ORIGINAL ARTICLE

Predicting stress and test anxiety among 1st-year chiropractic students

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Objective: We evaluated perceived stress in 1st-year chiropractic students and the relationship between perceived stress and test anxiety. Moreover, we sought student-identified stressors that complicate chiropractic education.

Methods: We tested 3 hypotheses in a longitudinal descriptive study: (1) student-perceived stress would increase over 6 months of chiropractic training, (2) depression level and grade-point average (GPA) at matriculation would predict student-perceived stress 6 months into the program, and (3) perceived stress would correlate with cognitive and emotional test anxiety levels. Assessments used were prematriculation GPA, perceived chiropractic college stress (PCCS), the Center for Epidemiologic Studies Depression Scale, and the Test Anxiety Inventory.

Results: Four hundred and seven students participated during 2014 and 2015. PCCS increased 18% after 6 months ($t_{(406)} = 6.32$, $p < .001$, $d = .33$). Prematriculation GPA was not a significant predictor of PCCS at 6 months, $p = .082$. By contrast, the Center for Epidemiologic Studies Depression Scale at the beginning of the chiropractic training program was a significant predictor $p < .001$, multiple $R^2 = 7.1\%$. PCCS correlated with test anxiety worry and emotionality ($r = .37$, $p < .001$ and $r = .35$, $p < .001$, respectively). The top 4 stressors identified by students were (by priority) finances, time for a life outside school, personal competence/endurance, and curriculum/environment.

Conclusion: Our findings are consistent with perceived stress increases during medical school. Surprisingly, prematriculation GPA, a widely used academic performance predictor, was a poor predictor of PCCS, while depression level at matriculation was a moderate predictor. PCCS correlated with test anxiety worry and emotionality, known academic performance impediments.

Key Indexing Terms: Chiropractic; Depression; Education; Stress; Test Anxiety

INTRODUCTION

This exploratory study examined putative predictors of student-perceived stress and the anticipated correlation between stress and test anxiety among 1st-year students in a chiropractic training curriculum at a US chiropractic college.

Health profession training creates high levels of stress and has been the subject of many studies. Lazarus[1] defined stress as a transaction in which a stimulus, called a "stressor," provokes an emotion reaction that is in accordance with the individual's perception of the stimulus situation and the availability of resources for dealing with the stressor. High stress levels have been reported in students of medicine,[2] chiropractic,[3] dentistry,[4] and pharmacy.[5] This can have serious personal and societal ramifications, leading to depression and anxiety.[6] Elevated stress levels have also been shown to adversely influence student academic performance,[7,8] contribute to academic dishonesty,[9] increase the likelihood that students will drop out of educational programs,[10] and play a role in alcohol and substance abuse.[11,12]

Consequently, researchers have been interested in whether individuals entering medical studies are more likely to be depressed than the general population. Dahlin et al[13] found that the prevalence of depressive symptoms among medical students in years 1, 3, and 6 were 12.9%, higher than in the general population. Similarly, Schwenk et al[14] reported that the prevalence of moderate to severe depression in University of Michigan Medical School students was 14.3%. When compared with an age-matched population, medical students have been reported to have a strikingly higher prevalence of depression,[15] with up to one quarter exhibiting substantial depressive symptoms and a higher rate of suicidal ideation.[16] While these findings are concerning, they have not been consistent across studies. Quince et al[17] reported that Cambridge (UK) medical students did not have a higher prevalence of depression than students in general or comparable nonstudent members of the general population.

Table 1 - Data Collection at 2 Time Points

A1 (1st Week of 1st-Quarter Classes)	A2 (1st Week of 3rd-Quarter Classes)
Assessments: PCCS, TAI, PM-GPA, CES-D	Assessments: PCCS, TAI, CES-D

PCCS = perceived chiropractic college stress; TAI = Test Anxiety Inventory; PM-GPA = prematriculation grade-point average; CES-D = Center for Epidemiologic Studies Depression Scale.

