

# A Longitudinal Study of Stress in First-Year Dental Students

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*Abstract:* This study examines the association of stress with performance and health in first-year dental students and changes in the amount and sources of stress over one year. Students at four U.S. dental schools completed the Dental Environment Stress (DES) scale, Perceived Stress Scale (PSS), stress rating, and demographic questions at the start of their first year of school (baseline), 11.7 weeks, and one year later when first-year GPA, illnesses, health ratings, and symptom frequency were also assessed. Overall, 296 (186 men, 110 women) responded at baseline and after one year; 205 responded all three times. Stress scores were negatively correlated with GPA (DES,  $p=.006$ ; PSS,  $p=.04$ ; stress rating,  $p=.002$ ) and with physical and emotional health ratings ( $p's \leq .002$ ), but positively associated with illness ( $p<.05$ ), symptoms ( $p<.0001$ ), and symptom frequency ( $p's <.05$ ). Stress was higher after one year ( $p's <.001$ ) and varied by school ( $p<.0001$ ). Women ( $p<.01$ ), younger ( $p<.003$ ), and single students ( $p<.03$ ) had higher stress at baseline, but after one year, there were no differences by gender, age, or marital status. Ratings for items on the Dental Environment Stress scale related to schoolwork were high at baseline and increased further by one year ( $p's \leq .0001$ ); items related to school atmosphere had low ratings initially with large increases over time ( $p's <.0001$ ). In conclusion, stress increases over time in first-year dental students and is related to detrimental effects on performance and health. Variation between schools may reflect different teaching methods. Changes in sources of stress may reflect the different contributions of anticipatory and situational stress over time. First-year dental students may benefit from stress reduction programs.

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**S**tress occurs when the pressures and demands that are faced, whether real or imagined, are perceived as excessive. The definition of what is stressful varies from person to person, and it is the perception of an event that is important. Life changes, whether negative such as the death of a loved one, or positive, such as marriage, can be perceived as stressful because they result in new demands and pressures. Daily hassles or everyday pressures also lead to stress. While stress provides stimulation that up to a point can lead to improved performance, prolonged stress can lower performance and lead to negative health consequences such as high blood pressure, illnesses, and heart attacks.<sup>1</sup>

Dental school is a stressful experience. First-year dental students may be uniquely affected as they experience various life changes such as the need to move, leave friends and family, and make new friends, as well as worry about finances and insecurities concerning their ability to do well in class. However, few studies directly examine the associa-

tion of stress with dental students' performance and health. Two small studies of seventy-four and thirty-nine students, respectively, used proxies for stress and reported that students with higher anxiety or depression had lower grades.<sup>2,3</sup> A study of Australian dental students found no overall association of stress with academic performance, but students reporting higher stress from faculty and administration had lower grades on clinical competence and contextual understanding.<sup>4</sup> Results of the few previous studies of the relation between stress and health in dental students are also mixed,<sup>5-7</sup> and none specifically focused on the effects of stress on both physical and emotional health in first-year dental students from multiple schools in the United States.

Very little is known about whether the amount and sources of stress that dental students experience change over time. While studies have examined stress in dental students, almost all that include first-year students are cross-sectional, assessing students' stress at one point in time,<sup>8-11</sup> whereas only a longitudinal

study can examine the change in stress over time. However, there are no longitudinal studies examining changes in the amount and sources of stress among first-year U.S. dental students over an entire year using specific measures of stress and a large sample of students from more than one school. A greater understanding of the sources of stress as well as an elucidation of the associations of stress with performance and health in dental students is important to determine the need for and the specific types of measures necessary to reduce stress in dental students.

The purpose of this project was to determine if the stress first-year dental students experience is associated with detrimental effects on their performance and health and to examine changes in the amount and sources of stress over a one-year period of time. It is hypothesized that, in first-year dental students, 1) stress will be related to lower performance as shown by GPA; 2) stress will be related to poorer physical and mental health; 3) the amount of stress will increase over time; and 4) the sources of stress will change over time. A secondary aim of this study was to examine differences in stress by sociodemographic factors (age, gender, marital status) and curriculum differences.

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## Methods

During the summer of 2004, deans and faculty members at twelve dental schools across the United States were contacted and asked if their first-year students could participate in a longitudinal study of stress; four schools agreed to participate. Dental School 1 (DS1) is in the Southwest and follows a nontraditional approach in which students intensively study only one subject at a time; Dental School 2 (DS2) is in the Midwest and follows a traditional approach to education; Dental School 3 (DS3) is in the West and uses a traditional approach, but students go year round and finish in three rather than four years; and Dental School 4 (DS4) is located in the West and uses a problem-based learning approach to education. A baseline assessment of stress was obtained at the start of the school year (Time 1), an average of 11.7 weeks later (Time 2), and approximately one year later (average of 56.6 weeks later; Time 3). Of 407 first-year students at all schools combined, the 296 men and women who responded at Times 1 and 3 are the main focus of this report. Additional analyses are performed in the subsample of 205 participants who responded at all three times. This study was approved

by the Institutional Review Board at DS2; at each assessment, all students gave written informed consent prior to participation.

A self-administered survey was developed that assessed demographic characteristics (age, gender, marital status) and included three measures of stress:

1. The Dental Environment Stress (DES) Questionnaire,<sup>12</sup> a thirty-eight-item questionnaire that assesses stress specific to dental school; four of the original items relating to patient care were omitted as not being relevant to first-year students. Students rate each item on a scale of 0–4 in which 0=not applicable, 1=not stressful, 2=slightly stressful, 3=moderately stressful, and 4=severely stressful. Reliability based on Cronbach's alpha was .90.
2. The Perceived Stress Scale,<sup>13</sup> a ten-item questionnaire about feelings and thoughts during the past month, which assesses general perceived stress. Students are asked to rate the frequency with which they experienced each item on a scale of 0–4 in which 0=never, 1=almost never, 2=sometimes, 3=fairly often, and 4=very often. Reliability based on Cronbach's alpha was .82.
3. A self-rating of stress consisting of one question that asks students to rate the extent to which they currently feel stressed on a scale of 1–10, with 1 being the least and 10 being the most stressed.

