Burnout, Perceived Stress, Sleep Quality, and Smartphone Use: A Survey of Osteopathic Medical Students

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Context: Burnout is a psychological syndrome that results from prolonged exposure to stressful work activities and includes 3 dimensions: emotional exhaustion (EE), depersonalization (DP), and low sense of personal accomplishment (PA). Burnout is a widespread problem in numerous professions but is particularly high among medical students, residents, and early-career physicians compared with college graduates of similar age. However, minimal research has addressed burnout in osteopathic medical students.

Objective: To assess levels of burnout in osteopathic medical students and to examine the relationship among burnout, perceived stress, sleep quality, and smartphone use.

Methods: This study used a cross-sectional study design and an anonymous, electronic questionnaire service to administer the Maslach Burnout Inventory, the Perceived Stress Scale-4, the Pittsburgh Sleep Quality index, and the Smartphone Addiction Scale Short Version.

Results: A total of 385 participants (mean [SD] age, 25 [2.4] years; 208 [54.0%] women; 286 [74.3%] white; 138 [35.8%] second-year osteopathic medical students [OMSs]) completed the survey. Of the 385 participants, 9 (2.3%) reported high EE, 67 (17.4) reported high DP, and 310 (80.5) reported a high level of low PA. When comparing dimensions of burnout by gender, only levels of PA differed by gender, with men reporting higher levels of burnout compared with women ($\chi^2 = 5.2, P = .022$). Further, levels of DP differed by year in medical school ($\chi^2 = 17.3, P = .008$), with post-hoc comparisons showing differences between OMS I and OMS III ($F = 4.530, df = 3, P = .004$). Linear regression models showed that higher perceived stress (standardized $\beta = 0.5, P < .001$), poorer sleep quality (standardized $\beta = 0.2, P = .001$), and higher smartphone addiction scores (standardized $\beta = 0.1, P < .001$) were associated with higher EE. Similarly, higher perceived stress (standardized $\beta = 0.2, P < .001$), poorer sleep quality (standardized $\beta = 0.2, P = .001$), and higher smartphone addiction scores (standardized $\beta = 0.2, P = .001$) were associated with higher DP. Only higher perceived stress was associated with higher levels of low PA (standardized $\beta = -0.4, P < .001$).

Conclusions: These findings suggest independent associations with EE, DP, perceived stress, sleep quality, and smartphone use. Additional research with a larger, more diverse sample is needed to confirm these findings. If confirmed, wellness interventions can be designed to target 2 modifiable factors: sleep quality and smartphone use.

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Keywords: burnout, medical students, sleep, smartphone addiction
Burnout is a psychological syndrome that results from prolonged exposure to stressful activities. As a syndrome that is uniquely dependent on social and organizational contexts, burnout is considered to be an occupationally specific dysphoria. Burnout can lead to a wide range of poor outcomes; it is a significant predictor of coronary heart disease, musculoskeletal pain, and type 2 diabetes mellitus, as well as psychological morbidity and suicidal ideation. Studies of burnout in working populations have identified poor physical outcomes in a diverse range of professions, including dentists, forest industry employees, firefighters, correctional officers, lawyers, school teachers, manufacturers, child welfare workers, and software developers. Burnout is more likely to occur in individuals who experience vicarious trauma and is disproportionately present in medical students, residents, and practicing physicians.

Characterization of burnout at each step of medical education is important for determining outcomes and prevention strategies. Burnout is classically assessed with the Maslach Burnout Inventory and includes 3 subscales: emotional exhaustion (EE), which is a chronic state of physical and emotional depletion caused by excessive and prolonged stress; depersonalization (DP) or cynicism, which can lead to alienation and apathy; and low sense of personal accomplishment (PA), which may result in decreased productivity, low morale, and decreased experience of success and competence through work. Symptoms of burnout are stratified across the spectrum of medical education, with differences between medical students, residents, and early-career physicians.

The prevalence of burnout in medical students ranges between 28% and 71%. Suicidal ideation in medical students, which can be predicted by burnout, is 2 to 3 times more likely than in the US adult population (11.2% and 3.7%, respectively). Risk factors for burnout in the medical student population may include perceived stress, inadequate sleep or low sleep quality (which is correlated to nighttime digital media use), hypersonomnia, studying for more than 80 hours per week, experiencing reduced confidence, having a major illness, perceiving inadequate support by faculty, and having exposure to cynical residents. Imposter syndrome, characterized by self-doubt and fear of being discovered as an intellectual fraud, may also predispose medical students to burnout.