Depression and anxiety are widely used descriptive terms for both a symptomatic state and a medical diagnosis. Documenting depression as a symptomatic state requires identifying the frequency and severity of relevant symptoms, while documenting the medical diagnosis includes additional reasoned consideration of symptom longevity, situation context, and the numerous pathophysiologic conditions that may be involved (e.g., hypothyroid, brain tumor, or vitamin deficiency). Our study addresses depression as a symptomatic state. Interest in identifying students with elevated levels of depression has grown, but most studies have been cross-sectional designs that reveal only correlates of stress symptoms.[9,18] Little is known about depression as a predictor of important correlates such as test anxiety. High levels of anxiety have been reported in both medical[19] and chiropractic students,[3] and elevated test anxiety is associated with poor academic performance.[3,20,21]

Psychologists Liebert and Morris[22] attributed test anxiety to 2 main components: worry and emotionality. Worry refers to cognitive factors, such as negative expectations or feelings of inadequacy, while emotionality refers to physical symptoms, such as increased heart rate, muscle tension, or "butterflies."[23] Worry has shown the strongest connection to academic performance.[24] In a recent study, we found moderate to high test anxiety in 85% of students examined in 2 3rd-quarter cohorts of a 13-quarter chiropractic curriculum.[3] These findings are consistent with reports of test anxiety in medical training programs. In our study, total test anxiety, as measured by the Test Anxiety Inventory (TAI) total score, was only a weak predictor of written exam performance ($R^2 = 6.7\%$). By contrast, replacing the TAI total score in the regression model with worry and emotionality TAI subscales produced a substantially more predictive model for written exam performance ($R^2 = 15.9\%$).

Longitudinal studies, unlike cross-sectional studies, allow investigators to evaluate the power of causal models, wherein predictors (e.g., grade-point average [GPA], test anxiety, or depression) may be used to foretell future outcomes (e.g., performance on future exam scores). In a longitudinal study, Stewart et al[25] evaluated 1st-year Chinese medical students and identified vulnerable students who might benefit from additional academic support. Similarly, Ludwig et al[26] reported a significant increase in the proportion of American medical students at risk for depression in their 3rd year compared to their 1st year as well as an increase in perceived stress. In response to their findings, Ludwig et al adopted a multidisciplinary approach in the development of a comprehensive program to address student wellness, including efforts to address issues specific to clinical clerkships.

In consideration of these studies, we were interested in measuring perceived stress levels in chiropractic students and examining the anticipated relationship between stress and test anxiety. Moreover, we sought to identify the top 4 stressors that increase student difficulties in chiropractic training programs. Finally, we tested 3 hypotheses: (1) student-perceived stress levels would be greater 6 months after beginning the training program, (2) depression levels at week 1 of the chiropractic training program and prematriculation GPA would predict perceived stress levels 6 months later in the program, and (3) perceived stress levels would be correlated with concurrent cognitive and emotional test anxiety levels.

METHODS

Student Participants

Prior to implementation, the study protocol was reviewed and approved by the institutional review board of Palmer College of Chiropractic. Four hundred and seven 1st-quarter students across 8 consecutive classes participated in this longitudinal descriptive study during the 2014 and 2015 academic years.

Study Assessments

Assessments (Table 1) were performed at the beginning of the students' chiropractic training program during the 1st week of classes (Assessment 1, "A1") and, 6 months later, at the 1st week of the students' 3rd quarter (Assessment 2, "A2").

Perceived Chiropractic College Stress

Perceived stress in the chiropractic training program was assessed via a minor modification of Vitaliano's Perceived Medical School Stress survey instrument.[27,28] The Perceived Medical School Stress survey instrument is a validated measure of perceived stress in medical educational programs.[29–31] It consists of 11 items focusing on 4 areas: medical school curriculum and environment (6 items), personal competence and endurance (3 items), social/recreational life (1 item), and finances (1 item). All items are rated on 5-point Likert scales (0 = strongly disagree, 1 = disagree, 2 = neutral, 3 = agree, and 4 = strongly agree) with total instrument scores ranging from 0 to 44. The mean item score is calculated by summing all items and then dividing by 11. Higher scores indicate higher levels of perceived stress. We modified the Perceived Medical School Stress survey instrument by replacing the word "medical" with the word "chiropractic" in all survey items. The derivative perceived chiropractic college stress (PCCS) survey was administered in this study. To identify the top 4 student stressors in the chiropractic training program, we ranked them by the grand mean for each of the 11 student-perceived-stress sources from highest to lowest.