In August 2004, the survey, a cover letter explaining the study, and the consent form were emailed to the dean or faculty member at each dental school who had agreed to participate. They were asked to administer the survey as close to the start of the school year as possible (Time 1). The survey was administered during orientation at DS1, DS3, and DS4 and during a community dentistry class close to the beginning of the school year at DS2. An average of 11.7 weeks later the same survey was administered for a second time (Time 2) under informal conditions by a student at DS1 and by student leaders at a meeting at DS3, during a class at DS2, and in a review session at DS4. In September 2005, an average of 56.6 weeks later (at the start of students' second year), the same stress measures were assessed a third time (Time 3) in a survey that also included questions about first-year grade point average (GPA), health (number times sick, number colds/flu, and number times absent in first year; self-ratings of physical and emotional health in first year), and a list of stress-related symptoms (adapted from George et al.<sup>5</sup>) including migraines, stomach/digestive problems, acne, back pain, intense fatigue, tachycardia, insomnia, lack of appetite, overeating,

uncontrollable anger, feeling down/depressed, and difficulty concentrating. Students rated the frequency with which they experienced each symptom during their first year on a 0–7 scale in which 0=not at all, 1=less than 1x/month, 2=once a month, 3=2–3x/month, 4=1x/week, 5=1–2x/week, 6=3–5x/week, and 7=daily or almost daily. The total number of symptoms was calculated by counting number of symptoms students reported with a frequency rating of 1 or higher. This survey was administered informally by a student at DS1, informally by student leaders at a meeting at DS3, during a class at DS2, and during a review session at DS4. After each administration, the schools mailed the completed surveys back to the principal investigator.

A DES total score was created by summing responses to all items. Additionally, the rating given for each DES item was used separately to indicate sources of stress. The PSS was scored by reverse scoring items 4, 5, 7, and 8 (0=4, 1=3, 2=2, 3=1, 4=0), then summing across all ten items. Scores were imputed for participants missing up to three DES items or missing one PSS item; participants missing a greater number of items were considered to be missing the score on that measure.

After the stress measures were scored, data were entered into Excel files. Statistical analyses were performed with Excel and the program *VassarStats*.<sup>14</sup> Means and distributions were calculated for continuous variables, and rates were calculated for categorical variables. Pearson correlations of each stress scale score (DES, PSS, and Stress Rating) with GPA and with each of the health-related outcomes (e.g., frequency and number of symptoms, number of illnesses) were calculated. Comparisons of mean GPA and each health measure by gender, marital status, and age (based on a mean split  $\leq 24$  vs.  $> 24$  years) were performed with independent t-tests, while comparisons by school were performed with analysis of variance (ANOVA) and post hoc Tukey HSD tests were used to perform pair-wise comparisons. Paired t-tests were used to examine the change in stress over time by comparing mean stress scores at Time 1 and Time 3 (one year later). Additionally, repeated measures ANOVA was used to examine change in stress over time with data from the 205 students who had stress scores at all three time points. Independent t-tests were used to compare stress scores by gender (men vs. women), marital status (single vs. married), and age (younger vs. older) within a single point in time (e.g., within Time 1 or within Time 2). Comparisons of the change in stress over time

within a particular group (e.g., men) were performed with paired t-tests comparing stress scores at Time 1 vs. Time 3. To examine the changes in the sources of stress over time, paired t-tests were also used to compare the average stress ratings for each DES item (or source of stress) at Time 1 vs. 3. No adjustment was made for multiple comparisons; as suggested by Perneger,<sup>15</sup> exact p-values are shown instead.

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## Results

Among the four participating schools, there were 407 first-year students; 383 responded at Time 1 for a response rate of 94.1 percent ( $=383/407 \times 100$ ), 228 (56 percent) responded at Time 2, and 325 (79.9 percent) responded at Time 3. The 296 students (72.8 percent) who completed the survey at both Time 1 and Time 3 are the focus of most analyses; a subsample of 205 (50.4 percent) responded to all three surveys.

Among the 296 students responding at Times 1 and 3, there were 186 men (62.8 percent) and 110 women (37.2 percent), their ages ranged from nineteen to forty-six years with an average of 24.7 (median=24.0), and two-thirds (67.6 percent) were single.

## Stress Effects on Health and Performance

Means and distributions on each stress measure for students at the beginning of their first year (Time 1) are shown in Table 1. DES total scores ranged from 13 to 108 with a mean of 55.1; PSS scores ranged from 0 to 40 with a mean of 14.6; and stress ratings ranged from 1 to 10 with a mean of 4.7. Table 1 also shows the performance and health outcomes at the end of the first year. Performance, assessed by self-reported first-year GPA, ranged from 1.9 to 4.0 with a mean of 3.3. Means and distributions for each self-reported health-related outcome and for the frequency of each symptom are also shown in Table 1. It is of interest to note that while some symptoms such as migraines, tachycardia, and lack of appetite were reported relatively rarely (average frequency ratings  $\leq 1.0$ ), other stress-related symptoms such as difficulty concentrating, intense fatigue, back pain, and feeling down/depressed were much more common.

