparisons examining the effect of year on autonomy revealed a large effect of year on autonomy frustration, whereby third years reported the highest level of autonomy frustration and differed significantly from first and second years, but not fourth years (see Table 6). The mean difference between third and fourth years approached but did not achieve statistical significance. Fourth years did not differ from other years in the program (all p's > 0.05).

Effects of gender on stress, mindfulness, resilience, and basic need fulfilment

As expected, point-biserial correlational analyses revealed that females reported lower satisfaction (and higher

Table 4. Hierarchical regression of demographics, mindfulness, resilience, and basic need frustration on perceived stress among medical students.

Variable	B	*SE.B*	β	95% CI	sr^2
Step 1					
Year	0.258	0.409	0.045	[−0.550, 1.066]	0.002
Gender	3.038	0.897	0.242**	[1.268, 4.808]	0.059
Step 2					
Year	0.588	0.273	0.103*	[0.050, 1.126]	0.010
Gender	0.662	0.616	0.053	[−0.554, 1.879]	0.003
M	−2.584	0.449	−0.329**	[−3.469, −1.699]	0.075
R	−0.510	0.055	−0.525**	[−0.618, −0.401]	0.193
Step 3					
Year	0.211	0.233	0.037	[−0.248, 0.671]	0.001
Gender	1.138	0.520	0.091*	[0.111, 2.165]	0.008
M	−1.247	0.406	−0.158**	[−2.048, 0.671]	0.015
R	−0.302	0.052	−0.311**	[−0.404, −0.200]	0.053
BNF	0.360	0.041	0.482**	[0.279, 0.441]	0.122

$R^2 = 0.062$ for step 1 ($p < 0.005$); $\Delta R^2 = 0.530$ for step 2 ($p < 0.001$); $\Delta R^2 = 0.122$ for step 3 ($p < 0.001$); Overall $R^2 = 0.714$.
Year (1–4); Gender (male = 1, female = 2), BNF: basic psychological need frustration (autonomy, competence, and relatedness); M: mindful attention and awareness; R: resilience; B: unstandardized beta; *SE.B*: standardized error for the unstandardized beta; *β*: standardized beta; CI: confidence interval; sr^2: semi-partial correlation squared; R^2: coefficient of determination; ΔR^2: change in coefficient of determination.
*Statistically significant at $p < 0.05$ and ** at $p < 0.01$ level (two-tailed).

Table 5. Pairwise comparisons in medical students' perceived stress by year of study.

	Year	Year	MD	*SE*	*p*-Value	95% CI	*d*
	1	2	0.00	1.14	1.000	[−3.04, 3.04]	0.00
		3	−3.61	1.36	0.052	[−7.25, 0.02]	0.62
		4	0.10	1.31	1.000	[−3.39, 3.59]	0.02
	2	1	−0.00	0.66	1.000	[−1.59, 1.92]	0.00
		3	−3.62	1.41	0.068	[−7.38, 0.15]	0.62
		4	0.10	1.36	1.000	[−3.52, 3.73]	0.02
PS	3	1	3.61	1.36	0.052	[−0.02, 7.25]	0.62
		2	3.62	1.41	0.068	[−0.15, 7.38]	0.62
		4	3.72	1.55	0.105	[−0.42, 7.85]	0.62
	4	1	−0.10	1.31	1.000	[−3.59, 3.39]	0.02
		2	−0.10	1.36	1.000	[−3.73, 3.53]	0.02
		3	−3.72	1.55	0.105	[−7.85, 0.42]	0.62

PS: perceived stress; MD: mean difference; *SE*: standard error; CI: confidence interval; *d*: Cohen's effect size.
*Statistically significant (two-tailed).

Table 6. Pairwise comparisons in medical students' autonomy frustration by year of study.

