Stress in Dental Students: A Mixed Methods Study

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Acknowledgements

Preface

Declaration of contribution of co-authors of manuscripts contained in this thesis

Manuscript I "A Systematic Review of Stress in Dental Students" is a review article whose original concept, preparatory work and original preparation were performed by Hawazin Elani (the student). The role of the co-authors Dr Paul Allison and Dr Christophe Bedos was in advising on most appropriate study selection strategies and reviewing and modifying the texts of the draft. The role of co-authors Ritu Kumar and Laura Mancini was in reviewing the included articles and helping in extracting the data. The role of the co-author Angella Lambrou was advising on the most appropriate search strategies in conducting the review.

Manuscript II "Longitudinal Appraisal of Stress in Dental Students and Residents: A Mixed Methods Study", III "Sources of Stress in Canadian Dental Students: A Prospective Mixed Methods Study" and IV "Stress and Well-being in Dental Students: A Mixed Methods Investigation" are all based on findings from the data collected as part of the research reported in this thesis. The original concept of the research protocol, data collection and analysis, and preparation of first drafts of manuscripts were done by Hawazin Elani (the student). The role of the co-authors Dr Paul Allison and Dr Christophe Bedos was in supervising the preparation of the research protocol, the data collection, advising on most appropriate data analysis procedures, and modifying and reviewing the draft texts.

ABSTRACT – English

Previous research demonstrated that dental students experience high levels of psychological distress during their education. However, most of the available literature is based on cross-sectional studies that ignored variations over-time. Therefore, the aim of this research was to describe stress levels and sources of that stress in undergraduate dental students and first year residents longitudinally, and to explore the consequences of stress on participants' well-being. In this study we used a mixed methods approach. In the first quantitative phase, we collected data from participants every month for a period of one year. We used a Visual Analogue Scale to assess stress and impact levels. In addition, we used the Dental Environment Stress questionnaire to report sources of that stress. We also collected information about participants' demographic characteristics, stress-related symptoms, smoking, drinking habits and physical activity. In the qualitative phase, we used one-on-one, semi-structured interviews to explain and better understand the quantitative findings. Our results demonstrated a gradual increase in dental students stress levels throughout the four-year curriculum with a decline after their graduation. With respect to sources of that stress, most undergraduate students concerns were related to "examination and grades" and "workload". In addition, we observed an association between participants' stress level and their demographic characteristics, stress-related symptoms and drinking habits. In conclusion, findings from this study indicate that dental students experience high levels of stress that vary according to their stage in the program and time during the academic year. In addition, our results suggest a negative effect of high stress level on students' health and well-being, and this needs to be addressed by dental faculties and educators.

RÉSUMÉ – Français

La littérature scientifique montre que les étudiants en médecine dentaire éprouvent beaucoup de stress pendant leur éducation. Cependant, la majorité des études sont transversales et n'indiquent pas si le stress et ses conséquences évoluent avec le temps. Le but de cette étude était donc de décrire, de manière longitudinale, le niveau de stress des étudiants au 1er cycle en médecine dentaire ainsi que des résidents de 1ère année. Il s'agissait aussi d'identifier les causes de ce stress et d'en explorer les conséquences sur l'apprentissage et le bien-être des participants.

Cette étude reposait sur une approche à méthodes mixtes : une phase quantitative précédait une phase qualitative. Dans la phase quantitative, nous avons collecté des données une fois par mois pendant un an à l'aide de questionnaires auto administrés. Nous avons utilisé une *Visual Analogue Scale* pour évaluer le stress des participants et son niveau d'impact. Nous avons également utilisé le *Dental Environment Stress Questionnaire* pour déterminer les causes de ce stress. Pendant la phase qualitative, nous avons réalisé des entrevues individuelles, de type semi-structuré, avec des personnes ayant gradué l'année précédente. Le but des entrevues était de mieux comprendre et d'approfondir les résultats des analyses quantitatives.

Nos résultats montrent que le niveau de stress des étudiants augmente graduellement au cours du curriculum de 4 ans, puis baisse après leur graduation. Ce stress est souvent relié à leurs « examens et notes » ainsi qu'à leur « charge de travail », très lourde. De plus, nous avons observé une corrélation entre le niveau de stress des participants et leurs données démographiques, leurs symptômes de stress et leurs habitudes de consommation d'alcool. Les données qualitatives montrent notamment à quel point le stress peut affecter la qualité de vie et même la santé des étudiants. Pour conclure, cette étude indique que les étudiants en médecine dentaire éprouvent un très haut niveau de stress pendant leur

formation professionnelle. Ce niveau de stress et les sources de stress varient d'une année académique à l'autre et même d'un mois à l'autre. De plus, notre étude illustre les effets négatifs de ces hauts niveaux de stress sur la santé et le bien-être des étudiants. Cette situation devrait encourager les facultés dentaires à se pencher sur le problème du stress parmi ses étudiants et à y apporter des solutions.