Table 2 presents the correlations of each stress scores at Time 1 with reported GPA and health outcomes. Stress scores at Time 1 were significantly and inversely associated with GPA ( $r=-.17$ ,  $p=.006$  for DES;  $r=-.11$ ,  $p=.042$  for PSS; and  $r=-.19$ ,  $p=.002$

**Table 1. Mean stress scores at Time 1 and grades and health during first year for students in study**

	n	Range	Mean	Median	SD
Stress scores at start of 1 <sup>st</sup> year					
DES <sup>§</sup>	296	13–108	55.1	56.5	15.2
PSS <sup>§</sup>	296	0–40	14.6	14.0	6.1
Stress rating <sup>§</sup>	280	1–10	4.7	5.0	2.4
Outcomes at end of 1 <sup>st</sup> year					
GPA	232	1.9–4.0	3.3	3.4	0.4
Number of times sick	272	0–15	2.3	2.0	2.1
Number of colds/flu	205	0–10	1.6	1.0	1.5
Number of times absent	247	0–15	0.6	0	1.5
Physical health rating	290	1–10	6.8	7.0	1.9
Emotional health rating	289	1–10	6.9	7.0	2.0
Total number of symptoms	295	0–12	6.7	7.0	3.1
Frequency of symptoms <sup>†</sup>					
Migraines	291	0–7	0.6	0	1.1
Stomach/digestive problems	290	0–7	1.5	1	1.6
Acne	293	0–7	1.6	1	1.9
Back pain	293	0–7	2.3	2	2.0
Intense fatigue	293	0–7	2.6	2	2.2
Tachycardia	288	0–7	0.7	0	1.5
Insomnia	292	0–7	1.3	0	1.9
Lack of appetite	290	0–7	1.0	0	1.5
Overeating	293	0–7	2.1	1	2.2
Uncontrollable anger	294	0–7	1.2	0	1.7
Feeling down/depressed	295	0–7	2.0	2	1.8
Difficulty concentrating	292	0–7	2.9	3	2.3

<sup>§</sup>DES=total score on the Dental Environment Stress Questionnaire; PSS=Perceived Stress Scale; stress rating=response to the question “On a scale of 1–10, with 1 being the least and 10 being the most, how stressed do you feel right now?”

<sup>†</sup>Frequency of symptoms was rated on a scale from 0 to 7 in which 0=not at all; 1=less than 1x/month; 2=once a month; 3=2–3x/month; 4=once a week; 5=1–2x/week; 6=3–5x/week; and 7=daily or almost daily.

for stress rating). Thus, regardless of how stress was assessed, students who had higher stress scores at the start of their first year reported lower GPAs for the first year, indicating worse performance. Stress scores at Time 1 were also significantly and inversely associated with ratings of physical health ( $r=-.23$ ,  $p<.0001$  for DES;  $r=-.15$ ,  $p=.007$  for PSS;  $r=-.17$ ,  $p=.003$  for stress rating) and ratings of emotional health ( $r=-.16$ ,  $p=.004$  for DES;  $r=-.26$ ,  $p<.0001$  for PSS;  $r=-.17$ ,  $p<.002$  for stress rating). This shows that students with higher stress scores at the start of their first year rated their physical and emotional health as lower during the year. Stress was also positively and significantly correlated with the number of sickness episodes and cold or flu episodes they reported and with the total number of symptoms they reported (see Table 2). Thus, students with higher self-reported stress scores reported they were sick more often than were students with lower stress scores. However, stress scores were not significantly associated with

the reported number of absences ( $p>.10$ ), which was very low. Table 2 also shows that students with higher stress scores reported a higher frequency of each symptom. Significant positive associations were found between stress and the reported frequency of physical symptoms such as migraines, stomach or digestive problems, intense fatigue, tachycardia, insomnia, lack of appetite, and overeating, as well as psychological symptoms such as uncontrollable anger, feeling down or depressed, and difficulty concentrating.

Figure 1 shows comparisons of mean GPA and health measures by gender, marital status, age, and school. Independent t-tests showed that women reported more symptoms than men (means=7.3 for women vs. 6.4 for men,  $t=-2.30$ ,  $p=.02$ ), single students reported more symptoms than married students (means=7.1 for single vs. 6.0 for married students,  $t=2.89$ ,  $p=.004$ ), and younger students (based on a mean split  $\leq 24$  vs.  $>24$  years) reported higher GPAs

**Table 2. Association of stress scores at Time 1 with GPA and health of students in study**

	DES		PSS		Stress Rating	
	r	p	r	p	r	p
<b>Outcomes</b>						
GPA	-.17	<b>.006</b>	-.11	<b>.042</b>	-.19	<b>.002</b>
Number of times sick	.11	<b>.026</b>	.12	<b>.022</b>	.09	.086
Number of colds/flu	.12	<b>.048</b>	.03	.352	-.03	.348
Number of times absent	-.03	.348	.03	.341	.02	.401
Physical health rating	-.23	<b>&lt;.0001</b>	-.15	<b>.007</b>	-.17	<b>.003</b>
Emotional health rating	-.16	<b>.004</b>	-.26	<b>&lt;.0001</b>	-.17	<b>.002</b>
Total number of symptoms	.27	<b>&lt;.0001</b>	.25	<b>&lt;.0001</b>	.25	<b>&lt;.0001</b>
<b>Frequency of symptoms</b>						
Migraines	.16	<b>.002</b>	.10	<b>.041</b>	.14	<b>.009</b>
Stomach/digestive problems	.13	<b>.015</b>	.19	<b>.0005</b>	.07	.122
Acne	.04	.236	.06	.164	.02	.386
Back pain	.05	.179	.02	.352	.07	.141
Intense fatigue	.12	<b>.024</b>	.17	<b>.001</b>	.14	<b>.010</b>
Tachycardia	.11	<b>.037</b>	.11	<b>.027</b>	.18	<b>.002</b>
Insomnia	.11	<b>.025</b>	.07	.103	.11	<b>.033</b>
Lack of appetite	.09	.066	.10	<b>.041</b>	.13	<b>.017</b>
Overeating	.13	<b>.011</b>	.09	.062	.17	<b>.003</b>
Uncontrollable anger	.19	<b>.0005</b>	.14	<b>.009</b>	.14	<b>.011</b>
Feeling down/depressed	.27	<b>&lt;.0001</b>	.28	<b>&lt;.0001</b>	.26	<b>&lt;.0001</b>
Difficulty concentrating	.15	<b>.006</b>	.26	<b>&lt;.0001</b>	.25	<b>&lt;.0001</b>

Note: Associations examined with Pearson correlations (r=correlation coefficient). Bold indicates significant associations.

DES=total score on the Dental Environment Stress Questionnaire; PSS=Perceived Stress Scale; Stress Rating=response to the question "On a scale of 1–10, with 1 being the least and 10 being the most, how stressed do you feel right now?"

