

Effect of Perceived Stress on Student Performance in Dental School

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Abstract: A commonly held view is that chronic stress has an adverse affect on academic performance. Because dental students typically report high levels of stress, they may be at particular risk. This research examined the relationship between perceived stress and academic performance in 202 dental students enrolled in an Australian dental school. In this study, four key stress factors labelled “self-efficacy beliefs,” “faculty and administration,” “workload,” and “performance pressure” previously identified by our group from principal components analysis of the Dental Environment Stress (DES) questionnaire, together with gender, ethnicity, and stage of course, were entered as independent variables into multiple regression analyses. Three measures of academic performance (basic and applied science knowledge, clinical competency, and contextual understanding) were entered as dependent variables. Regression analysis revealed little support for the assumption that chronic stress predicted academic performance. The only finding of note was that students reporting higher levels of stress on the DES factor “faculty and administration” tended to show lower grades for clinical competency and contextual understanding. In summary, although the DES factor solution used in the present study remains to be validated, we found little support for an association between increased DES factor stress scores and reduced academic performance in dental students.

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It is widely acknowledged that students find dental education stressful, with a number of groups reporting that compared to clinical norms, dental students show higher levels of stress-related psychosomatic activity and increased mood disturbance.¹⁻⁵ What is less clear is whether stress has an impact on academic performance. Simply defined, stress is strain that accompanies a demand perceived to be either challenging (positive) or threatening (negative) and, depending on the appraisal, either adaptive or debilitating. One debilitating reaction to stress is anxiety, which to date is the only measure of stress that has been tested with academic performance in dental students. In general, anxiety is reported to be predictive of reduced performance. In their study of thirty-nine dental students, Fredericks and Mundy⁶ found a significant but weak negative correlation between anxiety and academic performance. Westerman et al.⁷ report a weak inverse relationship between trait anxiety (a stable long-term predisposition to easy arousal) and student grades. Although no significant relationship was observed with trait anxiety, Cecchini and Friedman⁸ report a modest inverse relationship between state anxiety (transient level of arousal specific to the situation) and grade point average. In summary, these studies support an

indirect relationship between stress and reduced academic performance.

Although the sources of stress in dental students are multifactorial, there is some evidence that interpersonal factors are important. Tedesco⁹ noted in a discussion paper that the continuous scrutiny of clinical supervisors that typifies dental school learning is highly stressful for students and becomes increasingly so as students progress through their education. Lloyd and Musser¹⁰ attribute heightened interpersonal sensitivity in dental students to the excessive demands on performance made by faculty. Consistent with the previous findings, two major stressors consistently identified by dental students themselves are examinations and student-faculty conflict.^{1,11-19}

We suggest that it would be valuable to dental educators to understand more fully those aspects of academic performance affected by stress. In their education, students are expected to acquire a science knowledge base, develop clinical competencies, and integrate these contextually in clinical decision-making scenarios. One or more of these three learning domains may be sensitive to the effects of stress, but this has yet to be determined.

It would also be valuable to know whether the effects of stress on academic performance are mediated by characteristics such as gender, ethnicity, and stage of dental education. There is a substantive literature showing that females and ethnic minority dental student groups report higher levels of stress.^{10-12,16-18} Further, because the move from preclinical to clinical years of dental education is reported to be highly stressful,^{15,20} we thought it would also be instructive to examine the relationship between stress and stage of education.

We propose that higher stress scores will be associated with reduced academic performance and that this association will be greater among females and students from ethnic minority groups and for the clinical years of education.

Methods

Participants in this study were recruited from the five-year undergraduate Bachelor of Dental Surgery (B.D.S.) program at Adelaide University, for whom sources and levels of stress were reported in an earlier study undertaken by our group.¹⁸ The sample of 202 students was comprised of approximately equal numbers of male and female students with a mean age of 22.6 years. Because the percentage of international students (principally from Malaysia, Vietnam, China, Nepal, Iran, Hong Kong, and Nepal) is so large, this group was examined separately from the permanent residents. For each year level, participants who were international students totalled 19.5 percent, 27.0 percent, 18.1 percent, 22.4 percent, and 20.5 percent, respectively.

The University of Adelaide Human Research Ethics Committee approved the present study.