Residents experience higher DP, overall sense of burnout, and increased fatigue when compared with other trainees. The prevalence of burnout in residents ranges from 40% to 80%, and is specialty-dependent. Sources of resident burnout include work hours, sleep deprivation, electronic health record use, and staff conflicts, as well as stressors related to moving to a new workplace, teaching responsibilities, and information overload.

Early-career physicians are more likely to experience increased EE when compared with residents and medical students. An estimated 51.4% of early-career physicians report burnout. In studies of early-career physicians, risk factors are highly variable and include younger age, shorter exercise duration, and low degree of respect from colleagues. Other studies cite poorly designed electronic health records and quality metrics, workload, and time pressure.

To date, minimal research has addressed burnout in osteopathic medical students. Informed by previous research, we assessed the relationship among burnout, perceived stress, sleep quality, and smartphone use. Research shows that blue light from the use of electronic devices at night prior to sleeping disrupts the circadian rhythm, decreases sleepiness, suppresses melatonin, alters sleep quality and sleep efficiency, and reduces cognitive performance in the morning. For these reasons, we included smartphone use as a potential contributing factor to burnout. Thus, the purpose of this study was to assess the level of burnout in osteopathic medical students. We hypothesized that higher levels of perceived stress, lower sleep quality, and higher smartphone use would be associated with higher levels of burnout.
Methods
A descriptive, cross-sectional study design was used to assess burnout in students enrolled at an osteopathic medical school with 3 distinct campuses during the 2017-2018 academic year. The University Office of Research Compliance approved the protocol (18-E-127) and all recruitment procedures and materials. An electronic, anonymous survey invitation was distributed by the study investigator (E.A.B.) via a school-maintained electronic mailing service. The survey opened on April 16, 2018, and a reminder email was sent on May 1, 2018. Participation in the study was voluntary. Participants received a $10.00 gift card as compensation for participating in the study. To receive compensation and maintain study anonymity, participants who completed the survey were directed to a new Qualtrics link where they could provide their name and email address.

In addition to sociodemographic factors (age, sex, race/ethnicity, year in medical school, medical school campus) and health factors (height, weight, body mass index, average hours of sleep), participants completed the following measures:

- Maslach Burnout Inventory-Human Services Survey\(^2\): a 22-item measure assessing EE, DP, and PA. Participants scored each item on a 7-point scale, where 0 was “never,” 1 was “sometimes per year or less often,” 2 was “once a month or less often,” 3 was “several times a month,” 4 was “once a week,” 5 was “several times a week,” and 6 was “daily.” High levels of burnout correspond to high scores for EE, high scores for DP, and low scores for PA.

- Perceived Stress Scale\(^2\): a 4-item measure assessing psychologic stress over the past month. This brief self-assessment measures the degree to which individuals perceive their lives to be stressful. Participants scored each item on a 4-point scale, where 0 was “never,” 1 was “almost never,” 2 was “sometimes,” 3 was “fairly often,” and 4 was “very often.” Perceived stress scores ranging from 0 to 5 were considered low stress, scores ranging from 6 to 10 were considered moderate stress, and scores ranging from 11 to 16 were considered high stress. Prior studies have demonstrated internal consistency for the Perceived Stress Scale to be between 0.67 to 0.73.\(^2\)-\(^3\)

- Pittsburgh Sleep Quality Assessment\(^3\): a 9-item measure assessing quality and patterns of sleep in adults. Participants provided qualitative and quantitative data describing usual sleep habits during the past month only. The scale was then scored to create a 7-component measurement, with a total score of 5 or greater indicating poor sleep quality.

- Smartphone Addiction Scale Short Version\(^3\): a 10-item measure assessing smartphone use. Participants scored items on a 6-point scale, where 1 was “strongly disagree,” 2 was “disagree,” 3 was “weakly disagree,” 4 was “weakly agree,” 5 was “agree,” and 6 was “strongly agree.” Internal consistency of the measure is excellent with a Cronbach \(\alpha\) correlation coefficient of 0.91.\(^3\) The cutoff value for smartphone addiction was 31 in male participants and 33 in female participants.\(^3\)

Data Collection
Participants completed the survey via the online questionnaire service Qualtrics. To consent, participants clicked a radio button indicating “Yes, I consent to participate in this study. I may withdraw my participation at any time.” To decline, participants clicked a radio button indicating “I decline to participate.” The online survey and informed consent document both specified the voluntary nature of participation. The informed consent document also explicitly informed potential participants that their responses had no bearing on academic performance. In an effort to avoid coercion, no researchers were present when potential participants decided to participate or decline. Participants with questions about the study were directed to email or telephone the research investigators. Participants were informed that completion of the survey required approximately 15 minutes. Qualtrics permitted the research team to download participants’ survey data.
responses into a spreadsheet without including identifying information (eg, name, email address) to ensure anonymity at the level of data.