1. GENERAL INTRODUCTION AND RESEARCH BACKGROUND

1.1 Introduction

The term "stress" was introduced by Hans Selye in 1936 [1]. Selye described biological stress as "nonspecific response of the body to any demand made upon it" [2]. In his consecutive work, Selye further divided stress into two concepts. Distress, which occurs when stress exceeds the ability of individuals to cope with stressors, and eustress, which is considered as the positive type of stress that enhances individuals' good feelings [3].

The pathophysiology of stress can be explained by the stress response system. In response to stressful situation, the body reacts by activating the components of that response system. Through hormonal regulation, both the hypothalamic - adrenal – pituitary and the autonomic axes of the stress response system are activated in an attempt to manage the situation. In addition to coping with stressful stimuli, activation of the stress response system leads to interaction with other body parts. Reproductive, endocrine, gastrointestinal, metabolic and immune systems are all affected by the released regulatory hormones. As a result, growth, appetite, temperature and thyroid may be influenced [4, 5].

Prolonged stress has been related to several adverse health outcomes[6]. Stress has been shown to affect individuals' immune response system [7], to increase risk of heart disease [8] and was related to negative psychological consequences such as burnout[9], depression[10] and in extreme cases could lead to suicide [11]. In addition, behavioral changes like drug and alcohol abuse [12, 13] were also linked to stress. Individuals' vulnerability to these consequences varies depending on how they appraise and react to the stressors they face[1, 14]. Thus individuals utilizing adaptive coping strategies tend to have fewer problems [15, 16].

Health professionals have been identified as a high-risk group to psychological distress [17-20]. Their occupations combine patients' responsibilities, long working hours in addition to risk of infection [21, 22]. Research among health professionals show that dentists particularly experience high levels of stress [18], burnout [23] [24, 25] and depression [26]. Other than having to manage their dental practice, dentists are expected to deal with demanding work schedules, financial responsibilities and sometimes to dealing with difficult and uncooperative patients. In addition to the aforementioned stressors of the dental practice, dental students are also under the demands of their heavy training that make them susceptible to elevated stress.

In this research we aim to provide a better understanding of how undergraduate dental students experience stress throughout their curriculum and how stress affects their well-being.

1.2 Manuscript I: "A Systematic Review of Stress in Dental Students"

Abstract

The aim of this study is to systematically review the available literature on levels, causes and the impact of stress in dental students. We searched eight electronic databases (Medline, Medline in process, Psychinfo, ERIC, Embase, Cochrane library, Web of science and SCOPUS). Two Independent reviewers conducted the selection, data extraction and quality appraisal for included studies. We coded both quantitative and qualitative studies using similar codes. In addition, we pooled results from studies that used the Dental Environment Stress questionnaire to demonstrate dental students' stress levels. We initially identified 4720 studies of which 124 studies were included in the final qualitative synthesis and 21 were included in the Meta-analysis. Evidence from current research showed that dental students experience considerable amount of stress during their education. This stress is mainly due to the demanding nature of their training. In addition, studies suggest adverse effects of elevated stress on students' health and well-being. Most of the available literature is based on cross-sectional studies, thus future longitudinal studies are needed to follow students throughout their curriculum. In addition, further research needs to explore and test stress management interventions.

Keywords: Stress, dental students, systematic reviews

INTRODUCTION

Stress is a very broad term that has been used imprecisely to describe different psychological conditions. According to Lazarus, psychological

stress is defined as "a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" [1]. It has been shown that university students are vulnerable to psychological problems [2] especially those in the health fields who face additional challenges compared to other students. Therefore many studies have focused on understanding medical and dental students' learning experiences. Medical students have to face life-threatening conditions in addition to long working hours and demanding workload. On the other hand, dental students need to obtain training in both theoretical and surgical aspects of dental care, including performing treatments on patients to qualify as competent dental professionals. In the preclinical years, dental students need to manage laboratory requirements that require a significant amount of time and manual skills. The clinical part of their training requires that students be responsible for their patients' care and perform irreversible dental treatments on those patients. All these factors collectively contribute to significant amounts of stress for dental students that make them at additional risk for psychiatric problems compared to other university students [3-5].

As a result, for the last three decades many researchers have investigated stress in undergraduate dental students. Numerous studies from different countries examined the level and sources of stress associated with dental education. Moreover, to improve students learning environment, several researchers examined the consequences of that stress and proposed different stress management strategies. In this systematic review, our objectives were to summarize the available literature on stress in dental students to answer the following questions: 1) what are the stress levels in undergraduate dental students? 2) What are the main causes of that stress? And 3) what are the implications of stress on dental students?

METHODS

Search strategy

The search strategies we used were designed in collaboration with a health sciences librarian. Since the term "stress" was introduced in 1936 by Hans Selye [1] and our aim was to conduct a comprehensive search of the available literature, no limits, such as date or language, were applied to the initial search. In addition, when conducting the search we used general synonymous terms for stress as some studies used different symptoms and proxy measures to describe psychological stress.