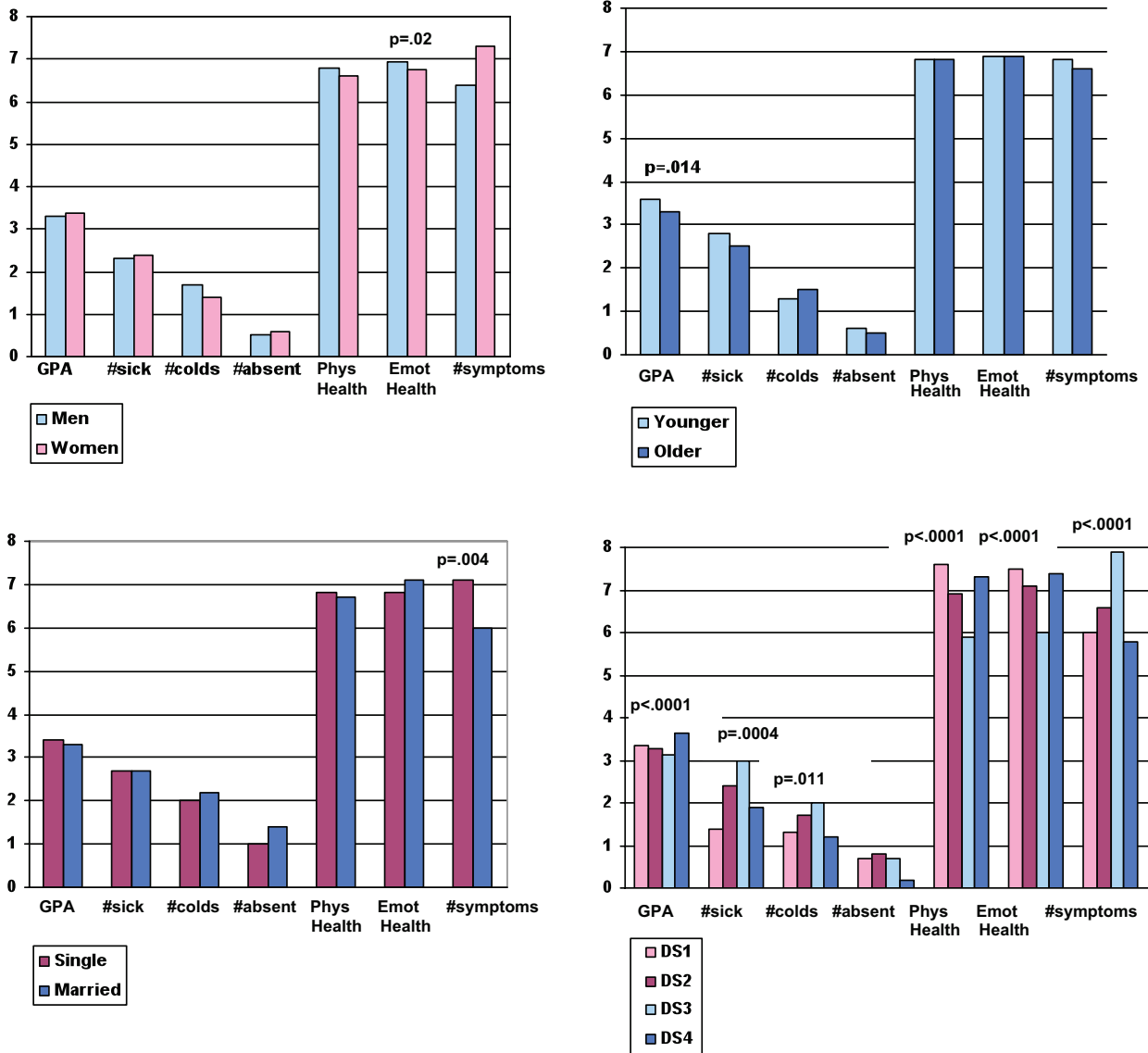
than older students (means=3.6 for younger vs. 3.3 for older students,  $t=2.46$ ,  $p=.014$ ), but there were no other differences by gender, marital status, or age. Analysis of variance (ANOVA) showed there were significant differences between the four schools on mean reported GPA ( $F=23.47$ ,  $p<.0001$ ), number of times sick ( $F=6.26$ ,  $p=.0004$ ), number of colds ( $F=3.80$ ,  $p=.011$ ), total number of symptoms reported ( $F=9.64$ ,  $p<.0001$ ), and ratings of physical and emotional health ( $F=12.07$  and  $F=11.63$ , respectively,  $p's<.0001$ ). Post hoc comparisons with Tukey HSD tests showed that mean reported numbers of times sick, colds, and symptoms were higher, while mean ratings of physical and emotional health were lower for DS2 and DS3 than for DS1 and DS4 ( $p's<.05$ ). Students at DS3 also had lower GPAs than students at DS1 and DS4 ( $p<.05$ ).

### Change in Stress Over Time

Change in stress over time was examined by comparing mean stress scores at Time 1 and Time 3 (one year later) using paired t-tests. Table 3 shows that, for all students combined, scores on each stress

scale increased over time with significant differences found for DES total and PSS scores ( $p<.0001$  and  $p<.0004$ , respectively). Within each school, mean DES total scores increased significantly over time ( $p=.001$  for DS1,  $p=.009$  for DS2 and DS3, and  $p<.0001$  for DS4). Both PSS scores and Stress Rating increased significantly between Time 1 and Time 3 for DS2 ( $p's=.05$  and  $.028$ , respectively) and DS4 ( $p's<.0001$  and  $.02$ , respectively). However, Stress Rating at DS3 decreased significantly between Time 1 and Time 3 ( $p=.02$ ), although it remained relatively high as compared to the other schools.