Table 2 - Demographic Data for All Students ($N = 407$)

Demographics	Group	N (%)
Gender	Male	248 (61)
	Female	159 (39)
Academic degree	Bachelor's	386 (95)
	Master's or PhD	21 (5)
Age, years	<30	353 (87)
	30–40	47 (11)
	>40	7 (2)
Ethnicity	Caucasian	305 (75)
	Hispanic	60 (15)
	African American	12 (3)
	Other	30 (7)

Depression

Depression level was measured with the Center for Epidemiologic Studies Depression Scale (CES-D).[32] The CES-D is a validated screening instrument designed to measure depressive symptomatology in the general population.[33–35] It has become one of the most widely used instruments in the field of psychiatric epidemiology.[35] The CES-D is a 20-item measure that asks respondents to rate how often over the past week they experienced symptoms associated with depression, such as restless sleep, poor appetite, and feeling lonely. Response options range from 0 to 3 for each item (0 = rarely or none of the time, 1 = some or little of the time, 2 = moderately or much of the time, and 3 = most or almost all the time). Total CES-D scores range from 0 to 60, with higher scores indicating greater depressive symptoms.

Test Anxiety

The Spielberger Test Anxiety Inventory (TAI) was administered to all participating students.[36] This survey instrument has also been extensively validated.[36–38] The TAI is a self-report questionnaire that consists of 20 statements in which respondents are asked to report how often they experience anxiety symptoms prior, during, and after taking tests. Each statement response is scored with a 4-point Likert scale (1–4) yielding a total test anxiety score ranging from 20 to 80 points. The TAI also yields 2 subscale scores. These measure worry (TAI-w) and emotionality (TAI-e), the 2 major components of test anxiety that reflect cognitive concerns and emotional responses associated with evaluation stress. Each subscale consists of 8 items, with a score range from 8 to 32 points.

Previous Academic Performance

Previous academic performance was estimated using each student's prematriculation GPA (PM-GPA).

Data Analysis

Data were examined graphically to reveal underlying distribution patterns and identify outliers. We then summarized and analyzed our data using the statistical computing environment R (version 3.4.1, R Foundation, Vienna, Austria). Statistical test assumptions were assessed, and standardized effect sizes (Pearson's r and Cohen's d) and 95% confidence levels were calculated. Study hypotheses were evaluated at a .05 family-wise alpha level.

Hypothesis 1 was evaluated with a paired t test: *Student-perceived stress levels (PCCS) would be greater 6 months after beginning the training program (PCCS at A2 minus PCCS at A1).*

Hypothesis 2 was evaluated via multiple linear regression using the forced entry method: *Depression levels (CES-D) at week 1 of the chiropractic training program (A1) and prematriculation GPA will predict perceived stress levels 6 months later in the program (A2).*

Hypothesis 3 was evaluated via a Pearson's correlation matrix, corrected for multiple inference using Holm's method:[39] *Perceived stress levels (PCCS) would be positively correlated with concurrent cognitive and emotional test anxiety levels (TAI-w and TAI-e).* These correlations were examined at both assessment periods, A1 and A2.

RESULTS

Demographic Information

Demographic data are summarized in Table 2. Out of 461 students, 407 completed and returned the questionnaire, giving an overall response rate of 88%. The demographic distributions of participating and nonparticipating students were similar. In this study, male students were more prevalent than females. Academic degree, age, and ethnicity were skewed substantially in favor of the bachelor's degree, <30 years of age, and Caucasians, respectively.