Medical, psychological, and educational databases were searched including Medline, Medline in process, Psychinfo, ERIC, Embase, Cochrane library, Web of science and SCOPUS. Each database was searched from the earliest available till December 31, 2010. We used a combination of subject headings and keywords to maximize retrieval. Subject headings were adjusted to reflect the preferred vocabulary of each database, while keywords were kept constant throughout the search process. An example of search terms we used in Medline is: "undergrad* or college* or universit* or student* or academic*" AND "dental or dentistry or oral" AND "anxi* or stress* or fear* or frustrat* or distress* or panic* or cope or coping or eustress* or cortisol or hassl* or general adaptation syndrome or emotion*". Additional references were found by systematically examining the reference lists of relevant papers and reviews.

Study selection

After we completed the search in each database, we imported all references and removed duplicates in Endnote (X4) [6]. Initial screening of all the retrieved studies was conducted by two independent reviewers (HE) and (LM). At this stage, the two reviewers screened the titles and

abstracts according to the following inclusion criteria: 1) original empirical studies; 2) that focus on undergraduate dental students; and 3) psychological stress.

Next, we retrieved full texts of all the potentially relevant articles obtained from the initial screen. The same reviewers (HE and LM) read the full texts to assess the eligibility of the studies. Studies were excluded if: 1) the study population was not undergraduate dental students (such as postgraduate dental students, dentists, dental patients or other university students); 2) not original studies (such as reviews or editorial letters); or 3) in any other language than English. After completing this selection phase, inter-rater reliability between the 2 reviewers was assessed and Kappa was 0.987 [(p<0.001), 95% CI (0.978, 0.984)]. Any disagreement between the 2 reviewers was resolved by discussion and by consulting the senior authors (CB and PJA).

Data extraction and quality assessment

Since we had different study designs, we used more than one quality assessment tool to appraise the methodological quality of the included studies. For descriptive studies we used a modified Newcastle-Ottawa Scale [7]. In this scale we used a star system to assess the quality of each study depending on its design (stars could range from 0-4 for cross-sectional studies, 0-6 for cross-sectional studies with sub-group comparison and 0-8 for cohort studies). For intervention trials we used the Cochrane Collaboration's Risk of Bias Tool to summarize the risk of bias into "low", "medium" or "high" [8]. Finally for qualitative studies we used a modified Critical Appraisal Skills Program tool (CASP) so that the quality of each item in that scale could be either yes, no or cannot tell [9]. The quality of all included studies is presented in Tables 2-7. Two independent

reviewers (HE and RK) assessed the quality of all retained quantitative and qualitative studies.

The same two reviewers also extracted data from included studies using piloted extraction forms. The forms were initially piloted using 10 studies to assure that both reviewers agreed and equally understood the items on that form. Data extracted included descriptive study characteristics (publication year, author, country of investigation), methods details (study design, sample size, response rate, participants' year of study, measurements used) and outcome variables: stress level (low, moderate, high), sources of stress (academic, clinical, faculty and personal related factors) and impact of stress (academic, psychological, behavioral, biological). Items in the data extraction sheet regarding outcomes variables were developed based on themes that emerged from screening the included studies. In addition, for studies that utilized the Dental Environment Stress Questionnaire (DES) we additionally extracted the mean stress data and its standards of deviation. We contacted primary authors of studies when we were unable to retrieve some information from studies, because it was not reported or was not clear in study reports. Data extracted were compared between the two reviewers (HE and RK) and any differences were discussed. Inter-rater reliability between the 2 reviewers was also calculated and kappa was 0.89 [(p <0.001), 95% CI (0.827, 0.926)].

Synthesis

We extracted data from included studies based on pre-defined codes that were piloted in the data extraction sheets so that both quantitative and qualitative studies were coded using the same variables (codes). We presented results from quantitative and qualitative studies as quantitative

data (using frequencies and percentages) in tables and the text of the discussion.

In addition, for our first research objective, the stress level in dental students, we conducted a meta-analysis and pooled results from studies that used the Dental Environment Stress questionnaire to demonstrate stress levels. From all eligible studies in our review there were 28 studies that used the DES. For 9 of those studies there were insufficient data to calculate the overall mean DES and its 95% confidence intervals. We contacted authors from those studies, 4 responded and 2 sent their data. Accordingly 7 studies that used DES were excluded from the meta-analysis. We calculated total DES mean score for each study and its 95% confidence interval. We then pooled the estimates calculated across studies using a random-effects model based on the Dersimonian and Liard method [10]. Heterogeneity was tested using Higgins's I^2. We used STATA statistical package for the meta-analysis[11].

RESULTS

Included studies

The process of identifying relevant studies is demonstrated in Figure 1. We identified a total of 4720 studies through searching different databases. We removed 1641 duplicate studies, and then according to our inclusion criteria we excluded another 2850 studies. We read the full text of the remaining 229 studies and excluded an additional 112 (reasons displayed in the graph). Finally, after checking the bibliographies of the eligible studies, we retrieved another 7 studies so the total final number of included studies was 124 studies. All studies were included in the qualitative synthesis and 21 were included in the Meta-analysis. Table 1 demonstrates the general characteristics of all the included studies in this

review. For purposes of clarity, studies that examined more than one outcome are repeated in tables and results of each outcome below.