Repeated measures ANOVA was used to examine change in stress over time using data from the subsample of 205 students with stress scores at all three time points. Figure 2 shows plots of stress scores for all students combined (solid black line) and separately for each school. For all students combined, significant differences in stress scores over time were found ( $F=17.31$  for DES;  $F=12.30$  for PSS;  $F=15.76$  for Stress Rating,  $p's<.0001$ ). Scores on all stress measures increased significantly between Times 1 and 2 ( $p's<.01$ ), and then decreased between Times



**Figure 1. Comparisons of GPA and health by gender, marital status, age, and school for students in study**

Note: Comparisons by gender, marital status, and age performed with independent t-tests; comparisons by school performed with ANOVA; Younger  $\leq 24$ , older  $\geq 25$ .

2 and 3 ( $p < .01$ ), although stress levels were still significantly higher at Time 3 than Time 1 ( $p < .01$  for DES;  $p < .05$  for PSS and Stress Rating). Scores for each school followed a similar pattern although DS1 scores decreased the most between Times 2 and 3 and DS3 scores at Time 3 on the PSS and Stress rating were similar to those at Time 1.

Table 4 shows comparisons of stress scores by gender, marital status, and age. Rows show results of paired t-tests comparing stress scores within a par-

ticular group (e.g., women) at Time 1 vs. Time 3 and indicate change *over time*. As shown, stress scores increased over time regardless of gender, marital status, and age group, with significant differences between Times 1 and 3 on DES scores for all groups; on PSS scores for men, married students, and older students; and on stress rating for older students. The columns in this table show results of independent t-tests comparing stress scores by gender (men vs. women), marital status (single vs. married), and age

**Table 3. Comparisons of mean stress scale scores at Time 1 (T1) and Time 3 (T3) for all students combined and separately within each school**

School	Stress Scale	T1	T3	t	p
All (N=296)	DES	55.0	63.1	-7.69	<b>&lt;.0001</b>
	PSS	14.6	16.0	-3.37	<b>.0004</b>
	Stress Rating	4.8	5.0	-0.80	.212
DS1 (N=30)	DES	42.3	54.7	-3.48	<b>.001</b>
	PSS	12.1	13.4	-1.18	.126
	Stress Rating	3.3	3.5	-0.35	.360
DS2 (N=58)	DES	60.6	65.6	-2.42	<b>.009</b>
	PSS	17.8	19.5	-1.66	<b>.050</b>
	Stress Rating	5.7	6.5	-1.96	<b>.028</b>
DS3 (N=104)	DES	60.4	65.0	-2.65	<b>.009</b>
	PSS	16.1	15.6	0.54	.295
	Stress Rating	5.8	5.2	2.08	<b>.020</b>
DS4 (N=104)	DES	50.5	62.8	-6.74	<b>&lt;.0001</b>
	PSS	12.2	15.5	-6.05	<b>&lt;.0001</b>
	Stress Rating	3.9	4.4	-2.05	<b>.020</b>

Note: Comparisons between stress scores at Time 1 and Time 3 were performed with paired t-tests. Bold indicates significant differences.

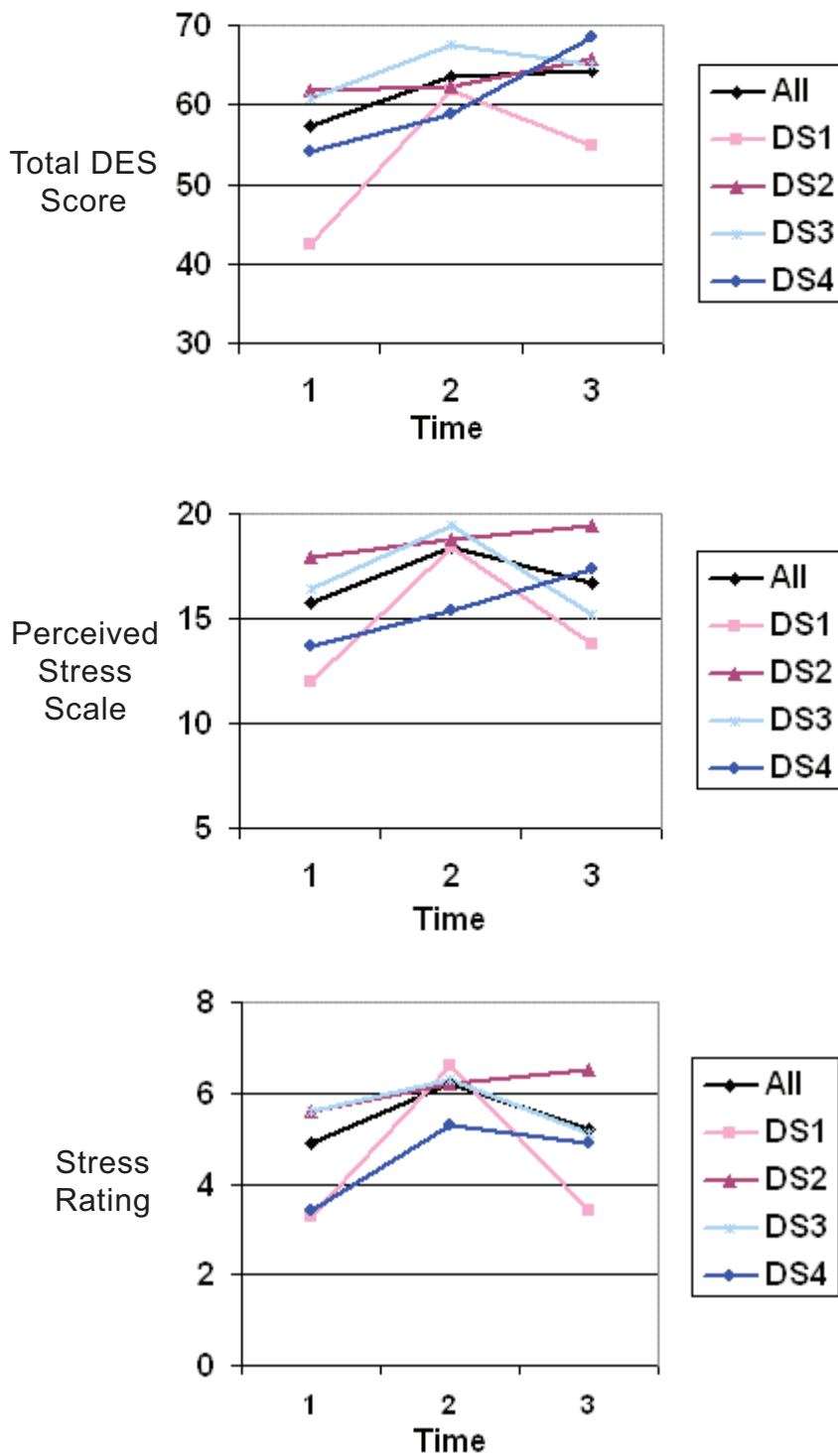
DES=total score on the Dental Environment Stress Questionnaire; PSS=Perceived Stress Scale; Stress Rating=response to the question "On a scale of 1–10, with 1 being the least and 10 being the most, how stressed do you feel right now?"