Top 4 Student-Reported Stressors

The top 4 student-reported stressors in this study, ordered from greatest to least stress, were the following: (1) "I am concerned about the debt I have incurred from loans," (2) "Chiropractic school controls my life and leaves too little time for other activities," (3) "I am concerned that I will not be able to master the entire pool of medical/chiropractic knowledge," and (4) "Chiropractic school is more competitive than I expected."

Hypothesis Testing

Assessment data are summarized in Table 3.

Hypothesis 1: Student-perceived stress levels increased substantially (18%) after 6 months in the chiropractic training program compared to the 1st week of the program ($t_{(406)} = 6.32$, $p < .001$, $d = .33$. While this increase was greater for women than for men, the gender effect was not statistically significant ($d_{men} = 0.28$, $d_{women} = 0.43$, $p = .233$).

Hypothesis 2: Prematriculation GPA at A1 was only a small, statistically nonsignificant predictor of PCCS at A2, $p = .082$. By contrast, depression level at the beginning of the chiropractic training program (CES-D at A1) was a statistically significant predictor of perceived stress 6 months later in the program (PCCS at A2), $p < .001$, multiple $R^2 = 7.1\%$.

Hypothesis 3: PCCS scores were moderately correlated with test anxiety (TAI-w and TAI-e) within each

Table 3 - Assessments (Perceived Stress, Test Anxiety, and Depression)

	A1 Mean (95% CI)	A2 Mean (95% CI)	Difference Absolute (%)	Paired *t* Test *p* Value
PCCS	1.00 (0.947–1.052)	1.18 (1.120–1.240)	0.18 (18.0%)	<.001
CES-D	16.38 (15.867–16.890)	17.21 (16.615–17.812)	0.83 (5.1%)	.005
TAI-w	14.10 (13.614–14.587)	13.51 (13.001–14.026)	−0.59 (−4.2%)	.010
TAI-e	17.00 (16.427–17.583)	15.87 (15.267–16.477)	−1.13 (−6.6%)	<.001

A1 = assessment 1 (1st week of chiropractic training program); A2 = assessment 2 (6 months after the start of chiropractic training program); CI = bias-corrected and accelerated bootstrap confidence intervals; PCCS = perceived chiropractic college stress; CES-D = Center for Epidemiologic Studies Depression Scale; TAI-w = Test Anxiety Inventory–worry; TAI-e = Test Anxiety Inventory–emotionality.

assessment period (A1 and A2). At assessment A1, PCCS correlation with TAI-w and TAI-e was $r = .37$, $p < .001$, and $r = .35$, $p < .001$, respectively. A weaker but statistically significant, correlation of PCCS with TAI-w and TAI-e was observed at assessment A2; $r = .28$, $p < .001$, and $r = .22$, $p < .001$, respectively.

Interestingly, these correlations were obtained while PCCS scores increased from A1 to A2 and TAI-w and TAI-e scores concurrently decreased from A1 to A2 (Table 3).

DISCUSSION

The top 4 areas of concern identified by students in our study were (in decreasing order of priority) finances, time for a life outside school, personal competence/endurance, and curriculum/environment. This observation suggests that these 4 areas should be priority targets in efforts to reduce student stress at chiropractic educational institutions.

As anticipated, we found a statistically significant, moderate increase in perceived stress among chiropractic students after 6 months in a 13-quarter chiropractic training program (Table 3; $p < .001$). While this increase in perceived stress was greater for women than men, the gender effect was not statistically significant ($p = .233$). Hester et al[40] reported that students in the 3rd and 4th years of a chiropractic training program consistently demonstrated the highest levels of stress but did not report stress levels at 6 months into the program. Our findings are also in agreement with student-perceived stress increasing as medical students progress through their training programs.[18,41,42]

In the United Kingdom, year 1 medical students were found to have the highest levels of mental distress.[42] And students of medicine at the University of Massachusetts were shown to have increased stress and depression rates in years 2 and 4.[18] Similar findings have been reported in non-English medical programs. Thai students were observed to be most stressed in their 3rd year,[43] and 83% of Iranian students had elevated perceived stress, with students in the later, clinical phase perceiving more stress than those in the earlier, basic science phase.[41]