Stress Level

We identified 44 studies according to our inclusion criteria that assessed stress in dental students (Table 2). Most of these studies were cross-sectional (70.5%), a few were cohort studies (20.5%) and only four studies (9.1%) used qualitative methodologies. In addition, less than half of all these studies were conducted in the US (40.9%).

Researchers have used various instruments to evaluate stress in dental students, but the most common (25% of the studies) is the Dental Environment Stress Questionnaire [12-22]. The DES, developed by Garbee in 1981, consists of 38-items describing stressors specifically related to undergraduate dental training [23]. The response to each item is rated on a 4-point Likert scale (1=not stressful, 2-slightly stressful, 3=moderately stressful, 4=very stressful) with a fifth possible response of "not pertinent". The mean score is calculated for each item of the DES to evaluate stress levels for each stressor; a total score can also be calculated by summing the responses from all items. Many studies modified the DES to make it applicable to the student population being studied, for instance eliminating factors related to patients and the clinic when assessing stress in pre-clinical students [12, 13, 15] or excluding items about children and partners in younger populations [17, 24]. Among the other instruments utilized to assess stress levels were the Perceived Stress Scale (20.5%), which measures individuals' appraisal to stressful life situations [12, 25-31], and the General Health Questionnaire (11.4%) [14, 15, 32-34] which has been validated in the general population to measure psychological distress.

Our assessment for stress level from all eligible studies showed that most studies (54.5%) consider dental students to experience at least moderate levels of stress, it needs to be noted though, that 34.1% of the studies reported high stress levels in dental students (Table 8). Figure 2 demonstrates the forest plot for studies that were included in the meta-analysis. The results showed that nearly all studies reported total mean DES scores in the range of 2 to 3, indicating at least moderate stress levels in dental students. Although there are no standardized cut-off mean scores for the DES, scores 2 and higher could suggest presence of elevated stress levels. The pooled total DES mean was 2.34 (95%CI 2.22, 2.45) and the test of heterogeneity I^2 was significant (p<0.001) indicating differences between stress levels reported between studies. We initially explored this heterogeneity by conducting subgroup analyses based on differences in educational systems (North American versus non-North American studies) and based on year of publication (years <2000 versus ≥2000). However these analyses did not explain heterogeneity.

On the other hand, findings from included studies further explained this heterogeneity. Research demonstrated variations in stress levels in dental students according to their demographic characteristics such as age and gender [13, 22, 25, 30]. In addition, findings from previous research indicated that stress levels vary according to students' stage in the curriculum [17, 35]. Although this finding also comes mainly from cross-sectional studies that compared students from different years in the program [13, 16, 17, 19, 21, 22], similar conclusions were provided by the few cohort investigations that reported changes of stress over-time. It has been shown that dental students report higher stress levels in their final year when compared to their first year levels [14]. In addition, first year dental students in the US and UK tended to demonstrate higher levels of stress at the end of the year when followed over-time [12, 29]. Some studies further showed that students at the transition phase to the clinic particularly experience higher stress

levels [13, 17, 25, 35]. However, we could not conduct subgroup analyses according to the previous findings (based on gender or year of study) due to lack of sufficient data from individual studies.

Sources of stress

Among studies that met our inclusion criteria, 55 studies investigated sources of stress in dental students (Table 3). Most of these studies were conducted in North America (45.5%) and the great majority used cross-sectional designs (85.5%).

Similar to studies that assessed stress levels, most researchers also used the DES to verify sources of stress in dental students (45.5%). Studies either used the mean score for each item from the DES or the mean scores for categories that emerged from DES factor analysis [14, 36-38] to report causes of stress. Other self-reported questionnaires used were the inventory of dental education stressors (IDES) [39, 40] and questionnaires developed by authors of each study. On the other hand, several researchers used a qualitative approach to better understand perceived stressors in the dental environment [35, 41, 42].

We grouped stressors identified from studies investigating sources of stress according to students' stage in the curriculum (Table 8). For pre-clinical students, most studies identified "academic factors" as a primary source for students' stress (92.5%). In addition, half of the studies considered "personal" issues to be a weak stressor (50.0%) and there was an almost equal split between studies regarding "faculty-related" stressors as a medium versus strong factor (20.0% and 25.0%). For clinical students, again most researchers found that "academic" factors (84.0%) are the main source of stress followed by "clinical" factors (63.6%). "Faculty" and "personal" issues contributed less to clinical students' stress levels (38.6%

and 11.4%). The most cited academic stressors were examination and grades [17, 38] and the workload [43-47] in dental school. Among faculty related issues reported were rules and regulation in the schools [37], receiving criticism [19, 37] and inconsistency of feedback from staff [43, 47]. Clinical concerns were primarily related to dealing with difficult patients [44, 48, 49] and difficulty of learning some clinical procedures [47, 50].