(younger vs. older) at a *single* point in time. At Time 1, women had higher stress scores than men ( $p=.009$  for DES,  $p=.01$  for PSS); single students had higher stress scores than married ones ( $p=.003$  for PSS); and younger students had higher stress scores than older students ( $p=.03$  for PSS). At one year (Time 3) though, there were no differences in stress by gender, marital status, or age. (This was largely due to the fact that although both genders increased in stress over time, men had larger increases than women, so that there was no difference between men and women at Time 3. Likewise, married students and older students had greater increases over time in stress, so that there were no differences by marital status or age group at Time 3.)

### Changes in Sources of Stress

Table 5 shows results of paired t-tests comparing the average stress ratings for each DES item (or source of stress) at Times 1 and 3 for all students. Items are grouped into three categories. Items in the schoolwork category had the highest stress ratings at both time points. Significant increases in stress ratings between Times 1 and 3 were found for exams

and grades, difficulty learning clinical procedures, difficulty learning precision manual skills, lack of confidence to be a successful dental student, lack of confidence to be a successful dentist, completing graduation requirements, and expectations of dental school vs. what it is really like. The greatest change over time in stress ratings was found for two items related to school atmosphere: atmosphere created by clinical faculty, which increased from 1.5 at Time 1 to 2.3 at Time 3 ( $p<.0001$ ), and inconsistency in feedback from different instructors, which increased from 1.6 at Time 1 to 2.8 at Time 3 ( $p<.0001$ ). Stress ratings of other items related to school atmosphere also increased significantly. The only notable stressors in the personal category were lack of time for relaxation, which was relatively high at Times 1 and 3; concern over personal physical health, which increased from 1.5 at Time 1 to 2.1 at Time 3; and financial responsibilities, which was high at Time 1 and, although it decreased significantly, was still high at Time 3 (means=2.7 and 2.5 respectively,  $p=.027$ ). Ratings for other items in the personal category were low although several increased over time.



**Figure 2. Comparisons of stress at Times 1, 2, and 3 for students with scores at all three time points**

Note: Comparisons performed with repeated measures ANOVA (N=205).

**Table 4. Comparisons of mean stress scores at Time 1 (T1) and Time 3 (T3) by gender, marital status, and age**

	N	DES				PSS				Stress Rating			
		T1	T3	t	p	T1	T3	t	p	T1	T3	t	p
Men	186	53.4	62.1	-6.63	<b>&lt;.0001</b>	13.9	15.6	-3.50	<b>.0006</b>	4.6	4.8	-0.19	.852
Women	110	58.1	65.2	-4.03	<b>.0001</b>	15.7	16.7	-1.23	.221	4.9	5.1	-0.49	.622
t=		-2.62	-1.72			-2.58	-1.12			-0.86	-0.84		
p=		<b>.009</b>	.087			<b>.010</b>	.124			.391	.403		
Single	200	55.4	63.8	-6.28	<b>&lt;.0001</b>	15.3	16.3	-1.81	.072	4.9	4.9	0.33	.741
Married	96	54.5	62.0	-4.48	<b>&lt;.0001</b>	13.1	15.5	-3.34	<b>.001</b>	4.4	4.9	-1.59	.116
t=		0.47	0.89			2.95	0.97			1.67	0.00		
p=		.639	.372			<b>.003</b>	.330			.391	.999		
≤24 years	180	56.3	63.5	-5.07	<b>&lt;.0001</b>	15.2	16.1	-1.49	.139	4.9	4.8	0.93	.356
≥25 years	116	53.3	62.8	-6.23	<b>&lt;.0001</b>	13.6	15.8	-3.41	<b>.0009</b>	4.4	5.1	-2.44	<b>.017</b>
t=		1.64	0.43			2.13	0.36			1.91	-0.81		
p=		.102	.669			<b>.030</b>	.716			.057	.420		

Notes: Comparisons going across a line show the comparison between Time 1 and Time 3 for that subsample (e.g., men); comparisons performed with paired t-tests. Comparisons going downward within a column show comparisons by gender, marital status, or age at one time point (either Time 1 or Time 3); comparisons performed with independent t-tests. Bold indicates significant differences.

DES=total score on the Dental Environment Stress Questionnaire; PSS=Perceived Stress Scale; Stress Rating=response to the question "On a scale of 1–10, with 1 being the least and 10 being the most, how stressed do you feel right now?"

## Discussion

The hypotheses were confirmed. Although some stress can spur on a better performance, this study shows that the stress levels that first-year dental students experience are related to detrimental effects on their performance and health. Higher stress levels in students were associated with lower GPAs, the reporting of more illnesses and physical and psychological symptoms, and lower ratings of physical and emotional health than students with lower stress levels. It is interesting to note that students at the schools that had the highest stress scores at Time 1 (DS2 and DS3) had the lowest GPAs and the worst health (see Figures 1 and 2). No association was found between stress and the number of times absent. However, the number of absences reported was low. Thus, the lack of an association may reflect the possibility that students go to class even when they are sick because they do not want to miss new material.