To test the relationship between stress and academic performance, the Dental Environment Stress (DES) factor scores were correlated with students' end-of-year grades. Garbee¹ developed the DES scale to identify and quantify stressors specific to dental students; it has also been used with dental student groups in America,¹³⁻¹⁴ Singapore,¹⁶ and Jordan.¹⁹ It contains thirty-eight items and five response categories (1=not stressful to 4=very stressful and 5=not applicable). The complete DES instrument appears as Appendix 1.

Scholastic performance was measured by grades attained for two coursework streams (Dental and Health Science, Dental Clinical Practice). In

addition, we included grades assigned to performance in an end-of-year Oral Interview that assesses the students' ability to assimilate and apply essential knowledge and express it verbally in a clinically relevant context.

All students undertake these learning domains in each year of the B.D.S. program. The Dental and Health Science stream covers basic and applied sciences. Assessment is accomplished through participation in tutorials and clinically based group learning sessions, as well as achievement in examinations, oral presentations, and written assignments. The Dental Clinical Practice stream develops laboratory/clinical proficiency and integrates theoretical and operative components of clinical practice. Grades in the Dental Practice stream reflect continuous assessments of staff mentors, clinical tutors, and students themselves of technical and interpersonal skills and professional qualities. Assessment methods include written assignments, examinations, and clinical assessment.

Together, these performance measures assess knowledge of basic and applied sciences, clinical proficiency, and understanding. It should be noted, however, that the highly integrated nature of learning components across the curriculum does not allow a clean separation of performance outcomes with respect to written versus oral assessment or knowledge from clinical proficiency. The main features of the problem-based learning (PBL) curriculum at the Adelaide school have been described elsewhere.²¹

Results

Of the 205 students in our previous study who completed the DES during semester one, end-of-year grades were obtained for 202 students. This sample represented 91.8 percent of the student body. There were seventy-eight students in the essentially pre-clinical years (years one and two) of the B.D.S. program: twenty-nine female Australian, thirteen female international, thirty-three male Australian, and three male international students. In addition, there were 124 students in the clinical years three to five: forty-eight female Australian, seventeen female international, fifty-one male Australian, and eight male international students.

For the Dental and Health Science and Dental Clinical Practice streams, final marks—expressed as a percentage score—comprise the aggregate results

of continuous assessment procedures. Oral Interview grades were assigned a value on a ten-point scale, with higher scores indicating higher achievement. For the purpose of analysis, according to year of study, students were divided into those not working with patient groups (preclinical, or years one and two) and those who were (clinical, or years three through five).

The mean performance grades are given in Table 1. Results from a three-way—year (preclinical, clinical), gender (male, female), and ethnicity (Australian, international)—analysis of variance (ANOVA) with academic performance as dependent variables are reported in Table 2. For Dental and Health Science performance, we found a significant main effect for year and ethnicity and a significant interaction between year and ethnicity. Post-hoc analyses (Student T test) revealed that preclinical Australian = clinical Australian = clinical international > preclinical international Dental and Health Science performance ($p < 0.05$). For Dental Clinical Practice and Oral Interview grades, no significant main or interaction effects were observed.

Pearson-r correlational analyses were used to explore the relationship between stress and academic performance, and significance was tested using r-z transformations. Because our previous analyses indicated the presence of several single or double item DES factors, the present analyses were restricted to

those factors that showed high internal validity, that is, contained three or more items.²² These included self-efficacy beliefs (factor 1), faculty and administration (factor 2), workload (factor 3), and performance pressure (factor 6). Correlational results are reported in Table 3. For the analyses involving the DES factor and academic performance only, we observed six significant relationships at $\alpha = 0.05$ (two-tailed). Specifically, higher faculty and administration stress scores were associated with lower Dental Clinical Practice and Oral Interview grades; higher workload stress scores were associated with lower Oral Interview grades; and higher performance pressure stress scores were associated with lower Dental Clinical Practice grades. It is also to be noted that while the DES factor scores were highly intercorrelated, only modest relationships were observed between academic performance measures especially for those involving Oral Interview.