Most of the previous research regarding sources of stress described sources of stress at one time point and very few longitudinal studies examined changes in those sources overtime. Polychronopoulou et al surveyed 109 Greek dental students through their 5-year curriculum in attempt to understand how sources of stress evolve throughout the curriculum [36]. Students stress from workload and clinical training increased as they progressed in their curriculum while stress from faculty and administration factors decreased. Two other studies, conducted in the US, also described variations in sources of stress over-time but within the first year of dental school [12, 51].

Consequences of stress

We found 24 studies that evaluated the effect of stress on dental students (Table 4). The majority of those studies were cross-sectional (70.8%) and only 2 used a qualitative methodology [35, 52].

Academic performance was the main impact of stress investigated by most studies in this group. Almost half of the 24 studies (41.7%) reported detrimental effects of stress on dental students' academic achievements [12, 35, 53-59], even though two, conducted in Australia [20] and in the US [31], did not support this finding. In addition, 37.5% of the studies described various psychological consequences of stress: students reported high levels of burnout [14, 15, 35, 39, 60, 61], as a consequence of chronic stress, and mental

illness related to mood changes, frustrations and decreased concentration [56, 62]. Moreover, biological impact of stress was demonstrated by 29.2% of the studies. High stress levels were related to students' physical health such as number of times sick, loss of appetite and digestive problems [12, 14, 56, 63]. Some other studies also demonstrated significant association between stress levels and immune function measured by salivary IgA [26, 64]. Finally, a few studies (16.7%) suggested changes in dental students' behaviors like smoking habits and substance abuse in relation to high stress levels. Gordon et al, in a study among dental students in Africa, described smoking practices and found that students reported "examination stress" and "relaxation" among their reasons to smoke [65]. Similarly, relaxation and relief tension were among the commonly reported reasons in Dutch dental students for substance use [66]. In addition, in a qualitative study, stressed students reported social isolation from family and friends as a manifestation of their stress [35]. Although these findings suggest an association between stress and students quality of life, further research is still needed to document and explore these consequences in dental students.

Interventions

Only 8 of the eligible studies proposed and tested different interventions to help dental students deal with stress during their education (Table 5). All were conducted in the US and most were published in the 80s (62.5%); and only 2 studies were published in the last decade.

Two of the early studies examined reducing clinical requirements as a way to decrease stress [67, 68]. Other studies focused more on the individuals, recommending stress management courses to teach students how to deal and cope with high stress levels and demands of dental school [69-72]. In the same perspective, Howard et al demonstrated the effectiveness of

different relaxation techniques as part of University of California wellness program [73].

Other studies

Another 12 studies met our inclusion criteria because they investigated stress levels, sources or impact of stress in dental students, but they were related to specific stressors and did not examine students' stress in the general setting (Table 6). Half of these studies (50%) were testing biological markers at induced stress periods like exams [74-78]. Some others assessed dental students' stress levels to evaluate new educational systems [79-81]. Similarly, two other cross-sectional studies explored stress in relation to bullying and ethical climate in the dental school environment [82, 83].

In addition, we identified another 20 studies from the included studies that did not directly measure stress but assessed proxy measures or indictors of stress (Table 7). Among those psychological outcomes investigated were anxiety and depression [84-87], emotional intelligence [88], psychological adjustment [89] and psychological functioning [90]. It has been shown that dental students experience higher levels of anxiety than the general population [3] and that state and trait anxiety varies over-time [85]. In addition, in Iran, dental patients tended to be more satisfied from students who reported higher emotional intelligence scores [88].

DISCUSSION

In this systematic review we provided a comprehensive summary of the literature regarding stress in dental students. Our review was also original in that it included a meta-analysis to demonstrate stress levels in dental students. Findings from this systematic review using both quantitative and

qualitative analyses demonstrate that dental students experience considerable levels of stress during their training. In addition, the current literature indicates that sources of that stress are mainly related to academic and clinical aspects of the dental training. These elevated stress levels have been shown to have an effect on students' academic performance, physical health and psychological well-being.

The documented stress level experienced by dental students was further highlighted in studies that compared dental students to other student populations. Dental students reported higher stress levels in comparison to medical students [29] and similar stress levels to other health sciences students [91]. Our findings are also in agreement with other reviews among medical students. Dyrbye et al, in their systematic review reported that medical students experience high levels of anxiety and depression. They also noted that among the medical literature there was very limited research done to explore consequences of psychological distress on medical students [92]. Moreover, in another literature review investigating stress management in medical education, authors concluded that although several interventions targeting the individual rather than the educational structure were conducted, most were methodologically weak; this emphasizes the need for future well designed interventions [93]. Finally, although our review provides a different view of the literature than that presented in Alzahem et al systematic review in dental students [94], our results regarding sources of stress are consistent in that examination and grades and clinical requirements are the main sources of stress in dental students. In Alzahem et al. review, authors provided an interesting summary of the literature that provided an overview of stress in dental students. On the other hand, in this paper we grouped studies based on outcome and we additionally appraised the quality of all included studies. Moreover, we conducted a meta-analysis for studies that used DES to assess dental students stress levels.