Surprisingly, prematriculation GPA, a widely applied predictor of student performance within academic programs, was not a statistically significant predictor of student-perceived stress later in the program ($p = .082$), while depression level at matriculation was a moderately

strong predictor of subsequent perceived stress ($p < .001$, multiple $R^2 = 7.1\%$). It might be argued that elevated depression levels at baseline could sensitize students to stresses experienced during the training program. However, predictive capacity does not ensure a causal relationship. Both PCCS and CES-D increased over the time interval (Table 3). It might also be argued that increased perceived stress levels at baseline could predispose students to depression later in the program. In fact, in a longitudinal study of 264 medical students, Rosal et al[18] reported that increased student-perceived stress at preadmission baseline was a predictor of elevated depression in year 2 of the curriculum. These investigators suggested the possibility that elevated perceived stress levels could predispose students to depression but warned against drawing causation conclusions from regression in nonexperimental study designs. Similar results were reported by both Marshall et al[44] and Larson[45] on levels of stress and negative mental states.

Our prematriculation GPA results are in apparent conflict with studies by Stewart et al[46] and Elias et al[47] Stewart et al[46] examined depression and anxiety in a longitudinal study of 121 1st-year medical students. They found that previous academic performance determined by standardized "gatekeeper" examinations had a significant negative correlation with depression and stress ($r = -.29$, $p < .025$). These gatekeeper examinations are materially different measures of academic performance than the prematriculation GPAs used in our study. The substantial differences between these 2 measures of academic performance may explain the disparate findings between Stewart's study and our study. Elias et al[47] reported a weak but statistically significant negative relationship between stress level in 376 undergraduate students and their GPA from the previous semester ($r = -.20$, $p < .001$). The immediacy of their GPA assessment (prior semester) to the assessed stress level may explain the difference between our findings, which examined prematriculation GPA as a predictor of student-perceived stress 6 months after the start of the chiropractic training program.

Surprisingly, we observed that while student-perceived stress increased from the start of the program to 6 months into the program, test anxiety (both worry and emotionality) decreased over the same period (Table 3). This suggests that students were developing more affective coping skills during that same period. Despite the overall decrease in test anxiety over the 6-month period, we still observed a moderate, positive correlation between student-

perceived stress and the 2 subscales of test anxiety, emotionality and worry, at the 2 assessment periods; the 1st week of the chiropractic training program (A1) and 6 months after the start of the chiropractic training program (A2).

Stress levels may escalate substantially in some students, producing increased anxiety during examination periods. Investigators have reported a 10%–35% prevalence of functionally disabling test anxiety among college students.[48,49] In a previous study, we found moderate to high test anxiety in 85% of the 166 3rd-quarter chiropractic students examined.[3] Moreover, we observed a statistically significant negative correlation between the TAI subscales worry and emotionality and written exam performance.

Study Limitations

The generalizability of our study results is restricted by our sample, which was recruited from a single chiropractic college. It may be reasonably argued that students in our chiropractic training program should not be considered representative of students in all US chiropractic training programs. We note that the demographic profile of chiropractic students in our study reflects that reported recently for North American chiropractic college students.[50] While this is generally reassuring, similar studies examining predictive factors for stress and test anxiety are needed with students enrolled in a diversity of chiropractic training programs. In recognition of the complex psychosocial nature of the study variables, future studies should include, in addition to perceived stress, objective sources of stress, measures of stress-coping style and social support, state-trait assessments, and both personal and family history of anxiety and depression. Finally, examination of possible causal relationships between depression and test anxiety will require an experimental or analytical study design.