Multiple regression analyses were used to further test the relationship between stress and academic performance. The DES factor scores for gender, ethnicity (Australian/international), and year of education (preclinical/clinical) were entered as independent variables, along with the three academic performance measures as dependent variables, into a series of multiple regression analyses (see Table 4). R for regression was significantly different from zero

Table 1. Number of students and mean (SD) student grade for Dental and Health Science, Dental Clinical Practice, and Oral Interview according to year level (preclinical, years one to three, and clinical, years four and five) by gender and ethnicity (Australian and international)

Assessment	Preclinical				Clinical			
	Australian		International		Australian		International	
	Female (n=29)	Male (n=33)	Female (n=13)	Male (n=3)	Female (n=48)	Male (n=51)	Female (n=17)	Male (n=8)
Dental and Health Science	65.0 (7.2)	63.8 (7.7)	59.8 (6.6)	55.7 (17.5)	66.4 (6.6)	65.5 (5.3)	65.2 (5.1)	66.5 (8.2)
Dental Clinical Practice	65.8 (3.7)	63.8 (5.0)	62.5 (3.2)	59.7 (7.6)	63.4 (8.3)	62.1 (4.9)	61.3 (8.0)	62.8 (5.0)
Oral Interview	5.7 (2.1)	6.2 (2.4)	5.7 (1.9)	5.7 (3.1)	5.5 (1.9)	6.0 (2.2)	5.5 (1.7)	5.2 (2.3)

Performance scores for DHS and DCP are given as percentages, and for Oral Interview on a ten point scale. In all cases, higher scores indicate higher academic performance.

Table 2. ANOVA results examining the effects of year of study (preclinical, years one to three, and clinical, years four and five), ethnicity (Australian and international), and gender on student scores for Dental and Health Science (DHS), Dental Clinical Practice (DCP), and Oral Interview

Assessment	Year (df = 1, 194)	Ethnicity (df = 1, 194)	Gender (df = 1, 194)	Year by Ethnicity (df = 1, 194)	Year by Gender (df = 1, 194)	Ethnicity by Gender (df = 1, 194)	Year by Ethnicity by Gender (df = 1, 194)
DHS	11.6*****	5.8*	0.8	5.4*	1.1	0.1	0.8
DCP	0.2	3.1	0.9	1.4	1.0	0.1	0.5
Oral Interview	0.3	0.5	0.2	0.1	0.1	0.5	0.1

NB *denotes $p < 0.05$ and ***** $p < 0.0005$.

Table 3. Correlation matrix between dental environment stress (DES) factor scores (1-3, and 6) and student scores for dental and health science (DHS), dental clinical practice (DCP), and oral interview

	1	2	3	4	5	6	7
1. Self-efficacy beliefs (factor 1)	1.00	0.48*****	0.65*****	0.74*****	0.05	-0.13	-0.17*
2. Faculty and administration (factor 2)	*****	1.00	0.52*****	0.64*****	0.01	-0.32*****	-0.17*
3. Workload (factor 3)	*****	*****	1.00	0.61*****	0.10	-0.11	-0.16*
4. Performance pressure (factor 6)	*****	*****	*****	1.00	0.11	-0.19**	-0.14*
5. Dental and Health Science					1.00	0.56*****	0.31*****
6. Dental Clinical Practice		*****		**	*****	1.00	0.29*****
7. Oral Interview	*	*	*	*	*****	*****	1.00

202 observations were used in this computation. *denotes $p < .05$, ** $p < .01$, *** $p < .005$, **** $p < .001$, ***** $p < .0005$, ***** $p < .0001$. The present analysis was restricted to those DES factors that showed high internal validity, that is, contained three or more items: self-efficacy beliefs (*factor 1*); faculty and administration (*factor 2*); workload (*factor 3*); and performance pressure (*factor 6*) (18)

Table 4. Regression analysis summary for performance variables predicting Dental Health Science (DHS), Dental Clinical Practice (DCP), and Oral Interview (OI) grades

Performance Variable	B	SEB	β	t-value	P-value
<i>Dental Health Science</i>					
Year of Study	2.72	1.18	0.19	2.30	0.02
Ethnicity	-2.06	1.23	-0.12	1.66	0.10
Gender	-0.68	0.99	-0.05	0.69	0.49
Self-efficacy beliefs (DES factor 1)	-0.17	0.23	-0.09	0.76	0.45
Faculty and administration (DES factor 2)	-0.27	0.16	-0.16	1.63	0.10
Workload (DES factor 3)	0.17	0.19	0.09	0.90	0.37
Performance pressure (DES factor 6)	0.31	0.28	0.14	1.10	0.27
<i>Dental Clinical Practice</i>					
Year of Study	0.38	1.01	0.030	0.38	0.70
Ethnicity	-1.27	1.06	-0.08	1.20	0.23
Gender	-1.19	0.85	-0.10	1.41	0.16
Self-efficacy beliefs (DES factor 1)	-0.02	0.20	-0.01	0.12	0.90
Faculty and administration (DES factor 2)	-0.57	0.14	-0.36	3.73	0.0002
Workload (DES factor 3)	0.14	0.16	0.08	0.85	0.40
Performance pressure (DES factor 6)	-0.04	0.24	-0.02	0.17	0.87
<i>Oral Interview</i>					
Year of Study	0.20	0.36	0.05	0.56	0.57
Ethnicity	-0.09	0.38	-0.02	0.25	0.80
Gender	0.33	0.30	0.08	1.08	0.28
Self-efficacy beliefs (DES factor 1)	-0.05	0.07	-0.08	0.73	0.47
Faculty and administration (DES factor 2)	-0.06	0.05	-0.12	1.26	0.21
Workload (DES factor 3)	-0.03	0.06	-0.05	0.52	0.60
Performance pressure (DES factor 6)	0.01	0.09	0.01	0.08	0.94