	Year	Year	MD	*SE*	*p*-value	95% CI	*d*
	1	2	−0.17	0.66	1.000	[−1.92, 1.59]	0.05
		3	−2.90	0.78	0.002*	[−4.98, −0.81]	0.76
		4	−0.72	0.76	1.000	[−2.75, 1.30]	0.21
	2	1	0.17	0.66	1.000	[−1.59, 1.92]	0.05
		3	−2.73	0.81	0.005*	[−4.88, −0.57]	0.73
		4	−0.55	0.79	1.000	[−2.65, 1.54]	0.16
AF	3	1	2.95	0.805	0.002*	[0.80, 5.09]	0.76
		2	2.80	0.832	0.006*	[0.58, 5.02]	0.73
		4	2.28	0.912	0.080	[−0.15, 4.71]	0.58
	4	1	0.72	0.76	1.000	[−1.30, 2.75]	0.21
		2	0.55	0.79	1.000	[−1.54, 2.65]	0.16
		3	−2.17	0.89	0.095	[−4.55, 0.21]	0.58

AF: autonomy frustration; MD: mean difference; *SE*: standard error; CI: confidence interval; *d*: Cohen's effect size.
*Statistically significant (two-tailed).

frustration) of their need for competence, lower mindfulness and resilience, and higher perceived stress (see Table 2). As per *a priori* hypotheses, follow-up MANOVA analyses similarly found significant main effects of gender on perceived stress [F (1, 185) = 12.129, $p = 0.001$], mindfulness [F (1, 185) = 13.163, $p < 0.001$], resilience [F (1, 185) = 8.727, $p = 0.004$], competence satisfaction [F (1, 185) = 9.338, $p = 0.003$] and competence frustration [F (1, 185) = 5.665, $p = 0.018$]. The effect of gender was not significant on autonomy satisfaction [F (1, 185) = 2.395, $p = 0.123$] and autonomy frustration [F (1, 185) = 0.110, $p = 0.740$], nor on relatedness satisfaction [F (1, 185) = 0.001, $p = 0.973$] or relatedness frustration [F (1, 185) = 0.203, $p = 0.653$].

Post-hoc unpaired *t*-tests were conducted to unpack these main effects and see where the differences lay. Specifically, cases were split by year of study to explore whether the gender effects varied by students' year in the medical program. Interestingly, these *post hoc* analyses revealed that significant gender differences in perceived stress, resilience, mindfulness, and competence satisfaction and frustration specifically occurred in years 2 and 4 (see Table 7). Within these year-subgroups, female students reported higher perceived stress, lower resilience and mindfulness, and less competence satisfaction. Additionally, female students reported more competence frustration specifically in 4th year, compared to males.

Table 7. Unpaired *t*-tests comparing male and female medical students with cases split by year.

	M_{male} (*SD*)	M_{female} (*SD*)	*t*	*df*	*p*-Value	95% CI	*d*
Perceived stress							
Year 1	17.94 (6.82)	17.74 (6.14)	0.13	66	0.901	[−2.94, 3.34]	0.03
Year 2	15.17 (6.76)	19.89 (5.25)	−2.97	53	0.005*	[−7.98, −1.49]	0.78
Year 3	20.09 (5.24)	22.37 (5.12)	−1.16	29	0.281	[−6.03, 1.81]	0.44
Year 4	14.53 (6.33)	20.77 (5.89)	−3.02	33	0.005*	[−10.44, −2.03]	1.02
Resilience							
Year 1	26.22 (7.34)	28.69 (5.25)	−1.60	66	0.114	[−5.54, 0.65]	0.39
Year 2	31.73 (6.23)	25.50 (6.13)	3.82	56	<0.001*	[2.96, 9.50]	1.01
Year 3	29.52 (5.46)	25.05 (6.20)	1.99	29	0.082	[−0.54, 8.69]	0.76
Year 4	32.78 (6.60)	26.78 (5.60)	2.94	34	0.006*	[1.85, 10.15]	0.98
Mindful attention and awareness							
Year 1	3.67 (0.84)	3.60 (0.81)	0.34	69	0.732	[−0.32, 0.46]	0.01
Year 2	3.87 (0.71)	3.29 (0.66)	3.24	56	0.002*	[0.22, 0.94]	0.85
Year 3	3.47 (0.86)	3.33 (0.79)	0.36	30	0.718	[−0.50, 0.71]	0.01
Year 4	4.27 (0.79)	3.21 (0.75)	4.16	34	<0.001*	[0.55, 1.59]	1.38
Competence satisfaction							
Year 1	15.21 (3.23)	15.40 (3.34)	−0.24	66	0.814	[−1.78, 1.40]	0.06
Year 2	16.50 (2.55)	14.03 (2.18)	3.91	54	<0.001*	[1.21, 3.74]	1.04
Year 3	14.75 (3.17)	13.89 (3.30)	0.73	30	0.472	[−1.53, 3.23]	0.26
Year 4	16.76 (2.54)	14.11 (2.91)	2.87	33	0.007*	[0.77, 4.54]	0.97
Competence frustration							
Year 1	10.06 (3.96)	9.38 (3.64)	0.73	65	0.468	[−1.18, 2.53]	0.26
Year 2	8.89 (4.03)	10.50 (3.09)	−1.69	54	0.097	[−3.51, 0.30]	0.45
Year 3	10.67 (3.82)	12.05 (3.01)	−1.15	30	0.258	[−3.83, 1.07]	0.40
Year 4	7.88 (2.91)	11.56 (3.91)	−3.13	33	0.004*	[−6.06, −1.29]	1.07

