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RESEARCH ARTICLE

Neck Pain and Low Back Pain in Medical Students: A Cross-Sectional Study

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Abstract

Background: Neck Pain (NP) and Low Back Pain (LBP) are among the top four major causes of disability. There is a paucity of data regarding the prevalence and Quality of Life (QOL) issues associated with NP and LBP in American medical students. The aim of the present study was to characterize NP and LBP in American medical students.

Methods: A cross-sectional print-based survey was conducted from May to September 2013 among medical students (MS1, MS2, MS3, MS4 and new MS0 classes) enrolled at a Liaison Committee on Medical Education-accredited medical school (Weill Cornell Medical College). Pain severity and QOL issues were assessed using Visual Analog Scale (VAS) and Oswestry Disability Index (ODI). Perceived stress was assessed using the Perceived Stress Scale (PSS)-10. Main outcome measures were the prevalence and severity of self-reported NP and LBP and association with QOL issues, lifestyle and stress. Statistical analysis was performed using one way Analysis of Variance or two-tailed student's t-tests as appropriate.

Results: Survey completion rate was 96% (210 of 221 surveys administered out of 506 total enrolled students). Mean age of study participants was 24.7 ± 4.3 years (range: 20-53 years). Overall prevalence of NP and LBP were 35% (74/210) and 47% (99/210), respectively. A total of 66 medical students reported both NP and LBP (31%). Of students with NP and LBP, the average VAS scores were 2.6 ± 1.8 out of 10 and 3.2 ± 1.6 out of 10 respectively. There were 26 students (12%) who reported moderate to severe NP (VAS ≥ 3), 62 students (30%) who reported moderate to severe LBP (VAS ≥ 3) and 36 students (17%) who reported moderate to severe effect QOL issues (ODI ≥ 9). The most common QOL issues were headaches (n = 83) for NP and pain exacerbated during standing (n = 60) for LBP. Increased sleep (r = - 0.138, p = 0.045) and decreased stress (r = 0.145, p = 0.035) correlated with decreased ODI. Compared to students with none or mild back pain and QOL issues, students with moderate to severe back pain (12.98 ± 14.93 vs. 22.92 ± 17.50 hours/week, p < 0.001) and QOL issues (13.54 ± 15.58 vs. 21.21 ± 17.43 hours/week, p = 0.02) spent less time studying. Onset of pain began during medical school for 23 students and before medical school for 84 students. There were no significant differences in VAS neck, VAS back, or ODI across MS1 through MS4 classes (p = 0.485, p = 0.523, p = 0.264, respectively) or between MS0 vs. MS1-4 classes (p = 0.865, p = 0.828, p = 0.944, respectively).

Conclusions: There was a high prevalence of mild NP and LBP in medical students at a LCME-accredited U.S. medical school. Headache and pain exacerbated by standing were common QOL issues. Increased musculoskeletal pain may impact academic performance. Onset of pain commonly occurred before medical school.

Introduction

The medical school application and training process is demanding, with many medical students experience great deals of both physical and emotional stress. Psychological stress due to academic, ethical and financial pressures has led to high prevalence of psychological morbidity, including burn-out and depression [1-5]. Psychological distress may also manifest as musculoskeletal symptoms, even in young populations [6-10].

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Previous studies have reported a high incidence of musculoskeletal pain in medical students. A study at a Malaysian medical college found that 65% of students had musculoskeletal pain within the past year and reported an association with clinical years, computer use and a prior history of trauma [11]. A study at an Austrian medical school reported a prevalence of 53% for low back pain among medical students [12]. American and foreign medical training are also different in terms of length and curriculum design and there have been no studies conducted on the prevalence and severity of NP and LBP in American medical students [13,14]. Low Back Pain (LBP) and Neck Pain (NP) were found to be the number 1 and number 4 top causes of years lived with disability and may have a significant impact on student Quality of Life (QOL), which has not been explored [10].

The purpose of this study was to assess the prevalence and severity of NP and LBP, associations of NP and LBP with QOL issues, stress and lifestyle and differences in NP and LBP across medical school classes (MS0-4) in American medical students at a major academic medical school.

Materials and Methods

After receiving an Institutional Board Review approval (IRB), a cross-sectional survey was conducted from May-September 2013 among medical students enrolled at a major medical school accredited by the Liaison Committee on Medical Education (LCME). The medical school curriculum involves basic science and normal physiology with early clinical exposure during the first year, disease pathology during the second year, required clinical rotations during the third year and elective rotations and research electives during fourth year.

Print surveys were administered directly to medical students. Before survey administration, an oral informed consent script was read to students. A full description of the study, potential harm of participation (no more than minimal), rights of study participants, rights to decline participation without adverse consequences and the right to freely terminate or withdraw participation were communicated. Participation in the survey signified informed consent of the participating medical student. There was no financial compensation for survey participation.