The present review has several limitations that need to be considered when interpreting our findings. Results from most studies are based on small cross-sectional descriptive studies that are considered relatively weak evidence. In addition, the instruments we used for quality appraisal are not specifically designed to assess survey studies. However, we modified the NOS and the CASP scales for studies included in our review. Finally, although we excluded intervention studies and studies investigating specific stressors from our analysis, we decided to keep them in the review to provide a comprehensive literature regarding stress in undergraduate dental training.

Our systematic review and meta-analysis add significantly to the previous literature on the subject of stress in dental students and should alert future research and dental faculties to consider and implement stress management strategies either through changes in the structure of the curriculum or using more individualized approaches to enhance students' well-being and ensure their healthy learning environment. As our research confirms, the main sources of stress for dental students are academic work (including particularly examinations, grades and the workload), clinical care, faculty-related factors and personal factors. It also confirms that the main effects of stress are felt on academic performance, psycho-emotional well-being and physical health and on habits such as smoking and alcohol consumption. Finally, we have identified that there have been very few intervention studies aimed at reducing stress or helping dental students manage that stress, and that the majority of the few studies performed were done in the 1980s, with little clarity on any benefits from these interventions. As previously mentioned, therefore, it is clear from our review that research should now concentrate on developing and testing the effects of various strategies aimed at reducing stress levels in dental students.

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REFERENCES

1. Lazarus RS. Stress, Appraisal, and Coping. New York: Springer Publishing Company; 1984.

2. Tosevski DL, Milovancevic MP, Gajic SD. Personality and psychopathology of university students. Curr Opin Psychiatry 2010;23(1):48-52.

3. Lloyd C, Musser LA. Psychiatric symptoms in dental students. Journal of Nervous & Mental Disease 1989;177(2):61-9.

4. Schmitter M, Liedl M, Beck J, Rammelsberg P. Chronic stress in medical and dental education. Medical Teacher 2008;30(1):97-99.

5. O'Mahony P, O'Brien S. Demographic and social characteristics of university students attending a psychiatrist. Br J Psychiatry 1980;137:547-50.

6. Reuters T. EndNote software program: Release XIV; 2011.

7. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses.

8. Higgins JPT, Altman DG. Chapter 8: Assessing risk of bias in included studies: The Cochrane Collaboration; 2008.

9. Critical Appraisal Skills Programme (CASP) making sense of evidence. UK: National CASP collaboration for qualitative methodologies. Public Health Resource Unit; 2006.

10. DerSimonian R, Laird N. Meta-analysis in clinical trials. Control Clin Trials 1986;7(3):177-88.

11. StataCorp. Stata Statistical Software: Release 11: College Station, TX: StataCorp LP.; 2009.

12. Silverstein ST, Kritz-Silverstein D. A longitudinal study of stress in first-year dental students. Journal of Dental Education 2010;74(8):836-48.

13. Sugiura G, Shinada K, Kawaguchi Y. Psychological well-being and perceptions of stress amongst Japanese dental students. European Journal of Dental Education 2005;9(1):17-25.

14. Gorter R, Freeman R, Hammen S, Murtomaa H, Blinkhorn A, Humphris G. Psychological stress and health in undergraduate

dental students: fifth year outcomes compared with first year baseline results from five European dental schools. European Journal of Dental Education 2008;12(2):61-8.

15. Humphris G, Blinkhorn A, Freeman R, Gorter R, Hoad-Reddick G, Murtomaa H, et al. Psychological stress in undergraduate dental students: baseline results from seven European dental schools. European Journal of Dental Education 2002;6(1):22-9.

16. Yap AU, Bhole S, Teo CS. A cross-cultural comparison of perceived sources of stress in the dental school environment. Journal of Dental Education 1996;60(5):459-64.

17. Naidu RS, Adams JS, Simeon D, Persad S. Sources of stress and psychological disturbance among dental students in the West Indies. Journal of Dental Education 2002;66(9):1021-30.

18. Muirhead V, Locker D. Canadian dental students' perceptions of stress and social support. European Journal of Dental Education 2008;12(3):144-8.

19. Sofola OO, Jeboda SO. Perceived sources of stress in Nigerian dental students. European Journal of Dental Education 2006;10(1):20-3.

20. Sanders AE, Lushington K. Effect of perceived stress on student performance in dental school. Journal of Dental Education 2002;66(1):75-81.

21. Morse Z, Dravo U. Stress levels of dental students at the Fiji School of Medicine. European Journal of Dental Education 2007;11(2):99-103.

22. Peker I, Alkurt MT, Usta MG, Turkbay T. The evaluation of perceived sources of stress and stress levels among Turkish dental students. International Dental Journal 2009;59(2):103-11.