Over the past two decades, several studies have examined stress and tried to identify stressors in dental students, but most did not include first-year students.<sup>8-11</sup> However, being a first-year dental student may represent a situation that is unique from those experienced by students in their second, third, or fourth years. While first-year students may be happy

about starting dental school, they may experience stress at the start of the school year because of various life changes. These students often have to move to attend dental school, leave their familiar social situations, and develop new friendships as well as deal with worry regarding finances and face insecurities concerning their ability to do well in classes. They are entering a new environment with unknown and unfamiliar demands. However, based on previous studies, it is unclear whether stress is greater at the beginning of the school year when much of the stress may be anticipatory and from imagining what dental school will be like, or later in the first year when stress levels would be comprised of the situational stress that comes from the reality of being in dental school with its daily hassles, constant heavy workload, lack of time for relaxation, and other chronic stressors, as well as anticipatory stress over things yet to be experienced.

Most previous studies that included first-year students were cross-sectional and involved comparisons between students in the various years within a single dental school.<sup>8-11</sup> However, these studies do not address changes in stress over time. One previous longitudinal study of first-year dental students in the United States<sup>16</sup> assessed depression and anxiety in a sample of forty students from one school who were followed for six months. That study found

**Table 5. Comparisons of mean stress ratings for each DES item at Time 1 and Time 3**

	Time 1	Time 3	t	p
<b>Q# Schoolwork-related items</b>				
1 Amount of classwork	2.4	2.5	- 1.11	.132
2 Difficulty of classwork	2.3	2.4	- 0.97	.174
3 Competition for grades	2.1	2.1	- 0.49	.310
4 Exams and grades	2.6	2.8	- 2.51	<b>.006</b>
5 Difficulty of learning clinical procedures	2.0	2.6	- 6.04	<b>&lt;.0001</b>
9 Difficulty of learning manual skills	2.0	2.3	- 4.66	<b>&lt;.0001</b>
10 Lack confidence to be successful student	2.0	2.2	- 2.21	<b>.01</b>
11 Lack confidence to be successful dentist	1.8	2.1	- 4.13	<b>&lt;.0001</b>
16 Completing graduation requirements	1.6	2.2	- 6.92	<b>&lt;.0001</b>
19 Expectations vs. what school really like	2.0	2.2	- 2.10	<b>.018</b>
21 Fear of failing course or year	2.0	1.9	1.56	.060
24 Lack time to do assigned schoolwork	2.4	2.4	0.21	.418
34 Fear being unable to catch up if behind	2.4	2.3	1.62	.050
<b>Q# Atmosphere of school</b>				
6 Atmosphere created by clinical faculty	1.5	2.3	-12.27	<b>&lt;.0001</b>
8 Receiving criticism about work	1.7	2.0	- 5.28	<b>&lt;.0001</b>
13 Amount of cheating in school	1.1	1.6	- 7.83	<b>&lt;.0001</b>
14 Rules of the school	1.3	1.7	- 6.26	<b>&lt;.0001</b>
20 Lack of input in decision making process of school	1.6	2.1	- 8.21	<b>&lt;.0001</b>
33 Inconsistency in feedback on work from different instructors	1.6	2.8	-14.78	<b>&lt;.0001</b>
<b>Q# Personal</b>				
7 Relations with opposite sex	1.2	1.5	- 4.90	<b>&lt;.0001</b>
12 Lack of time for relaxation	2.3	2.5	- 1.47	.072
15 Lack home atmosphere in living quarters	1.3	1.5	- 4.01	<b>&lt;.0001</b>
17 Having children in the home	0.7	0.8	- 2.55	<b>.005</b>
18 Marital problems	0.8	0.9	- 1.29	.098
22 Insecurity about professional future	1.8	2.0	- 2.18	<b>.015</b>
23 Financial responsibilities	2.7	2.5	1.93	<b>.027</b>
25 Considering some other field	0.9	1.2	- 4.08	<b>&lt;.0001</b>
26 Forced postponement of marriage	0.6	0.9	- 4.29	<b>&lt;.0001</b>
27 Personal physical health	1.5	2.1	- 8.32	<b>&lt;.0001</b>
28 Attitudes toward women students	1.0	1.2	- 3.93	<b>&lt;.0001</b>
29 Necessity to postpone having children	0.9	1.1	- 2.56	<b>.005</b>
30 Conflict with partner over career decision	0.8	0.9	- 1.58	.058
31 Discrimination due to race, class, ethnicity	1.0	1.2	- 2.73	<b>.003</b>
32 Having dual role wife/mother or husband/father and dental student	1.0	1.2	-2.90	<b>.002</b>

Notes: Comparisons performed with paired t-tests. Students indicated how much stress they felt for each item, in which 0=not applicable; 1=not stressful; 2=slightly stressful; 3=moderately stressful; 4=severely stressful. Bold indicates significant differences.

that although depression remained stable, anxiety decreased at six months. It is unknown whether differences would have been observed over a longer period of follow-up such as a year. Direct measures of stress were not used; anxiety and depression were used as proxy measures of stress. Additionally, only a small sample of students at one school was studied. It is possible that different schools, using alternative teaching methods, may have students with different

stress levels. Therefore, findings based on students at one school may not be applicable or generalizable to first-year students at other schools.

A more recent study<sup>17</sup> compared first- and fifth-year stress scores of 132 dental students in five European dental schools (Manchester, Belfast, Helsinki, Amsterdam, and Cork). That study reported that although rates varied by school, the overall proportion of students having high levels of stress was

similar in the first and fifth years. However, there were significant cross-sectional associations of fifth-year stress scores with physical and mental health.

Using a large sample of students from multiple U.S. dental schools, the present longitudinal study found that stress among first-year dental students increased over time: students had higher stress scores one year after school started than when they began dental school. This was found using a stress scale specifically related to the dental school environment, as well as with general measures of stress. There was some indication that though stress was higher at Time 2 (three months into the school year) and actually decreased a bit by Time 3 (one year), stress was still higher after one year than it was when students began dental school. The decline in scores between Times 2 and 3 may represent the fact that students have less anticipatory stress after one year of dental school than they do after only three months.