Print surveys were administered after lectures for MS0, MS1 and MS2 classes. For the MS0 class, surveys were administered during a lecture after orientation week. For the MS1 class, surveys were administered a few days before final examinations for the academic term. For the MS2 class, surveys were administered a few weeks after students took the United States Medical Licensing Exam (USMLE) Step 1. For the MS3 class, surveys were administered during a monthly class administrative meeting near the end of their final clerkships. For the MS4 class, surveys were administered during a pre-graduation function. After completion, surveys were collected and responses were manually entered in a password-protected database that was accessible only to the IRB-approved study personnel. The paper surveys were also placed in a locked file cabinet. Because surveys were administered directly to students, demographic questions in the survey were limited in order to preserve anonymity.

Survey

A survey consisting of 33 multiple choice or open response questions was designed by an attending fellowship-trained orthopedic spine surgeon, an orthopedic spine service research fellow and a medical student involved in the study. To preserve anonymity of participants, demographic information was limited to age and Body Mass Index (BMI), which have been identified as risk factors for musculoskeletal pain in the general population [8,15,16]. The hours per week spent on five activities were used to assess lifestyle of medical students: Exercising, sleeping, studying, sitting and walking. A copy of the survey can be found in Supplemental File 1.

Students were asked if the onset of their pain was during medical school, with the specific year, or before medical school. Frequency of pain episodes was assessed using a 5-point verbal rating scale: “never”, “almost never”, “sometimes”, “often” and “constant”. Students were also asked if they self-treated their pain and to describe their methods.

The severity of pain and the associated QOL issues were graded according to the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) [17-20]. Neck and Back VAS were used to measure severity of pain from a scale of 0 for “no pain” to 10 for “most severe pain”. A modified ODI questionnaire combining standardized questions from the neck and back ODI questionnaires was used in this study. The ODI questionnaire assesses the degree of severity of 15 quality of life issues that students associate with NP or LBP. The sum of degrees of severity of all 15 questions gives an ODI score for overall quality of life issues due to NP and LBP, with a higher score indicating more severe quality of life issues. Common questions found in both neck and back ODI surveys were combined and students were asked to describe if the morbidity was associated with NP, LBP or both. Unique questions were included and specifically stated if they referred to NP or LBP only.

The Perceived Stress Scale (PSS)-10 was used to assess the degree of self-perceived stress of medical students [21]. The PSS-10 is a 10-item questionnaire assesses the degree of unpredictability and uncontrollability of situations in the participant’s life. The sum of scores for all 10 questions (inverted for positive questions 4, 5, 7 and 8) gives a PSS score for overall perceived stress, with a higher score indicating more stress. The PSS questionnaire is widely employed, has strong normative

data and strong reliability and validity [22,23].

Patient population

Surveys were administered to a total of 221 students (out of 506 total enrolled; 44%), with a survey completion rate of 96% (210 out of 221 administered). There were 2 students that did not participate and 9 students that incompletely filled out the surveys. Completed surveys consisted of 78 MS0, 57 MS1, 45 MS2, 27 MS3 and 14 MS4 student responses.

Statistical analysis

Descriptive statistics were calculated as mean ± standard deviation. Hours spent per week on lifestyle activities and PSS-10 score were assessed for association with VAS neck, VAS back and ODI score using Pearson product-moment correlation coefficient. The association of moderate to severe NP (VAS neck ≥ 3), LBP (VAS back ≥ 3) and QOL issues (ODI ≥ 9) with BMI, lifestyle activities and PSS-10 score were assessed using independent samples t-tests.

Comparisons of VAS neck, VAS back and ODI across MS1-MS4 classes were performed using one-way Analysis of Variance (ANOVA). For exploratory purposes, one-way ANOVA was also performed to compare age, BMI, PSS-10 score and lifestyle activities. Multiple comparisons with Bonferroni post hoc tests were performed to limit Type 1 error. Two-tailed independent student's t-tests were used to compare VAS neck, VAS back and ODI scores of pre-medical MS0 students vs. MS1-MS4 students. For exploratory purposes, age, BMI, PSS-10 score and lifestyle activities were also compared by two-tailed independent samples t-test. $\alpha = 0.05$ was considered statistically significant. Statistical analysis was performed using SPSS 20.0 (IBM, Armonk, New York).

Post-hoc power analyses were performed for ANOVA and independent samples t-test. Minimal Clinically Important Difference (MCID) scores, a minimal threshold of clinically meaningful improvement that is distinguished from statistically significant improvement, were utilized for VAS neck, VAS back and ODI to estimate the effect size for the power analysis [24,25]. MCID values used in the power analysis were 2 points for VAS neck, 2 points for VAS back and 9 points for ODI [26,27]. For PSS-10, a difference of 7 in score was used as a conservative estimate of effect size for the power analysis [23]. The results of the power analysis showed sufficient power ($\beta > 0.80$) to detect the MCID scores given the number of surveys completed for both ANOVA and independent samples t-tests.