CONCLUSION

Although demographic and family history may contribute vulnerability to depression and anxiety, these factors are not modifiable. Therefore, prevention/intervention efforts should focus on the chiropractic college environment, including early intervention and curriculum reform. These efforts should reflect awareness that most students will not recognize the extent of their need and may resist it in recognition of the stigma attached to that need.[51,52] Several factors have been found to particularly influence student academic performance in health care training programs: high academic expectations,[25] heavy workload,[53,54] and financial concerns.[54] These same factors influence student-perceived stress and test anxiety.[55–57] Since student-perceived stress is multifactorial (including sociocultural, environmental, and psychological attributes),[58] strategies to reduce student stress should be similarly multifactorial. In consideration of this body of research and the top 4 stressors that students in our study reported increase the difficulty in chiropractic training programs, we suggest that college policymakers and administrators may reduce student-perceived stress and test anxiety, with improved academic performance, by providing several targeted services: (1) financial counseling that integrates education expenses/loans with the student's other life-cost issues, (2) time management counseling and sponsored social/recreational programs that can help students maintain a more robust social life during their chiropractic training period, (3) emphasizing content mastery through practical application exercises and comprehension examinations rather than rote memorization and simple recall examinations, and (4) incorporating active learning approaches that encourage real-world, peer-to-peer collaborations and deemphasize student learners as competitors. Such programs and activities should reduce the student's stress load, develop better coping skills, and improve academic performance.

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Author Contributions

REFERENCES

1. Lazarus RS. *Psychological Stress and the Coping Process*. New York: McGraw-Hill; 1966.
2. Dyrbye LN, Thomas MR, Shanafelt TD. Systematic review of depression, anxiety, and other indicators of psychological distress among U.S. and Canadian medical students. *Acad Med.* 2006;81(4):354–373.

3. Zhang N, Henderson CN. Test anxiety and academic performance in chiropractic students. *J Chiropr Educ*. 2014;28(1):2–8.

4. Abu-Ghazaleh SB, Rajab LD, Sonbol HN. Psychological stress among dental students at the University of Jordan. *J Dent Educ*. 2011;75(8):1107–1114.

5. Frick LJ, Frick JL, Coffman RE, Dey S. Student stress in a three-year doctor of pharmacy program using a mastery learning educational model. *Am J Pharm Educ*. 2011;75(4):64.

6. Regehr C, Glancy D, Pitts A. Interventions to reduce stress in university students: a review and meta-analysis. *J Affect Disord*. 2013;148(1):1–11.

7. Spiegel DA, Smolen RC, Jonas CK. An examination of the relationships among interpersonal stress, morale and academic performance in male and female medical students. *Soc Sci Med*. 1986;23(11):1157–1161.

8. Sohail N. Stress and academic performance among medical students. *J Coll Physicians Surg Pak*. 2013; 23(1):67–71.

9. Clark DC, Zeldow PB. Vicissitudes of depressed mood during four years of medical school. *JAMA*. 1988; 260(17):2521–2528.

10. Dyrbye LN, Thomas MR, Power DV, et al. Burnout and serious thoughts of dropping out of medical school: a multi-institutional study. *Acad Med*. 2010; 85(1):94–102.

11. Stewart SM, Betson C, Marshall I, Wong CM, Lee PW, Lam TH. Stress and vulnerability in medical students. *Med Educ*. 1995;29(2):119–127.

12. Melaku L, Mossie A, Negash A. Stress among medical students and its association with substance use and academic performance. *J Biomed Educ*. 2015;2015:1–9.

13. Dahlin M, Joneborg N, Runeson B. Stress and depression among medical students: a cross-sectional study. *Med Educ*. 2005;39(6):594–604.

14. Schwenk TL, Davis L, Wimsatt LA. Depression, stigma, and suicidal ideation in medical students. *JAMA*. 2010;304(11):1181–1190.

15. Dyrbye LN, Thomas MR, Huntington JL, et al. Personal life events and medical student burnout: a multicenter study. *Acad Med*. 2006;81(4):374–384.

16. Dyrbye LN, Thomas MR, Massie FS, et al. Burnout and suicidal ideation among U.S. medical students. *Ann Intern Med*. 2008;149(5):334–341.