In our study, stress scores were higher for women, younger students, and students who were single at the beginning of dental school. However, although stress increased over time for all groups, it increased somewhat more for men, married students, and older students, so that there were no differences between groups by one year after starting dental school. Previous cross-sectional studies have reported inconsistent results with regard to gender differences in stress: while most reported higher stress in women dental students as compared to men,<sup>7,9,17-20</sup> one study reported higher levels of stress in men,<sup>21</sup> and Humphris et al.<sup>22</sup> reported no overall differences between the genders in stress. Our results are in accord with those of Gorter et al., who also reported no overall gender differences in stress after five years of follow-up.<sup>17</sup> Results of our study are also in accord with those of Musser and Lloyd,<sup>23</sup> who found that, overall, marital status was associated with few differences in stress among dental students. Results of our study concerning age differences in stress disagree with those of a cross-sectional study that reported higher stress scores for United Kingdom dental students older than twenty-one years as compared to those twenty-one years of age or younger.<sup>20</sup> However, Gorter et al. also reported no overall age differences among European dental students.<sup>17</sup>

The possibility that stress may vary by teaching method or curriculum is suggested by the reports of differences in stress scores of students at dental schools in various (generally European) countries.<sup>6,17,22,24</sup> Furthermore, Polychronopoulou and Divaris,<sup>24</sup> in comparisons of stress among dental

students in Greece, Ireland, Slovenia, Sweden, Spain, and Croatia, reported that a problem-based learning approach to education was associated with lower stress scores as compared with a more traditional approach. Similarly, our study of U.S. students found that stress varied by school, with DS1 reporting the lowest scores followed by DS4, DS3, and DS2, which had the highest stress scores. Teaching methods and approach to the dental school curriculum vary at each school. DS1 has a nontraditional curriculum in which students intensively study only one subject at a time; DS4 uses a problem-based learning approach in which students are taught by giving them examples of the situations they may encounter; DS3 has a somewhat traditional approach to teaching, but the program is only three years long and year-round, which leaves little time off; and DS2 follows a traditional four-year approach in which students take multiple courses in the basic sciences during the first two years and courses giving them clinical experience in the last two years. Stress scores between the schools were still different one year after the start of dental school. While most schools had stress scores at Time 3 that were still higher than those at Time 1, scores at DS3 on the general measures of stress (PSS and Stress Rating) were lower at Time 3 than at Time 1, but they were still higher than those found at most other schools.

The present longitudinal study also found that the sources of stress for first-year dental students changed over time. At both Time 1 and Time 3, items relating to schoolwork were the most stressful, along with the lack of time for relaxation and financial responsibilities. Items relating to the school atmosphere, specifically the atmosphere created by the clinical faculty and inconsistency in feedback from instructors, though initially not stressful, became important sources of stress over time. This may also reflect the different contributions of anticipatory and situational stress. At Time 1, most students had not yet started school. Thus, stress ratings would reflect mostly anticipatory stress. By Time 2, students had been in school for two to three months; stress ratings would therefore reflect a combination of situational stress from the realities of dental school and anticipatory stress. By Time 3, students had been in school for over a year, and stress ratings would be influenced the least by anticipatory stress and reflect mostly situational stress. The fact that school atmosphere increased in stressfulness over time suggests an important role that faculty could play in reducing stress. Most personal items such as having

to postpone marriage or having multiple roles were not considered stressful at either time.

This study has a number of strengths including the use of a large sample of first-year students from multiple dental schools who were followed for over a year and assessed for stress at three points in time. Although there are many cross-sectional studies of stress in dental students, this is probably the only longitudinal study of first-year dental students attending several U.S. schools. This is also probably the first longitudinal study to examine the association of stress with performance in dental students that directly assesses stress rather than using proxy measures such as anxiety; and it is the first study to examine the associations of stress with both physical and emotional health outcomes in first-year students from multiple U.S. dental schools.

This study is limited in that students at the four schools did not complete the survey under the same conditions. At DS2, all surveys were given during class; other schools gave the survey for the first time during orientation and for the second and third times under informal conditions. Completing the survey during class may have contributed to the higher stress scores in DS2 students. Students at the four schools also did not complete the surveys on the same particular day within the school year (i.e., during the second day of orientation or the eighth week of classes). Most schools gave the first survey at orientation, but waiting for IRB approval at DS2 delayed the first survey until four weeks after classes had started. Thus, any initial low stress levels at orientation would have been unmeasured. DS2 also delayed in administering the third survey until almost three months after the second-year classes had started, which could have also contributed to their higher scores. This study is also limited in that all data were based on self-report and participants had to recall symptoms and health over a period of a year. However, while some participants may be more likely to recall symptoms, others may be less likely to do so, thereby making any bias due to recall a source of random rather than systematic error. This study may also be limited by sampling bias as only a little over a third of the respondents were women; but given the similar distribution of sexes found at baseline (39 percent women) when all but twenty-three students at all four schools combined participated, it is likely that the relatively low proportion of women in the study reflects an anomaly of admission at those particular schools for that particular year.

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## Conclusion

Each year, thousands of students start dental school. Results from this study show that stress is related to detrimental effects on performance and health and that the amount and sources of stress change over time for first-year students. Knowledge of how stress affects performance and health and how it changes over time can be used by schools to counsel first-year students and stimulate the implementation of stress reduction programs.

Potential stressors in dental school could be discussed with the students throughout the year, and stress management programs could be made available to help reduce stress. It is interesting to note that DS1, whose students had lower stress levels at all points and showed greater decreases from Time 2 to Time 3, gives students a membership to a gym and encourages them to be physically active. Other schools may want to consider initiating similar programs. Finally, given the importance of the school's atmosphere as a source of stress that was shown in this study, schools could also try to make faculty members more aware of the impact they have on the stress associated with dental school.

Future studies could examine which stress score (Time 1, Time 2, or Time 3), if any, affects performance as shown by scores on national boards and whether regular physical exercise has any effects in terms of lowering stress level or lessening its impact on performance and health. It would also be interesting to compare the stress levels of first-year students as assessed three months prior to and three months after starting dental school.

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