M: mean; *SD*: standard deviation; *df*: degrees of freedom; CI: confidence interval; *d*: Cohen's effect size.
*Statistically significant (two-tailed).

The corresponding Cohen's d values were all large, indicating strong gender effects among the two years.

Discussion

In the present study, we set out to determine the relationship between medical students' perceptions of their learning environment in medical school (i.e. how supportive or thwarting it was to their basic psychological needs for autonomy, competence, and relatedness), and their mindfulness, resilience, and perceived stress. We hypothesized that mindfulness and resilience would both relate to reduced stress ratings for medical students, but that students' basic psychological need fulfilment would emerge as the stronger contributor to medical students' perceived stress.

Factors contributing to perceived stress in medical school

In line with BPNT and our hypotheses, greater mindfulness, resilience, and basic need satisfaction (versus frustration) each related to lower perceived stress (Weinstein and Ryan 2011). However, while higher levels of mindfulness and resilience were initially associated with lower ratings of stress, their stress-protective benefits diminished when students' basic need fulfilment was considered. This was most evident with students' basic need frustration, which contributed most to the variance in perceived stress. It was unsurprising that resilience accounted for a slightly higher amount of variance in students' perceived stress than their need satisfaction, given low levels of need satisfaction do not necessarily equate to need frustration, but still invite more stress than those with higher need satisfaction (Ryan and Deci 2017). These results illustrate the importance of both supporting *and* not thwarting medical learners' basic needs, toward facilitating their mindfulness and helping reduce their stress levels in medical school. Additionally, findings highlight the value of studying models that account for medical students' perceptions of the learning environment, and not simply personal attributes (e.g. mindfulness and resilience), or outcome-oriented interventions that aim to bolster them. In other words, supporting (and, particularly, not frustrating) medical students' basic psychological needs in medical school is as important, if not more critical to reducing their perceived stress and fostering their well-being. These findings add to the existing literature demonstrating the beneficial role of learning environments that support medical student' basic psychological needs in medical school (Neufeld and Malin 2019, 2020).