Results

The average age of students was 25.5 ± 3.6 years (range: 20-53 years). Average BMI of students was 22.9 ± 2.9 kg/m^2 (range: 18-38 kg/m^2).

Neck pain and low back pain

A total of 107 students reported NP, LBP, or both (51%). The overall prevalence of NP and LBP were 35% (74/210) and 47% (99/210), respectively. A total of 66 medical students reported both NP and LBP (31%). The overall VAS NP score was 0.92 ± 1.63. In students that complained of NP (VAS neck ≥ 1), the VAS score increased to 2.6 ± 1.8 out of 10 (range: 1-7). There were 26 students (12%) who reported moderate to severe NP (VAS ≥ 3). The overall VAS LBP score was 1.49 ± 1.91. In students that complained of LBP (VAS back ≥ 1), the VAS score increased to 3.2 ± 1.6 out of 10 (range: 1-8). There were 62 students (30%) who reported moderate to severe LBP (VAS ≥ 3). Of the 107 students with some degree of pain, 49 students reported self-treatment of NP or LBP (46%), while 58 students reported no self-treatment (54%).

Frequency of NP and LBP episodes was "never" for 81 students (39%), "almost never" for 41 students (20%), "sometimes" for 66 students (31%), "often" for 15 students (7%) and "constant" for 7 students (3%).

Quality of life

Overall, the average ODI score was 4.0 ± 5.3. Among students who reported NP or LBP by VAS scores, the average ODI score was 6.7 ± 5.9 (range: 0-33). There were 36 students (17%) who reported that NP and/or LBP had a moderate to severe effect on QOL (ODI ≥ 9). The most commonly reported QOL issue associated with NP was headache (n = 83), followed by pain during reading (n = 63). The most commonly reported QOL issue associated with LBP was pain exacerbated during standing (n = 60), followed by pain exacerbated during sitting (n = 52). A breakdown of individual QOL issues is presented in Table 1.

Table 1: Quality of life issues associated with neck and lower back pain.

Quality of life issue	Associated area	No. (%)[a]	Average severity[b]
Pain intensity	Neck	28 (13%)	0.18
	Back	48 (23%)	0.31
Personal care	Neck	3 (1%)	0.01
	Back	10 (5%)	0.05
Lifting	Neck	18 (9%)	0.10
	Back	38 (18%)	0.24
Sleeping	Neck	31 (15%)	0.22
	Back	45 (21%)	0.32
Sitting	Back	52 (25%)	0.34
Standing	Back	60 (29%)	0.38
Walking	Back	6 (3%)	0.04
Social life	Back	13 (6%)	0.08
Traveling	Back	29 (14%)	0.15
Reading	Neck	63 (30%)	0.42
Headaches	Neck	83 (40%)	0.66
Concentration	Neck	40 (19%)	0.26
Work	Neck	11 (5%)	0.07
Driving	Neck	26 (12%)	0.13
Recreation	Neck	15 (7%)	0.08

[a]Number with some degree of disability (> 0); [b]Degree of severity ranged from 0-5, with 5 being most severe. Calculated for all responders, including those who reported severity of 0.

Table 2a: Correlation between demographics, stress and lifestyle activities with pain scales.

			Pain scale					
			VAS neck		VAS back		ODI	
Variable[a]		No. responses	Correlation[b]	P-value[b]	Correlation[b]	P-value[b]	Correlation[b]	P-value[b]
Demographics								
	Age	210	- 0.043	0.54	0.097	0.16	0.126	0.07
	BMI	164	0.002	0.98	0.054	0.49	0.144	0.07
Stress								
	PSS-10	210	0.097	0.16	0.105	0.13	0.145	0.04
Lifestyle activities								
	Exercise	206	- 0.024	0.74	- 0.085	0.23	- 0.048	0.49
	Sleep	207	- 0.016	0.82	- 0.097	0.17	- 0.138	0.05
	Study	203	0.116	0.10	0.076	0.28	0.070	0.32
	Sit	200	- 0.034	0.63	- 0.074	0.30	- 0.045	0.52
	Walk	200	0.048	0.50	0.069	0.33	0.091	0.20

[a]BMI: Body Mass Index; PSS-10: Perceived Stress Scale-10; [b]Calculated by Pearson product-moment correlation test.