For regression analysis involving DES, $R^2 = .07$ [$F(7, 194) = 2.1$, $p = 0.04$]; DHS, $R^2 = .13$ [$F(7, 194) = 4.0$, $p < 0.0005$]; and OI, $R^2 = .05$ [$F(7, 194) = 1.4$, ns].

for Dental and Health Science and Dental Clinical Practice but not for Oral Interview. We found that year of study was a significant but weak predictor of Dental and Health Science performance ($\Delta r^2 = .03$), while faculty and administration (DES factor 2) was a significant but weak predictor of Dental Clinical Practice performance ($\Delta r^2 = .07$).

There is some evidence that individuals under moderate levels of arousal perform better than those under either hyper- or hypo levels of arousal.²³ To exclude the possibility that a curvilinear relationship may exist between stress factor scores and grade performance, we also performed a series of second-

order polynomial regressions with grades as the dependent variables and stress factor scores as the independent variables. These revealed no significant curvilinear relationships.

Discussion

It is a commonly held view that student stress has a negative effect on academic performance. Although that may be the case for individual students, for the group as a whole we found limited support for an association between stress and academic per-

formance. Apart from one comparison involving stress associated with faculty and administration, none of the remaining DES factors were predictive of academic performance. Stress did not have a stronger effect on knowledge-based than on clinical and laboratory practical learning.

There are several possible explanations for our inability in this study to find a relationship between stress and academic performance. First, the DES factor scores selected for investigation may not be sufficiently sensitive measures of stress. Clearly, there is a need to replicate the factor structure observed in our previous work. Moreover, there is a strong need to validate the DES against alternate instruments with well-established psychometric properties such as the Perceived Stress Scale.²⁴ Second, because the DES measures chronic rather than acute stress, this may have limited the association with academic performance. There is evidence in medical students that acute stress is predictive of reduced scholastic performance, especially exam performance.^{25,26} Third, while it may be the case that students are stressed, academic grades may be refractory to the influence of stress. Selection into dental school is highly prized, and because of the high salience placed by students themselves or in the case of international students by sponsoring bodies on successful program completion, this may quarantine the effects of stress on academic performance. Moreover, the individual coping styles of students and their access to forms of social support have not been examined for their stress-mitigating effect. Finally, the shift from didactic teaching styles to problem-based learning with its greater emphasis on deeper, contextual understanding of the material may reduce the adverse effect of stress on grade performance. In a recently reported study measuring stress among Jordanian dental students, Rajab¹⁹ reported that these students rated their learning environment as being more stressful than did our Australian cohort and students elsewhere, and the author commented that this finding supports the rationale for the introduction of a problem-based program of learning in their school. Whether dysfunctional levels of stress are buffered by this approach to learning has not yet been investigated.

Although students in the Adelaide school were less concerned than their overseas peers about stress linked to faculty and administration,¹⁸ this factor emerged as a significant, though weak, predictor of lower Dental Clinical Practice grades. DES items loading onto the factor *faculty and administration*

include “receiving criticism about work,” “inconsistency of feedback from different instructors,” “atmosphere created by clinical faculty,” “discrimination,” “rules and regulations,” and “lack of input into decision making processes.” These items deal with concerns about appraisal, equity, and autonomy. Students in the Adelaide program are encouraged to become critical thinkers and self-directed learners with the ability to evaluate their own performance,²⁷ yet in the formal assessment process, this autonomy is largely suspended as responsibility for grades is assumed by academic staff. This tension between autonomy and submission is particularly pertinent in clinical dentistry, where students are closely supervised, and in the Oral Interview, where the student is examined by two staff members in what may be perceived as a threatening encounter.