23. Garbee WH, Jr. Sources of stress in the dental school environment. LDA journal 1981;39(4):9-14.

24. Polychronopoulou A, Divaris K. Perceived sources of stress among Greek dental students. Journal of Dental Education 2005;69(6):687-92.

25. Pau AKH, Croucher R. Emotional intelligence and perceived stress in dental undergraduates. Journal of Dental Education 2003;67(9):1023-8.

26. Ng V, Koh D, Mok B, Lim LP, Yang Y, Chia SE. Stressful life events of dental students and salivary immunoglobulin A. International Journal of Immunopathology & Pharmacology 2004;17(2 Suppl):49-56.

27. Dumitrescu AL. Investigating the relationship between self-reported oral health status, oral health-related behaviors, type A behavior pattern, perceived stress and emotional intelligence. Romanian journal of internal medicine = Revue roumaine de medecine interne 2007;45 (1):67-76.

28. Laurence B, Williams C, Eiland D. Depressive symptoms, stress, and social support among dental students at a historically black college and university. Journal of American College Health 2009;58(1):56-63.

29. Birks Y, McKendree J, Watt I. Emotional intelligence and perceived stress in healthcare students: a multi-institutional, multi-professional survey. BMC Medical Education 2009;9:61.

30. Pau A, Rowland ML, Naidoo S, AbdulKadir R, Makrynika E, Moraru R, et al. Emotional intelligence and perceived stress in dental undergraduates: a multinational survey. Journal of Dental Education 2007;71(2):197-204.

31. Tervit SL. An examination of perfectionism, stress, and self-esteem as predictors of clinical performance for dental students. Dissertation Abstracts International: Section B: The Sciences and Engineering 2002;62(8-B):3817.

32. Al-Nimer MS. Measuring mental health following the 6-year American invasion of Iraq. A general health questionnaire analysis of Iraqi medical and dentistry students. Neurosciences 2010;15(1):27-32.

33. Newton JT, Baghaienaini F, Goodwin SR, Invest J, Lubbock M, Marouf Saghakhaneh N. Stress in dental school: a survey of students. Dental update 1994;21(4):162-4.

34. Newbury-Birch D, Lowry RJ, Kamali F. The changing patterns of drinking, illicit drug use, stress, anxiety and depression in dental students in a UK dental school: a longitudinal study. British Dental Journal 2002;192(11):646-9.

35. Dahan H, Bedos C. A typology of dental students according to their experience of stress: a qualitative study. Journal of Dental Education 2010;74(2):95-103.

36.   Polychronopoulou A, Divaris K. A longitudinal study of Greek dental students' perceived sources of stress. Journal of Dental Education 2010;74(5):524-30.

37.   Kumar S, Dagli RJ, Mathur A, Jain M, Prabu D, Kulkarni S. Perceived sources of stress amongst Indian dental students. European Journal of Dental Education 2009;13(1):39-45.

38.   Sanders AE, Lushington K. Sources of stress for Australian dental students. Journal of Dental Education 1999;63 (9):688-97.

39.   Davis EL, Tedesco LA, Meier ST. Dental student stress, burnout, and memory. Journal of Dental Education 1989;53(3):193-5.

40.   Gross AJ. Dental education: Through the students' eyes. Dissertation Abstracts International Section A: Humanities and Social Sciences 1996;57(6-A):2356.

41.   Fredericks MA, Mundy P. Dental students: behaviorally observed aspects of professionalization. Journal of the American College of Dentists 1968;35(3):275-81.

42.   Register J. Dental students today. Feeling pressure/stress. Florida dental journal 1986;57 (2):6-7, 58-59.

43.   Westerman GH, Grandy TG, Ocanto RA, Erskine CG. Perceived sources of stress in the dental school environment. Journal of Dental Education 1993;57(3):225-31.

44.   Rajab LD. Perceived sources of stress among dental students at the University of Jordan. Journal of Dental Education 2001;65(3):232-41.

45.   Polychronopoulou A, Divaris K. Dental students' perceived sources of stress: a multi-country study. Journal of Dental Education 2009;73(5):631-9.

46.   Rosli TI, Abdul Rahman R, Abdul Rahman SR, Ramli R. A survey of perceived stress among undergraduate dental students in Universiti Kebangsaan Malaysia. Singapore Dental Journal 2005;27(1):17-22.

47.   Muirhead V, Locker D. Canadian dental students' perceptions of stress. Journal 2007;73(4):323.

48.   Martin RT. An investigation of the attitude and adjustment of practising dentists and dental students to their profession. Dental Outlook (Sydney) 1971;28:4-6.

49. Garbee Jr WH, Zucker SB, Selby GR. Perceived sources of stress among dental students. Journal of the American Dental Association (1939) 1980;100 (6):853-57.

50. Grandy TG, Westerman GH, Combs CE, Turner CH. Perceptions of stress among third-year dental students. Journal of Dental Education 1989;53(12):718-21.

51. Hoyle JD. Psychosocial sources of stress in dental education. Dissertation Abstracts International 1980;41(6-B):2111.