Lifestyle activities and stress

Five typical lifestyle activities were assessed in the survey: Exercise (average: 4.6 ± 3.3 hours/week), sleep (average: 48.5 ± 8.4 hours/week, study (average: 19.9 ± 17.3 hours/week), sit (average: 41.0 ± 21.0 hours/week) and walk (average: 9.9 ± 7.8 hours/week). There was a significant correlation between increased hours of sleep per week and a decreased ODI score ($r = - 0.138$, $p = 0.05$). The average PSS score was 21.1 ± 3.6 (range: 12-31), with a significant correlation between an increased PSS score and an increased ODI score ($r = 0.145$, $p = 0.04$). Pearson correlation coefficients for demographics, PSS score and lifestyle activities versus VAS neck, VAS back and ODI scores are presented in Table 2a.

Compared to students with none to mild neck pain (VAS neck < 3), students with moderate to severe neck pain (VAS neck ≥ 3) had higher BMI (24.79 ± 3.85 vs. 22.72 ± 2.83, $p = 0.02$) and spent more hours per week walking (13.24 ± 9.11 vs. 9.37 ± 7.48 hours/week, $p = 0.02$). Compared to students with none to mild back pain (VAS back < 3), students with moderate to severe back pain (VAS back ≥ 3) had higher BMI (24.13 ± 3.06 vs. 22.46 ± 2.80, $p = 0.002$) and spent more hours per week walking (12.18 ± 8.43 vs. 8.86 ± 7.30 hours/week, $p = 0.005$), but spent fewer hours per week studying (12.98 ± 14.93 vs. 22.92 ± 17.50 hours/week, $p < 0.001$) and sitting (32.73 ± 19.17 vs. 44.50 ± 20.75 hours/week, $p < 0.001$). Compared to students with none to mild QOL issues (ODI < 9), students with moderate to severe QOL issues (ODI ≥ 9) spent fewer hours studying (13.54 ± 15.58 vs. 21.21 ± 17.43 hours/week, $p = 0.02$) and sitting (33.42 ± 17.04 vs. 42.43 ± 21.34 hours/week, $p = 0.03$) (Table 2b).

Cross-class differences

Of the 107 medical students who reported NP or LBP, 84 medical students (79%) began experiencing NP or LBP before medical school (average 5.1 ± 3.3 years before medical school) and 23 medical students (21%) began experiencing NP or LBP during medical school. A comparison of VAS neck, VAS back and ODI scales across MS1-MS4 classes is presented in Table 3a. There were no significant differences in VAS neck ($p = 0.49$), VAS back ($p = 0.52$) or ODI ($p = 0.264$) across classes.

The results of the comparison across MS1-MS4 in demographics, PSS-10 score and lifestyle activities are presented in Table 3b. In terms of demographics, there was a significant increase in age between MS1 and MS4 classes, from 25.05 ± 3.28 to 27.07 ± 2.06 ($p = 0.02$) and BMI between MS2 and MS3 classes, from 21.91 ± 2.25 to 24.20 ± 2.65 ($p = 0.005$). There were no significant differences in PSS score across classes ($p = 0.93$), but there were significant differences in individual PSS-10 questions. MS2 students felt "that things were going your way" (question 5) less often than MS4 students (2.37 ± 0.86 vs. 3.29 ± 0.83, $p = 0.003$) and MS1 students (2.37 ± 0.86 vs. 3.07 ± 0.73, $p < 0.001$). MS2 students felt that they "could not overcome difficulties" (question 10) more often than MS1 students (1.78 ± 1.26 vs. 1.04 ± 0.91, $p = 0.01$). MS4 students felt more "on top of things" than MS2 students (3.21 ± 0.80 vs. 2.50 ± 0.96, $p = 0.03$). There were also significant differences in terms of lifestyle activities. MS4 students spent significantly less time studying than MS1 (5.21 ± 6.51 hours/week vs. 30.41 ± 13.98 hours/week, $p < 0.001$), MS2 (5.21 ± 6.51 hours/week vs. 24.90 ± 17.39 hours/week, $p = 0.001$) and MS3 students (5.21 ± 6.51 hours/week vs. 21.32 ± 18.69 hours/week, $p = 0.02$). MS4 students spent significantly less time sitting than MS1 (25.93 ± 11.38 hours/week vs. 51.45 ± 19.49 hours/week, $p < 0.001$) and MS2 students (25.93 ± 11.38 hours/week vs. 49.05 ± 20.54 hours/week, $p = 0.002$). MS3 student spent significantly more time walking than MS1 (15.05 ± 10.52 hours/week vs. 8.39 ± 6.79 hours/week) and MS2 students (15.05 ± 10.52 hours/week vs. 7.12 ± 7.95 hours/week, $p = 0.001$).

The pre-medical MS0 class, which has not begun the process of medical training, was compared to the MS1-MS4 classes in VAS neck, VAS back and ODI scales (Table 4a). There were no significant differences in VAS neck ($p = 0.865$), VAS back ($p = 0.828$), or ODI score ($p = 0.944$) when comparing the MS0- versus the MS1-4 classes.