Quantitative Data Analysis
Basic sociodemographic characteristics of participants were assessed using descriptive statistics. Frequencies of individual question responses were also calculated. Burnout scores were calculated 2 ways. First, the 3 dimensions of burnout were scored for EE, DP, and low PA. Second, each dimension was categorized as low-level, moderate-level, and high-level burnout. Third, \( \chi^2 \) tests and analysis of variance with post-hoc Bonferroni corrections were conducted to examine differences in levels of burnout by age, gender, year in medical school, medical school campus, perceived stress, sleep quality, and smartphone use. Finally, linear regression analyses were conducted to assess the relationship among perceived stress, sleep quality, smartphone use, and burnout in osteopathic medical students. Statistical significance was defined as a \( P<.05 \). All analyses were conducted with SPSS statistical software version 25.0 (IBM).

Results
Of the 906 osteopathic medical students enrolled at the 3 campuses, 396 consented to participate. Eleven participants did not complete all measures and were removed. A total sample of 385 participants had complete data and were included in the analysis for a response rate of 42.5%. The mean (SD) age of the students was 25.4 (2.4) years, 208 (54%) identified as women, 286 (74.3%) identified as white, and 138 (35.8%) were second-year medical students. The majority of students (220 [57.1%]) attended the main campus of the medical school. Additional demographic data are presented in Table 1.

Burnout
Of the 385 participants, 9 (2.3%) reported high EE, 67 (17.4%) reported high DP, and 310 (80.5%) reported a high level of low PA (Figure 1). \( \chi^2 \) square tests of independence compared the association between burnout and age by different age groups (ie, 18-25 years and \( \geq 26 \) years). No differences were observed in levels of EE (\( \chi^2 = 2.8, P = .242 \)), DP (\( \chi^2 = 3.6, P = .170 \)), or PA

<table>
<thead>
<tr>
<th>Variable</th>
<th>Participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y, mean (SD)</td>
<td>25.4 (2.4)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>208 (54.0)</td>
</tr>
<tr>
<td>Men</td>
<td>175 (45.5)</td>
</tr>
<tr>
<td>Genderqueer or gender nonconforming</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>13 (3.4)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>American Indian/Alaskan Native</td>
<td>1 (0.3)</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>29 (7.6)</td>
</tr>
<tr>
<td>Black/African American</td>
<td>25 (6.5)</td>
</tr>
<tr>
<td>Middle Eastern</td>
<td>14 (3.6)</td>
</tr>
<tr>
<td>Mixed race</td>
<td>20 (5.2)</td>
</tr>
<tr>
<td>Other</td>
<td>9 (2.3)</td>
</tr>
<tr>
<td>White</td>
<td>286 (74.3)</td>
</tr>
<tr>
<td>Year in Medical School</td>
<td></td>
</tr>
<tr>
<td>OMS I</td>
<td>127 (33.0)</td>
</tr>
<tr>
<td>OMS II</td>
<td>138 (35.8)</td>
</tr>
<tr>
<td>OMS III</td>
<td>62 (16.1)</td>
</tr>
<tr>
<td>OMS IV</td>
<td>57 (14.8)</td>
</tr>
<tr>
<td>Medical School Campus</td>
<td></td>
</tr>
<tr>
<td>Athens</td>
<td>220 (57.1)</td>
</tr>
<tr>
<td>Dublin</td>
<td>87 (22.6)</td>
</tr>
<tr>
<td>Cleveland</td>
<td>78 (20.3)</td>
</tr>
</tbody>
</table>

\( a \) Data are given as No. (%) unless otherwise indicated. Values missing for year in medical school (n=1), race (n=1), and ethnicity (n=1).

Abbreviations: OMS, osteopathic medical student.
When comparing dimensions of burnout by gender, only levels of low PA differed by gender, with male participants reporting higher levels of burnout compared with female participants ($\chi^2=5.2, P=.022$ vs EE, $\chi^2=1.5, P=.463$; DP, $\chi^2=31.8, P<.001$; and low PA ($\chi^2=19.5, P<.001$).