Gender and year differences in mindfulness, resilience, basic needs and perceived stress

Medical educators tend to place significant emphasis on transition years in medical school (such as first and third year), which are often considered the most stressful for medical students (Kjeldstadli et al. 2006; Brennan et al. 2010; Salgar 2014). Accordingly, our results showed a main effect of year on medical students' perceived stress and follow-up tests pointed to third year as the culprit. Unfortunately, however, the pairwise comparisons in perceived stress across the four years did not achieve statistical significance. The reason for these null findings is unclear but may be related to issues of statistical power. Nonetheless, findings (e.g. medium effect sizes) keep with other reports in the literature which indicate third year is a particularly stressful time for medical students (Bernstein and Carmel 1991; O'Brien et al. 2007; Hojat et al. 2009; Jadoon et al. 2010). Interestingly, the same third year students reported the highest level of autonomy frustration compared to all other years, which is a known predictor of distress (Ryan and Deci 2000, 2017). This result may be a reflection of the challenges medical students face in third year, which is the first year of clinical clerkship, when medical students have less freedoms and choices

(e.g. demanding work and sleep schedules) (White 2007). However, further research is needed to understand this phenomenon (e.g. with structural equation modelling or qualitative research).

Another interesting finding of this study was the particularly high correlation between perceived stress and competence frustration, which suggests that supporting learners' need for competence may be critical for reducing their stress and promoting their well-being, during their medical education (Neufeld and Malin 2019). Findings indicate this may be even more important for female medical students, particularly in years two and four, whom reported significantly more stress, lower mindfulness and resilience, and lower fulfilment of their need for competence, compared to their male peers. While other studies have reported similar gender differences to this study (e.g. in perceived stress and resilience), particularly in later years of medical students' training (Dahlin and Runeson 2007; Blanch et al. 2008; Shah et al. 2010; Rahimi et al. 2014), to our knowledge, this represents the first study to explore gender differences in need fulfilment, in relation to medical student stress. Given mixed gender findings exist in the well-being literature (Tempski et al. 2015), further research is needed to elucidate these outcomes.

Although the specific reasons for these gender differences were not explored in the present study, it is possible they stem from the feelings and concerns these female medical students have about their own confidence at these times in their medical education (Blanch et al. 2008) (i.e. prior to transitioning into new and different responsibilities, such as clerkship or residency). Studies show that many women in higher education tend to feel this way (Cokley et al. 2015; Vaughn et al. 2019), so it follows that negative perceptions of the medical environment and culture may intensify this even more (Henning et al. 1998; Gottlieb et al. 2020). Findings may also reflect gender differences in medical students' motivation—that is, in their motivational orientations (individual differences in basic need strength) or self-regulatory styles (which differentially correspond to varying levels of need satisfaction) (Ryan and Deci 2000, 2017). Future studies may consider these factors in relation to medical students' well-being in medical school.

The results that third years had the highest autonomy frustration may have some practical implications. For example, when medical leaders (e.g. directors, teachers, administrators, etc.) take autonomy-supportive approaches (discussed below), it can result in improved resilience and well-being for medical students and residents during their medical education (Williams and Deci 1998; Kusurkar and Croiset 2015; Farquhar et al. 2018). Hence, medical learners' perceptions of autonomy-support matter, both in classroom and clinical learning environments. At the same time, an emphasis on transition years in medical school (e.g. first and third year) may overshadow the needs of medical students in second and fourth year. Indeed, our results indicate that they may also experience less mindfulness, resilience, and competence fulfilment in these years, especially among females. More attention may therefore be warranted for medical students at these times, to ensure they are engaged, stimulated, and confident about their progress in their medical education.

Limitations and future directions

Our study has several limitations which may help guide future research. This is a correlational study conducted at one University, in which the authors relied solely on self-report measurement instruments. This limits generalizability and prevents conclusions about causal variable relationships. Future studies may therefore consider experimental designs or structural equation modelling to approach causality inferences. Another limitation was in modifying the original wording in the survey scales, which despite preserving strong internal consistency scores, could have potentially affected the scales' internal validity. While the study benefits from inclusion of demographic variables (e.g. year of study) and highlights potential timepoints when supports may be warranted for medical students, data were not assessed over time, but at the end of the year (asking students to reflect back over the past year). This may limit our hypothesized explanations for the gender and year-subgroup differences that were found. Replication of this study, including longitudinal and qualitative methods, would help to validate these findings and further explore differences in basic need satisfaction and perceived stress, by gender and year. Additionally, it may be worthwhile to evaluate the potential impact of response bias among the respondents and non-respondents, to further validate and generalize these findings.