Table 2b: Comparison of activities, BMI and stress between patients with severe and mild pain.

		Neck pain				Back pain				Quality of life issues			
Variable[a]		**No. students**	**Mean**	**P-value[b]**	**95% CI[c]**	**No. students**	**Mean**	**P-value[b]**	**95% CI[c]**	**No. students**	**Mean**	**P-value[b]**	**95% CI[c]**
BMI	None to mild[d]	153	22.72 ± 2.83	0.02	- 3.86, - 0.28	125	22.46 ± 2.80	0.002	- 2.70, - 0.62	141	22.91 ± 2.82	0.59	- 0.95, 1.67
	Moderate to severe[e]	11	24.79 ± 3.85			39	24.13 ± 3.06			23	22.55 ± 3.66		
PSS-10	None to mild[d]	184	21.20 ± 3.62	0.28	- 0.67, 2.30	148	21.41 ± 3.71	0.05	t - 0.01, 2.13	174	21.26 ± 3.69	0.16	- 0.37, 2.22
	Moderate to severe[e]	26	20.38 ± 3.46			62	20.35 ± 3.24			36	20.33 ± 3.09		
Exercise	None to mild[d]	181	4.56 ± 3.20	0.31	- 2.08, 0.67	144	4.50 ± 3.00	0.36	- 1.44, 0.52	171	4.64 ± 3.45	0.98	- 1.19, 1.22
	Moderate to severe[e]	25	5.26 ± 3.77			62	4.96 ± 3.86			35	4.63 ± 2.30		
Sleep	None to mild[d]	181	48.88 ± 7.89	0.06	- 0.8, 6.80	145	48.88 ± 7.36	0.34	- 1.48, 4.30	171	48.25 ± 8.63	0.44	- 4.23, 1.83
	Moderate to severe[e]	26	45.52 ± 10.95			62	47.47 ± 10.38			36	49.44 ± 7.08		
Study	None to mild[d]	178	20.63 ± 17.27	0.10	- 1.24, 13.30	141	22.92 ± 17.50	< 0.001	4.90, 14.97	168	21.21 ± 17.43	0.02	1.39, 13.94
	Moderate to severe[e]	25	14.60 ± 17.24			62	12.98 ± 14.93			35	13.54 ± 15.58		
Sit	None to mild[d]	176	41.61 ± 21.36	0.28	- 4.08, 13.90	141	44.50 ± 20.75	< 0.001	5.57, 17.98	169	42.43 ± 21.34	0.03	1.01, 17.00
	Moderate to severe[e]	24	36.70 ± 17.47			59	32.73 ± 19.17			31	33.42 ± 17.04		
Walk	None to mild[d]	175	9.37 ± 7.48	0.02	- 7.11, - 0.62	140	8.86 ± 7.30	0.005	- 5.65, - 1.00	168	9.05 ± 7.43	0.14	- 5.17, 0.73
	Moderate to severe[e]	25	13.24 ± 9.11			60	12.18 ± 8.43			32	11.72 ± 9.36		

[a]BMI: Body Mass Index; PSS-10: Perceived Stress Scale-10; [b]Calculated by independent samples t-test; [c]95% Confidence interval of the difference of the means; [d]None to mild was defined as VAS < 3 for neck and back pain, ODI < 9 for quality of life issues; [e]Moderate to severe was defined as VAS ≥ 3 for neck and back pain, ODI ≥ 9 for quality of life issues.

Table 3a: Comparison of pain scales by medical school class.

		Medical school class				
Pain scale[a]	**No. responses**	**MS1**	**MS2**	**MS3**	**MS4**	**P-value[b]**
VAS neck	135	1.09 ± 1.77	0.61 ± 1.00	1.04 ± 1.66	1.07 ± 2.06	0.49
VAS back	135	1.56 ± 1.77	1.12 ± 1.57	1.70 ± 2.12	1.71 ± 2.13	0.52
ODI	135	4.58 ± 5.97	3.15 ± 3.94	4.96 ± 4.28	2.57 ± 3.86	0.26

[a]VAS: Visual Analog Scale; ODI: Oswestery Disability Index; [b]Calculated by ANOVA.

Table 3b: Comparison of demographic, stress and lifestyle factors by medical school class.