**Sleep Quality**
The mean (SD) global sleep quality score was 6.1 (2.9). Overall, 255 participants (66.2%) met the criteria for poor sleep quality. Poor sleep quality was associated with high perceived stress scores ($\chi^2=38.2, P<.001$). In addition, poor quality of sleep was associated with high levels of EE ($\chi^2=19.9, P<.001$) and DP ($\chi^2=20.7, P<.001$) but not low PA ($\chi^2=0.2, P=.648$).

**Smartphone Use**
In this sample, 86 participants (22.3%) met the criteria for smartphone addiction. Smartphone addiction was not associated with perceived stress scores ($\chi^2=0.9, P=.624$); however, it was associated with poor sleep quality ($\chi^2=5.3, P=.021$). Further, smartphone addiction was associated with high levels of EE ($\chi^2=10.0, P=.007$) and DP ($\chi^2=10.7, P=.005$) but not with low PA ($\chi^2=0.026, P=.9$).

**Linear Regression Models**
Linear regression models examined associations among burnout, perceived stress, sleep quality, and smartphone use in osteopathic medical students. In model 1, higher perceived stress scores ($\beta=0.5, P<.001$), poorer sleep quality ($\beta=0.2, P=.001$), and higher scores on the Smartphone Addiction Scale ($\beta=0.147, P=.001$) were independently associated with higher levels of EE after controlling for age, gender, and year in medical school;
this model accounted for 41% of the variation in EE (Table 2). Similarly, in model 2, higher perceived stress scores ($\beta=0.2, P<.001$), poorer sleep quality (standardized $\beta=0.2, P=.001$), and higher scores on the Smartphone Addiction Scale (standardized $\beta=0.2, P=.001$) were independently associated with higher levels of DP after controlling for age, gender, and year in medical school; this model accounted for 21% of the variation in DP. In model 3, only higher perceived stress scores were associated with higher levels of burnout in participants with...
low PA (standardized $\beta = -0.4$, $P < .001$); this model accounted for only 15% of the variation in low PA.

**Discussion**

This descriptive, cross-sectional study assessed burnout among osteopathic medical students. Overall, participants reported low levels of EE and DP but high levels of low PA across all 4 years of medical school. High levels of perceived stress, poorer sleep quality, and higher scores on the Smartphone Addiction Scale were independently associated with higher scores of EE and DP but not low PA. Additional research is needed to confirm these findings. If confirmed, interventions can be designed to target 2 modifiable factors: sleep quality and smartphone use.

**Burnout**

A worldwide problem affecting both clinical and non-clinical professions, burnout can affect any individual who experiences high levels of stress or exhaustion, works long hours, and feels devalued or underappreciated.\(^3\) Burnout tends to occur more frequently among persons whose profession involves constant demands and personal interactions that require emotional and physical exchanges,\(^3\) which is why

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**Table 2.**

Linear Regression Models Examining Associations Among Burnout, Perceived Stress, Sleep Quality, and Smartphone Addiction in Osteopathic Medical Students (N=385)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Standardized Estimate</th>
<th>t Score</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model 1: Emotional Exhaustion, $R^2=0.41$</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>$-0.027$</td>
<td>$-0.615$</td>
<td>.539</td>
</tr>
<tr>
<td>Gender</td>
<td>$0.034$</td>
<td>$0.822$</td>
<td>.411</td>
</tr>
<tr>
<td>Year in medical school</td>
<td>$-0.011$</td>
<td>$-0.252$</td>
<td>.801</td>
</tr>
<tr>
<td>Perceived stress</td>
<td>$0.513$</td>
<td>$11.263$</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Sleep quality</td>
<td>$0.157$</td>
<td>$3.458$</td>
<td>.001</td>
</tr>
<tr>
<td>Smartphone addiction scores</td>
<td>$0.147$</td>
<td>$3.568$</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Model 2: Depersonalization, $R^2=0.21$</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>$-0.051$</td>
<td>$-1.017$</td>
<td>.310</td>
</tr>
<tr>
<td>Gender</td>
<td>$0.230$</td>
<td>$4.812$</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Year in medical school</td>
<td>$0.190$</td>
<td>$3.727$</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Perceived stress</td>
<td>$0.247$</td>
<td>$4.695$</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Sleep quality</td>
<td>$0.176$</td>
<td>$3.371$</td>
<td>.001</td>
</tr>
<tr>
<td>Smartphone addiction scores</td>
<td>$0.160$</td>
<td>$3.371$</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Model 3: Low Sense of Personal Accomplishment, $R^2=0.15$</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>$0.009$</td>
<td>$0.179$</td>
<td>.858</td>
</tr>
<tr>
<td>Gender</td>
<td>$-0.144$</td>
<td>$-2.907$</td>
<td>.004</td>
</tr>
<tr>
<td>Year in medical school</td>
<td>$0.118$</td>
<td>$2.244$</td>
<td>.025</td>
</tr>
<tr>
<td>Perceived stress</td>
<td>$-0.374$</td>
<td>$-6.875$</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Sleep quality</td>
<td>$0.026$</td>
<td>$0.475$</td>
<td>.635</td>
</tr>
<tr>
<td>Smartphone addiction scores</td>
<td>$-0.044$</td>
<td>$-0.891$</td>
<td>.373</td>
</tr>
</tbody>
</table>
burnout levels are so high among health care workers. High levels of burnout have been documented in both developed and developing countries. For example, high levels of EE have been reported in hospital workers, with 65.2% in Ethiopia,34 32.7% in Malawi,35 and 19.9% in Hungary.36 Studies3,37,38 examining medical students and residents show that burnout begins during their training. The findings of the current study were specific to osteopathic medical students; in particular, we noted a high level of low sense of PA (80.5%), indicating that burnout in medical students may derive from decreased feelings of competence and successful achievement in one’s work with people.9 This finding is comparable to that of Lapinski et al,16 who reported that 73.9% of students had a low sense of PA.