17. Quince TA, Wood DF, Parker RA, Benson J. Prevalence and persistence of depression among undergraduate medical students: a longitudinal study at one UK medical school. *BMJ Open*. 2012;2(4): e001519.

18. Rosal MC, Ockene IS, Ockene JK, Barrett SV, Ma Y, Hebert JR. A longitudinal study of students' depression at one medical school. *Acad Med*. 1997;72(6):542–546.

19. Heinen I, Bullinger M, Kocalevent RD. Perceived stress in first year medical students—associations with personal resources and emotional distress. *BMC Med Educ*. 2017;17:4.

20. DordiNejad FG, Hakimi H, Ashouri M, et al. On the relationship between test anxiety and academic performance. *Procedia Soc Behav Sci*. 2011;15:3774–3778.

21. Euma K, Ricea KG. Test anxiety, perfectionism, goal orientation, and academic performance. *Anxiety Stress Coping*. 2011;24(2):167–178.

22. Liebert RM, Morris LW. Cognitive and emotional components of test anxiety: a distinction and some initial data. *Psychol Rep*. 1967;20(3):975–978.

23. Szafranski DD, Barrera TL, Norton PJ. Test anxiety inventory: 30 years later. *Anxiety Stress Coping*. 2012; 25(6):667–677.

24. Cassady JC, Johnson RE. Cognitive test anxiety and academic performance. *Contemp Educ Psychol*. 2002; 27(2):270–295.

25. Stewart SM, Lam TH, Betson CL, Wong CM, Wong AM. A prospective analysis of stress and academic performance in the first two years of medical school. *Med Educ*. 1999;33(4):243–250.

26. Ludwig AB, Burton W, Weingarten J, Milan F, Myers DC, Kligler B. Depression and stress amongst undergraduate medical students. *BMC Med Educ*. 2015; 15(1):141.

27. Vitaliano PP, Russo J, Carr JE, Heerwagen JH. Medical school pressures and their relationship to anxiety. *J Nerv Ment Dis*. 1984;172(12):730–736.

28. Vitaliano PP, Maiuro RD, Mitchell E, Russo J. Perceived stress in medical school: resistors, persistors, adaptors and maladaptors. *Soc Sci Med*. 1989;28(12): 1321–1329.

29. Lee EH. Review of the psychometric evidence of the perceived stress scale. *Asian Nurs Res (Korean Soc Nurs Sci)*. 2012;6(4):121–127.

30. Andreou E, Alexopoulos EC, Lionis C, et al. Perceived Stress Scale: reliability and validity study in Greece. *Int J Environ Res Public Health*. 2011;8(8):3287–3298.

31. Kötter T, Voltmer E. Measurement of specific medical school stress: translation of the "Perceived medical school stress instrument" to the German language. *GMS Z Med Ausbild*. 2013;30(2):Doc22.

32. Radloff LS. The CES-D Scale: a self-report depression scale for research in the general population. *Appl Psych Meas*. 1977;1(3):385–401.

33. Olson TR, Presniak MD, MacGregor MW. Reevaluating positive affect in the center for epidemiologic studies-depression scale. *Psychiatry Res*. 2010;178:545–549.

34. Van Dam NT, Earleywine M. Validation of the Center for Epidemiologic Studies Depression Scale—Revised (CESD-R): pragmatic depression assessment in the general population. *Psychiatry Res*. 2011;186:128–132.

35. Carleton RN, Thibodeau MA, Teale MJ, et al. The Center for Epidemiologic Studies Depression Scale: a review with a theoretical and empirical examination of item content and factor structure. *PloS One*. 2013;8(3): e58067.

36. Spielberger CD. *Test Anxiety Inventory. The Corsini Encyclopedia of Psychology*. Hoboken, NJ: John Wiley & Sons; 2010.

37. Shabbir Ali M. Test Anxiety Inventory (TAI): Factor Analysis and Psychometric Properties. *IOSR J Humaniti Soc Sci*. 2013;8(1):73–81.