		Medical school class				
Variable[a]	**No. responses**	**MS1**	**MS2**	**MS3**	**MS4**	**P-value[b]**
Demographic						
Age	135	25.05 ± 3.28	26.27 ± 3.17	26.96 ± 2.48	27.07 ± 2.06	0.02
BMI	126	22.51 ± 3.01	21.91 ± 2.25	24.20 ± 2.65	24.15 ± 3.33	0.005[c]
Stress						
PSS-10	135	21.37 ± 3.74	21.61 ± 4.49	21.52 ± 2.74	22.14 ± 3.84	0.93
Breakdown of PSS						
Felt upset	135	1.49 ± 0.89	1.61 ± 0.95	1.74 ± 0.92	1.36 ± 1.01	0.58
Felt unable to control	135	1.32 ± 0.95	1.63 ± 1.04	1.65 ± 1.07	1.36 ± 1.45	0.39
Felt stressed	135	2.47 ± 1.00	2.49 ± 1.03	2.61 ± 0.078	2.07 ± 1.38	0.47
Felt confident	135	3.25 ± 0.89	2.98 ± 0.80	3.04 ± 0.82	2.86 ± 1.17	0.33
Felt things were going your way	135	3.07 ± 0.73	2.37 ± 0.86	2.57 ± 0.99	3.29 ± 0.83	< 0.001[d]
Felt unable to cope	135	1.53 ± 1.40	1.88 ± 1.10	1.52 ± 0.95	2.00 ± 1.47	0.37
Felt able to control	135	2.84 ± 0.98	2.66 ± 0.76	2.74 ± 1.01	3.36 ± 0.74	0.10
Felt on top of things	135	2.88 ± 0.89	2.50 ± 0.96	2.52 ± 0.85	3.21 ± 0.80	0.03
Felt angered	135	1.49 ± 0.87	1.85 ± 1.04	1.87 ± 1.01	1.36 ± 0.84	0.11
Felt could not overcome	135	1.04 ± 0.91	1.78 ± 1.26	1.26 ± 1.01	1.29 ± 1.27	0.01[e]
Lifestyle activities						
Exercise	132	4.53 ± 3.14	3.56 ± 2.16	4.13 ± 2.90	4.04 ± 1.74	0.39
Sleep	132	48.00 ± 6.37	49.37 ± 9.17	46.04 ± 8.16	49.07 ± 7.40	0.41
Study	131	30.41 ± 13.98	24.90 ± 17.39	21.32 ± 18.69	5.21 ± 6.51	< 0.00[f]
Sit	130	51.45 ± 19.49	49.05 ± 20.54	36.09 ± 25.95	25.93 ± 11.38	< 0.00[g]
Walk	129	8.39 ± 6.79	7.12 ± 7.95	15.05 ± 10.52	9.21 ± 6.02	0.002[h]

[a]BMI: Body Mass Index; PSS-10: Perceived Stress Scale-10; [b]P-value comparing medical school classes by ANOVA; [c]MS2 and MS3 (p = 0.01); [d]MS4 and MS2 (p = 0.003), MS2 and MS1 (p < 0.001); [e]MS2 and MS1 (p = 0.006); [f]MS4 and MS1 (p < 0.001), MS4 and MS2 (p = 0.001), MS4 and MS3 (p = 0.02); [g]MS4 and MS1 (p < 0.001), MS4 and MS2 (p = 0.002); [h]MS3 and MS1 (p = 0.006), MS3 and MS2 (p = 0.001).

Table 4a: Comparison of pain scales between MS0 and MS1-4 Classes.

		Medical school class			
Variable	**No. responses**	**MS0**	**MS1-4**	**95% CI[a]**	**P-value[b]**
VAS neck	210	0.89 ± 1.71	0.93 ± 1.58	- 0.92	0.87
VAS back	210	1.53 ± 2.08	1.47 ± 1.81	- 1.08	0.83
ODI	210	4.05 ± 5.78	4.00 ± 4.97	- 2.99	0.94

[a]95% confidence interval of the difference of the means between MS0 and MS1-4 classes; [b]Calculated by independent samples t-test.

The results of the comparison between MS0 and MS1-4 classes in demographics, PSS-10 score and lifestyle activities are presented in Table 4b. In terms of demographics, the MS0 class was significantly younger than the MS1-MS4 classes (24.65 ± 4.28 years vs. 25.96 ± 3.10 years, p = 0.012). The MS0 class also had a lower average PSS-10 score compared to the MS1-4 classes (20.29 ± 3.04 vs. 21.55 ± 3.82, p = 0.015). The MS0 class felt "upset" (question 1) less often than the MS1-4 classes (1.19 ± 0.82 vs. 1.56 ± 0.92, p = 0.004), felt "stressed" (question 3) less often than the MS1-4 classes (1.84 ± 0.93 vs. 2.46 ± 1.02, p < 0.001), felt "things were going your way" (question 5) more often than the MS1-4 classes (3.15 ± 0.73 vs. 2.79 ± 0.89, p = 0.004), felt "on top of things" (question 8) more often than the MS1-4 classes (3.00 ± 0.81 vs. 2.74 ± 0.92, p = 0.04), felt "angered" (question 9) less often than the MS1-4 classes (1.29 ± 1.01 vs. 1.65 ± 0.96, p = 0.01) and felt "unable to overcome difficulties" (question 10) less often than the MS1-4 classes (0.68 ± 0.87 vs. 1.33 ± 1.11, p < 0.001). In terms of lifestyle activities, the MS0 class spent more time exercising (5.55 ± 3.95 hours/week vs. 4.13 ± 2.71 hours/week, p = 0.003) and less time studying (11.40 ± 14.61 hours/week vs. 24.55 ± 16.99 hours/week, p < 0.001) and sitting (32.94 ± 16.24 hours/week vs. 45.38 ± 21.94 hours/week, p < 0.001) than their MS1-4 counterparts.