There are several possible explanations for this finding. Whereas medical school and board examinations provide a temporary end point, medical students often continue studying for subsequent examinations; this behavior may limit opportunities to develop a sense of PA. Additionally, medical students cannot autonomously provide direct patient care, which may limit perceptions of achievement and accomplishment, particularly in preclinical years. Personality traits common to medical students, such as extraversion, conscientiousness, and agreeableness,39 may also be associated with higher levels of low PA. In one systematic review,40 demographic factors that correlated with increased burnout were being a man, experiencing poorer psychologic functioning, and being a more senior medical student.

Perhaps of equal significance are the relatively low levels of EE (2.3%) and DP (17.4%) in our study participants. This finding contrasts with Lapinski et al,16 who reported that 53.2% of osteopathic medical students had high EE and 35.6% had high DP. In a study9 of allopathic medical students, high levels of EE, high levels of DP, and high levels of low PA occurred in 44.6%, 37.9%, and 31.3% students, respectively. The findings in the current study need to be confirmed with additional research to determine whether they are unique to this institution or to all osteopathic medical students. Lower levels of EE and DP reported by these participants may be attributed to school-specific curricula, awareness of burnout in medical students, social support, or other factors.

**Perceived Stress**

Perceived stress is the perceived imbalance between a person’s daily demands and their capability to respond to them.40 Research with medical students has shown higher perceived stress scores are associated with more depressive and anxiety symptoms, alcohol and substance abuse, and suicide.42,43 Further, higher perceived stress scores in medical students are associated with a reduced likelihood of recovering from burnout, thereby suggesting perceived stress perpetuates burnout.45 The findings in this study contribute to the literature by demonstrating that higher perceived stress scores were associated with all 3 domains of burnout. Interventions that protect medical students from stress and promote resilience to burnout are needed to prevent negative mental health outcomes.

**Sleep Quality**

In this study, the majority of participants (66.2%) reported poor quality of sleep, and sleep quality was associated with all 3 subscales of burnout. This finding may be compared with a 2012 study45 of allopathic medical students, which found that 39% of students experienced inadequate sleep and met criteria for burnout. Consistent with studies that have identified a causal relationship between sleep and burnout,46 these findings indicate that sleep quality may play a role in factors such as emotional depletion, cynicism, apathy, and decreased productivity. Sleep deprivation is common among medical students; one study47 showed that 72.9% of medical students had poor sleep in comparison with 51.9% of their nonmedical peers. In addition, high rates of smartphone use in this sample may have contributed to poor quality of sleep via the effects of blue light and circadian physiology.24-26 While the finding of poor sleep quality in medical students may seem unsurprising, its association with...
smartphone use and subscales of burnout may justify additional prevention measures.