38. Ali MS, Mohsin MN. Test Anxiety Inventory (TAI): Factor Analysis and Psychometric Properties. *IOSR Journal Of Humanities And Social Science*. 2013;8(1): 73–81.

39. Holm SA. A simple sequentially rejective multiple test procedure. *Scand J Statist*. 1979;6:65–70.

40. Hester H, Cunliffe C, Hunnisett A. Stress in chiropractic education: a student survey of a five-year course. *J Chiropr Educ*. 2013;27(2):147–151.

41. Borjalilu S, Mohammadi A, Mojtahedzadeh R. Sources and severity of perceived stress among Iranian medical students. *Iran Red Crescent Med J*. 2015;17: e17767.

42. Guthrie E, Black D, Bagalkote H, Shaw C, Campbell M, Creed F. Psychological stress and burnout in medical students: a five-year prospective longitudinal study. *J R Soc Med*. 1998;91(5):237–243.

43. Saipanish R. Stress among medical students in a Thai medical school. *Med Teach*. 2003;25(5):502–506.

44. Marshall LL, Allison A, Nykamp D, Lanke S. Perceived stress and quality of life among doctor of pharmacy students. *Am J Pharm Educ*. 2008;72(6):137.

45. Larson EA. Stress in the lives of college women: "lots to do and not much time." *J Adolesc Res*. 2016;21(6): 579–606.

46. Stewart SM, Betson C, Lam TH, Marshall IB, Lee PW, Wong CM. Predicting stress in first year medical students: a longitudinal study. *Med Educ*. 1997;31(3): 163–168.

47. Elias H, Ping WS, Abdullah MC. Stress and academic achievement among undergraduate students in Universiti Putra Malaysia. *Procedia Soc Behav Sci*. 2011; 29:646–655.

48. Chapell MS, Blanding ZB, Silverstein ME, et al. Test anxiety and academic performance in undergraduate and graduate students. *J Educ Psychol*. 2005;97(2): 268–274.

49. Naveh-Benjamin M, Lavi H, McKeachie WJ, Lin Y-G. Individual differences in students' retention of knowledge and conceptual structures learned in university and high school courses: the case of test anxiety. *Appl Cogn Psychol*. 1997;11(6):507–526.

50. Gliedt JA, Hawk C, Anderson M, et al. Chiropractic identity, role and future: a survey of North American chiropractic students. *Chiropr Man Therap*. 2015;23:4.

51. DeVoe P. A Learning specialist's tips for coordinating a medical school academic support program. *MedEdPublish*. 2016;5.

52. Rowlands A, Abbott S, Bevere G, Roberts CM. Medical students' perceptions and understanding of their specific learning difficulties. *Int J Med Educ*. 2013; 4:200–206.

53. Guthrie EA, Black D, Shaw CM, Hamilton J, Creed FH, Tomenson B. Embarking upon a medical career: psychological morbidity in first year medical students. *Med Educ*. 1995;29(5):337–341.

54. Wolf TM, Faucett JM, Randall HM, Balson PM. Graduating medical students' ratings of stresses, pleasures, and coping strategies. *J Med Educ*. 1988; 63(8):636–642.

55. Oliva Costa EF, Santos AS, Abreu Santos AT, Melo EV, Andrade TM. Burnout syndrome and associated factors among medical students: a cross-sectional study. *Clinics (Sao Paulo)*. 2012;67(6):573–579.

56. Hashmat S, Hashmat M, Amanullah F, Aziz S. Factors causing exam anxiety in medical students. *J Pak Med Assoc*. 2008;58(4):167–170.

57. Shah M, Hasan S, Malik S, Sreeramareddy CT. Perceived stress, sources and severity of stress among medical undergraduates in a Pakistani medical school. *BMC Med Educ*. 2010;10:2.

58. Brand HS, Schoonheim-Klein M. Is the OSCE more stressful? Examination anxiety and its consequences in different assessment methods in dental education. *Eur J Dent Educ*. 2009;13(3):147–153.