While we make several suggestions for supporting medical students' autonomy, competence, and relatedness during different years in medical school, another potential limitation is that clinical learning environments (e.g. in a hospital) may not always be as malleable as courses or teacher behavior in a classroom, for supporting students' basic psychological needs. That said, our findings (and SDT's principles in general) can certainly be applied in clinical settings, where smaller group and team-based interactions may actually facilitate opportunities for medical students to autonomously self-regulate and satisfy their basic psychological needs (e.g. through autonomy-supportive supervision, competence-supportive feedback and evaluations, and investing time with learners and actively involving them in the learning process, to help support their relatedness needs). It is in these types of settings that positive leader and team dynamics, setting optimal challenges, and creating room for choices and self-directed learning can be critical to learner motivation, performance, and well-being. As studies show that millennial medical students' stress often stems from underrecognized systems-level issues (Hill et al. 2018), future research may consider exploring ways to coordinate and evaluate efforts to support medical students' intrinsic motivation and well-being, particularly between departmental leaders (e.g. directors, administrators, and teachers in undergraduate medical education), clinical clerkship rotation coordinators, and medical staff that learners work with during their training (e.g. physician residents and attending physicians).

Conclusion and implications

This research contributes to a growing body of literature on medical student well-being and provides insight into the potential impact that motivational-psychological aspects of the learning environment can have on medical students' perceived stress, as well as their mindfulness and resilience. Findings align with SDT and show that both support and hindrance of students' basic psychological needs in medical school strongly relate to their perceived stress; in particular, autonomy for third years and competence for second and fourth years. Findings support that higher mindfulness and resilience relate to lower perceived stress for medical students but suggest that a stronger predictor of their stress may be their underlying perceptions of autonomy, competence, and relatedness satisfaction in medical school. In particular, the frustration of students' basic psychological needs in the learning environment seems to have detrimental effects on their ability to engage in mindfulness or resilience strategies.

While giving medical students tools to manage the stress of medical school can be beneficial (e.g. through wellness initiatives that aim to foster mindfulness and resilience), an overemphasis on reactive interventions may overshadow the importance of addressing, proactively, aspects of the learning environment that hinder learner motivation and well-being, through barriers to basic psychological need satisfaction. After all, when a plant is stressed and does not bloom, you fix the environment in which it grows, not the plant. This speaks to feasible implications for classroom practice, clinical teaching, curricular design, and education reform policies, in which we emphasize the important role that medical education leaders and teachers play in optimizing learners' intrinsic motivation and wellness.

Ethical approval

This study received ethical approval from the institutional Research Ethics Board in April 2018.

Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

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Glossary

Mindful awareness: A non-evaluative, receptive, moment-to-moment attention or awareness (Brown and Ryan 2003). This inner resource supports more autonomous functioning and basic psychological need satisfaction, and thereby facilitates well-being.

Resilience: Refers to an individual's positive adaptations and ability to thrive in the face of adversity, such as stress or trauma (Luthar, Cicchetti and Becker 2000).

Perceived stress: The degree to which situations in one's life are appraised as stressful—that is, how unpredictable, uncontrollable, or overloaded people find their lives (Cohen 1994).

Notes on Contributors

Adam Neufeld, MD, MSc, is a Resident in the Department of Family Medicine at the University of Calgary. His areas of research are in medical education and positive psychology.

Annik Mossière, PhD, is a registered Clinical Psychologist, who practices in Calgary, Alberta. Her research interests are in clinical and forensic psychology.

Greg Malin, MD, PhD, is a faculty member in the Department of Academic Family Medicine, and Academic Director for the Undergraduate Medical Education program at the University of Saskatchewan. His areas of interest are in medical education and self-determination.

ORCID

Adam Neufeld http://orcid.org/0000-0003-2848-8100
Annik Mossière http://orcid.org/0000-0001-5680-4524
Greg Malin http://orcid.org/0000-0001-5650-4353

Data availability statement

Data from this study can be made available upon reasonable request.

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