**Smartphone Addiction**

The *Diagnostic and Statistical Manual of Mental Disorders Fifth Edition* does not officially recognize smartphone addiction as a diagnosis. However, smartphone addiction falls under the broad category of “behavioral addictions,” categorized by the World Health Organization’s ICD-11 Working Group on Obsessive-Compulsive and Related Disorders. Behavioral addictions are defined by repeated failures to resist an impulse or urge to perform a behavior that is rewarding to a person in the short term, despite long-term harm to the person or others. The increased accessibility of the internet through smartphones has contributed to the rise in smartphone addiction and has raised concerns in advanced information technology countries like South Korea. Research on smartphone addiction shows its long-term negative effects on mental health, with increased depressive symptoms and anxiety, as well as suicidal ideation. To determine whether someone has smartphone addiction, administration of the 10-item Smartphone Addiction Scale Short Version will assess a person’s willingness to give up a smartphone, constant use of the smartphone, and the impact a smartphone has on his or her daily life. In addition, the 15-item Smartphone Addiction Proneness Scale assesses a person’s risk for smartphone addiction; it examines a person’s tolerance for limiting smartphone use, withdrawal behaviors/mood caused by not having the smartphone, and the impact on adaptive functions without the smartphone.

To our knowledge, the current study is the first to analyze the relationship between smartphone addiction and burnout in osteopathic medical students. Eighty-six participants (22.3%) exhibited addiction to their smartphones, and smartphone addiction was associated with higher levels of EE and DP. Smartphone addiction may therefore be related to feelings of being emotionally overextended and apathetic toward others. In prior studies, high engagement with cellular phones has been linked with anxiety and depression. Longitudinal research from a larger, more heterogeneous sample is needed to confirm these findings in osteopathic medical students.

The proportion of medical students exhibiting smartphone addiction has been widely studied and may be compared with allopathic students internationally (29.8% in Anhui Province, China; 39.9% in Delhi, India; and 36.5% in Jeddah, Saudi Arabia, with differences in gender). In the current study, the results are unclear whether smartphone addiction is a primary problem, a response to 1 or more subscales of medical student burnout, or a proxy for other issues. Paradoxically, the ubiquitous nature of smartphones may be exploited as a viable tool for intervention. For example, psychiatrists and clinical psychologists are beginning to harness smartphone technology and tele-health as a means for mental health maintenance, surveillance, and treatment.

**Medical Education**

The whole-person effects of burnout merit an approach to prevention that incorporates the body, mind, and spirit. In the working population, consequences of burnout may include insomnia, musculoskeletal disorders, increased alcohol consumption, sedentarism, and hospitalization for mental health disorders. In addition to decreased health and well-being in medical personnel, the effects of physician burnout on patients are troubling: a recent meta-analysis showed that physician burnout was associated with an increased risk of patient safety incidents, poorer quality of care because of low professionalism, and reduced patient satisfaction. Findings demonstrate evidence of burnout, particularly low sense of PA, early in medical education. For these reasons, the current study supports the initiation of early behavioral interventions in medical curricula, with an emphasis on improving wellness and building resilience.

**Limitations and Future Research**

The current study had several limitations, including the cross-sectional study design, homogeneity of the study...
sample from 1 osteopathic medical school with 3 campuses in a Midwestern state, timing of the study, and participants’ self-reported data. The cross-sectional study design prevented determinations of causality among burnout, perceived stress, sleep quality, and smartphone use. Burnout data from 1 osteopathic medical school with a predominantly white sample population limits the ability to generalize the findings to other osteopathic medicine schools. Furthermore, the response rate (42.5%) was moderate, and therefore the findings are susceptible to response bias and selection bias. For example, the students who volunteered to participate may have been more willing or motivated to answer questions about burnout compared with the students who did not participate. Data were collected at the end of the spring semester, which can be a stressful time for many students with tests, medical licensing examinations, and preparations for residency. Thus, future longitudinal research should assess these variables at multiple time points throughout the year with a larger, more racially and ethnically diverse sample of osteopathic medical students, from multiple schools in different geographic regions.

Conclusion
Osteopathic medical students in the current study reported low levels of EE and DP but high levels of low sense of PA. These findings suggest independent associations among perceived stress, sleep quality, smartphone addiction, EE, and DP. Modifiable risk factors for the development of burnout in osteopathic medical students may include sleep quality and smartphone use. Future studies should include longitudinal data collection and analysis of personality differences and academic success in the development of burnout. Personality assessments specific to osteopathic medical students may differ from those of allopathic medical students and may provide valuable directions for future study of medical student burnout. Socioeconomic factors, such as first-generation college students and medical student debt, are also important considerations. The role of smartphones in medical education, particularly as an aid or barrier to mental health and burnout prevention, is an important area of additional research.

Author Contributions
Both authors provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; both authors drafted the article or revised it critically for important intellectual content; both authors gave final approval of the version of the article to be published; and both authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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