Table 4b: Comparison of demographic, stress and lifestyle factors between MS0 and MS1-4 Classes.

		Medical school class			
Variable	**No. responses**	**MS0**	**MS1-4**	**95% CI[a]**	**P-value[b]**
Demographic					
Age	210	24.65 ± 4.28	25.96 ± 3.10	0.29, 2.31	0.01
BMI	164	23.03 ± 3.15	22.81 ± 2.89	- 1.29, 0.86	0.69
Stress					
PSS-10	210	20.29 ± 3.04	21.55 ± 3.82	0.24, 2.27	0.02
Breakdown of PSS					
Felt upset	210	1.19 ± 0.82	1.56 ± 0.92	0.12, 0.62	0.004
Felt unable to control	210	1.27 ± 0.98	1.47 ± 1.06	- 0.84, 0.50	0.16
Felt stressed	210	1.84 ± 0.93	2.46 ± 1.02	0.34, 0.90	< 0.001
Felt confident	210	3.20 ± 0.87	3.09 ± 0.89	- 0.36, 0.14	0.39
Felt things were going your way	210	3.15 ± 0.73	2.79 ± 0.89	- 0.59, - 0.12	0.004
Felt unable to cope	210	1.71 ± 1.36	1.68 ± 1.26	- 0.39, 0.34	0.89
Felt able to control	210	2.97 ± 0.85	2.82 ± 0.91	- 0.40, 0.10	0.24
Felt on top of things	210	3.00 ± 0.81	2.74 ± 0.92	- 0.51, - 0.01	0.04
Felt angered	210	1.29 ± 1.01	1.65 ± 0.96	0.08, 0.64	0.01
Felt could not overcome	210	0.68 ± 0.87	1.33 ± 1.11	0.37, 0.92	< 0.001
Lifestyle activities					
Exercise	206	5.55 ± 3.95	4.13 ± 2.71	- 2.34, - 0.51	0.003
Sleep	207	48.94 ± 9.48	48.18 ± 7.70	- 3.15, 1.63	0.53
Study	203	11.40 ± 14.61	24.55 ± 16.99	8.46, 17.83	< 0.001
Sit	200	32.94 ± 16.24	45.38 ± 21.94	7.05, 17.84	< 0.001
Walk	200	10.99 ± 6.89	9.23 ± 8.19	- 4.02, 0.50	0.13

[a]95% confidence interval of the difference of the means between MS0 and MS1- 4 classes; [b]Calculated by independent samples t-test.

Discussion

The association between psychological stress and musculoskeletal pain in healthcare professionals has been well documented [7,28]. The high prevalence of psychological stress in medical students and its consequences on mental health have been reported [29-31]. Moroder, et al. and Alshagga, et al. found a high prevalence of NP and LBP in Austrian (53.4%) and Malaysian (65.1%) medical students, respectively [11,12]. However, there is a paucity of literature on the characteristics of musculoskeletal pain in students attending United States medical colleges.

The results of this present study show that there is a high prevalence of NP and LBP (54%) that occurred with regular frequency in medical students at a LCME accredited American medical school. In a study on the general U.S. population, Strine, et al. reported a LBP prevalence of 15.0-15.9% and NP prevalence 1.8-3.7% in people ages 18-34 [32]. Compared to the general population, we found a high prevalence of NP and LBP in medical students. Common QOL issues reported by students to be associated with neck and back pain include headaches and pain during reading, standing and sitting. There was also a high prevalence of students with moderate to severe NP (12%) and LBP (30%), which was associated with fewer hours per week studying. A study by Nolet, et al. reported an association of worsening neck pain with poorer physical health-related quality of life, while a study by Mesas, et al. reported higher work absenteeism in patients with chronic pain that were stronger in younger patients compared to older patients [33,34]. Musculoskeletal pain in medical students may be associated with worse academic performance in medical students and should be further explored. Ergonomic training has been shown to be effective for improving musculoskeletal pain in a study by Kajiki, et al. [35]. Efforts to improve education on the prevalence and impact of musculoskeletal pain in the axial skeleton may improve understanding, prevention and treatment of NP and LBP in American medical students.