Examination of other variables that may potentially moderate performance revealed only one significant predictor for only one academic performance measure. Specifically, we found that year was a significant predictor of Dental and Health Science grade. By contrast, gender and ethnicity were not predictive of performance in any of the analyses. Further analysis examining the effect of year, gender, and ethnicity on grade performance, however, did reveal that international students in their preclinical years tended to show significantly lower Dental and Health Science grades than international students in their clinical years and Australian students in general. For ethnic minorities, cultural adjustment, language difficulties, and social isolation compound the stress related to academic demands in Dental and Health Science. This stream is assessed through multiple methods that require language skills in addition to theoretical understanding. International students have met language prerequisites, yet fluency and expression remain an additional challenge. There has been debate about the learning styles of Southeast Asian students in Australian universities, but the stereotypical assumption that these students are superficial learners has been discredited.²⁸ It is more likely that lower performance in the preclinical years reflects differences in culturally determined behavior and values such as assertiveness and hierarchical relationships,²⁹ rather than differences in learning styles or academic ability. While examination performance remains important, the shift to student-centered learning has brought a greater emphasis on attributes such as verbal communication skills, ability to succeed in self-directed learning, high motivation, and a willingness to participate in group activities.³⁰

Students from Asian cultures are more strongly motivated by social approval than are Australian students,³¹ and this may influence their willingness, or lack thereof, to engage in debate over contentious issues on which their participation is assessed.

Conclusion

The experience of stress for students in the health professions continues to be reported in the education literature. In the period between 1966 and 1999, 600 articles were published relating to medical school stress alone.³² While chronic stress may have implications for psychosocial functioning, this study found only weak evidence in dental students to support the assumption that stress impairs academic performance. We therefore suggest that calls for the introduction of stress management programs into dental curricula because of stress-impaired performance¹⁷ are precipitous, and there is no evidence that dental school stress is carried into professional life with adverse effects or is otherwise debilitating.

We see the challenge now as being to move beyond descriptions of stress in dental education to a greater understanding of the broader educational and mental health issues. These include the role of academic staff in pastoral care and an examination of chronic stress on professional life. While the notion that dentists are an at-risk professional group for suicide has been challenged recently,³⁴ it is unknown whether vulnerable students become vulnerable clinicians and what implications this may have for professional burnout and impaired health.

We recommend two areas for further research. Although the magnitude of DES scores varies among student populations, the same DES stress items appear to predominate and remain stable over two decades among culturally diverse groups—despite changing student demographics and educational curricula. Despite this consistency, the psychometric properties of the DES should be tested for validity against a standard psychological stress scale as well as its test-retest reliability before the cautious message of this study can be generalized to other student populations. Further research into whether learner-centered curricula promote adaptive coping in students through the development of problem-solving skills would have broad application for education in the health professions.

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Appendix 1. The dental environment stress questionnaire items

No	Dental Environment Stress Item		
1	Amount of assigned classwork	21	Having children in the home
2	Lack of cooperation by patients in their home care	22	Marital adjustment problems
3	Difficulty of classwork	23	Expectations of dental school and what in reality it is like
4	Responsibilities for comprehensive patient care	24	Lack of input into the decision-making process of school
5	Competition for grades	25	Fear of failing course or year
6	Patients being late or not showing for their appointments	26	Insecurity concerning professional future
7	Examinations and grades	27	Financial responsibilities
8	Difficulty in learning clinical procedures	28	Lack of time to do assigned school work
9	Atmosphere created by clinical faculty	29	Considering entering some other field of work
10	Relations with members of the opposite sex	30	Forced postponement of marriage or engagement
11	Receiving criticism about work	31	Personal physical health
12	Difficulty in learning precision manual skills required in preclinical and laboratory work	32	Attitudes of school toward women dental students
13	Lack of confidence to be a successful dental student	33	Necessity to postpone having children
14	Lack of confidence in self to be a successful dentist	34	Conflict with partner over career decision
15	Lack of time for relaxation	35	Discrimination due to race, class status, or ethnic group
16	Amount of cheating in dental school	36	Having a dual role of wife/mother or husband/father and dental student
17	Rules and regulations of the school	37	Inconsistency of feedback on your work between different instructors
18	Working on patients with dirty mouths	38	Fear of being unable to catch up if behind
19	Lack of home atmosphere in living quarters		
20	Completing graduation requirements		