There is interest in identifying potentially modifiable risk factors for musculoskeletal pain. Karahan, et al. reported age, female gender, smoking, occupation, perceived stress and heavy lifting as significant independent risk factors for low back pain in hospital staff [36]. This present study found an association between increased PSS score and increased ODI score. Increased sleep was found to be associated with a lower ODI score. In the American residency system, there has been significant interest in the impact of the 2011 work hour restrictions, which were implemented with the goal of improved education, patient care and quality of life [37]. Drolet, et al. reported that 57.8% of surgical residents reported no change in amount of rest with the implementation of duty hours while Auger, et al. reported improved sleep but also increased stress among pediatric interns [37,38]. While there is limited literature on the impact of work hour restrictions on physical well-being, our study suggests that increased sleep may be associated with decreased musculoskeletal pain. The impact of the 2011 work hour restrictions on musculoskeletal pain among medical trainees should be further explored.

The pain scales did not vary significantly across MS1-MS4 classes in this present study. The authors hypothe-

sized that there would be a concomitant increase in NP and LBP during progression through medical school due to stress and lifestyle factors. Interestingly, we found that a larger proportion of students experienced an initial onset of neck or back pain before medical school than during medical school (84 vs. 23). There were no significant differences in NP or LBP between pre-medical and medical students, despite significant statistical differences in lifestyle and stress. There is growing data that degenerative spine conditions are genetic and start early in life, with potential genetic contributions combined with environmental factors [39]. One study in 1983 on the general population reported an average PSS-10 score of 14.2 ± 6.2 for 649 participants between ages 18-29, while a more recent study on the general population in 2009 reported an average PSS-10 of 16.78 and 17.46 for participants of age < 25 and ages 25-34 respectively, which is markedly lower than the average score of 20.29 ± 3.04 found in MS0 21.55 ± 3.82 in MS1-4 students in this present study [22,23]. These findings may reflect the high stress environment of medical education that begins as early as pre-medical studies due to the competitiveness of medical school admissions [40]. A prospective study tracking a class of medical students through the 4 years of school may help elucidate the impact of medical school on neck and back pain.

Older age has been reported to be an important contributing factor for back pain [41]. Recent trends towards non-traditional medical students may result in increases in the average age of the class [42]. In this present study, the average age of the incoming MS0 class was 24.6 ± 4.2 years, with the oldest student being 53-years-old. Changing medical student demographics will pose novel challenges for college administrators. Older age and marital status may result in a higher prevalence of musculoskeletal symptoms.

The course of medical school, with its physical and mental demands on trainees, may impact musculoskeletal pain. The American medical school is typically structured as 1.5-2 years of pre-clinical coursework consisting primarily of lecture and laboratory based learning, while the latter 2-2.5 years consist of clinical clerkships on the wards of a hospital [43]. The rigor of the clinical clerkship years may contribute to the increase in BMI from MS3 and MS4 classes compared to the MS1-2 classes. Interestingly, the MS2 class reported having the most stress with regards to the PSS-10 scale compared to all other classes. MS2 students take the Step 1 of the United States Medical Licensing Exam at the end of the year, of which their performance has a significant impact on their ability to apply for certain medical subspecialties. This study was performed soon after students took this exam, which may have impacted their responses to this survey. MS4 students reported significantly less time studying, sitting and walking than their counterparts. MS4 students did not have clinical duties at the time of the survey administration as they were preparing for graduation, which may have impacted these findings. Further study should include a longitudinal study on NP and LBP in a cohort of medical students as they progress through medical school.

Limitations of the present study included a sampling bias, as only students who attended lectures and social functions were recruited [44]. However, this approach yielded a very high response rate (96%) and reduces responder bias. Self-reporting of pain and disability in preceding years may have introduced recall bias. A larger proportion of the study sample was composed of students in the pre-clinical, predominantly sedentary years (MS0-MS2) than the more active clinical years (MS3-MS4). However, we did not find a significant correlation between increased time sitting and NP or LBP, which concurs with previously reported findings [12,45,46]. Fewer survey responses from MS3 and MS4 students may introduce bias to findings on when students first began to experience NP or LBP. There were modifications to the PSS-10 and ODI surveys that were designed for the purpose of this study, including modifications of format and certain questions. This may limit the comparability of this study to others that use these survey instruments.

In conclusion, there was a high prevalence of relatively mild NP and LBP in medical students. Students experienced NP and LBP on a relatively frequent basis, with headaches and pain exacerbated while standing being the most frequently associated QOL issues. Increased sleep and decreased stress were weakly associated with decreased QOL issues associated with NP and LBP. Education on ergonomics and other factors may help improve the musculoskeletal health of medical trainees.

Conflict of Interest

The authors have no conflicts of interest to disclose related to the content of the present manuscript.

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