52. Pau AKH, Croucher R, Sohanpal R, Muirhead V, Seymour K. Emotional intelligence and stress coping in dental undergraduates - A qualitative study. British Dental Journal 2004;197 (4):205-09.

53. Fredericks MA, Mundy P. Dental students: relationship between social class, stress, achievement, and attitudes. Journal of the American College of Dentists 1967;34(4):218-28.

54. Fredericks MA, Mundy P. Relations between social class, stress-anxiety responses, academic achievement, and professional attitudes of dental students. Journal of Dental Education 1969;33(3):377-84.

55. Horton PS. Can academic distress be predicted prior to dental school. The Journal of the American College of Dentists 1978;45 (2):111-19.

56. Cohen H, Hurwitz M, Lanesman B, Myburg N, Prinsloo B. The perception and response to stress by dental students of the University of Witwatersrand. Diastema 1982;10:16-21.

57. Tedesco LA. A Psychosocial Perspective on the Dental Education Experience and Student Performance. Journal of Dental Education 1986;50(10):601-05.

58. MacInnis WA, et al. Identifying Dental Student Dissatisfiers Using a Delphi Technique. Journal of Dental Education 1987;51(9):539-42.

59. Cecchini JJ, Friedman N. First-year dental students: Relationship between stress and performance. International Journal of Psychosomatics 1987;34(3):17-19.

60. Pohlmann K, Jonas I, Ruf S, Harzer W. Stress, burnout and health in the clinical period of dental education. European Journal of Dental Education 2005;9(2):78-84.

61.   Badran DH, Al-Ali MH, Duaibis RB, Amin WM. Burnout among clinical dental students at Jordanian universities. [Arabic, English, French]. Eastern Mediterranean Health Journal 2010;16 (4):434-37.

62.   Freeman R, Lindner RL, Rooney J, Narendran S. Dental students in Northern Ireland in 1992 and 1995: Changing trends in psychological stress. Stress Medicine 2000;16(4):233-38.

63.   George JM, Whitworth DE, Sturdevant JR, Lundeen TF. Correlates of dental student stress. Journal of Dental Education 1987;51(8):481-5.

64.   Jemmott JB, 3rd, Borysenko JZ, Borysenko M, McClelland DC, Chapman R, Meyer D, et al. Academic stress, power motivation, and decrease in secretion rate of salivary secretory immunoglobulin A. Lancet 1983;1(8339):1400-2.

65.   Gordon NA, Rayner CA. Smoking practices of dental and oral health students at the University of the Western Cape. SADJ 2010;65(7):304-8.

66.   Plasschaert AJ, Hoogstraten J, van Emmerik BJ, Webster DB, Clayton RR. Substance use among Dutch dental students. Community Dent Oral Epidemiol 2001;29(1):48-54.

67.   Hicks JL, Dale RA, Hendricson WD, Lauer WR. Effects of reducing senior clinical requirements. Journal of Dental Education 1985;49 (3):169-75.

68.   Dodge WW, Dale RA, Hendricson WD. A preliminary study of the effect of eliminating requirements on clinical performance. Journal of Dental Education 1993;57(9):667-72.

69.   Shugars DA. A fitness course for dental students. Journal of Dental Education 1981;45(5):300-2.

70.   Tisdelle DA, Hansen DJ, St Lawrence JS, Brown JC. Stress management training for dental students. Journal of Dental Education 1984;48(4):196-202.

71.   Piazza-Waggoner CA, Cohen LL, Kohli K, Taylor BK. Stress management for dental students performing their first pediatric restorative procedure. Journal of Dental Education 2003;67(5):542-8.

72.   Lopez N, Johnson S, Black N. Does Peer Mentoring Work? Dental Students Assess Its Benefits as an Adaptive Coping Strategy. Journal of Dental Education 2010;74(11):1197-205.

73.   Howard CE, Graham LE, 2nd, Wycoff SJ. A comparison of methods for reducing stress among dental students. Journal of Dental Education 1986;50(9):542-4.

74.   Mouton C, Fillion L, Tawadros E, Tessier R. Salivary IgA is a weak stress marker. Behavioral Medicine 1989;15(4):179-85.

75.   Bosch JA, Brand HS, Ligtenberg AJM, Bermond B, Hoogstraten J, Nieuw Amerongen AV. The response of salivary protein levels and S-IgA to an academic examination are associated with daily stress. Journal of Psychophysiology 1998;12 (4):384-91.

76.   Bosch JA, Brand HS, Ligtenberg TJ, Bermond B, Hoogstraten J, Nieuw Amerongen AV. Psychological stress as a determinant of protein levels and salivary-induced aggregation of Streptococcus gordonii in human whole saliva. Psychosomatic Medicine 1996;58(4):374-82.

77.   Ng V, Koh D, Mok BYY, Chia S-E, Lim L-P. Salivary biomarkers associated with academic assessment stress among dental undergraduates. Journal of Dental Education 2003;67(10):1091-4.

78.   Krahwinkel T, Nastali S, Azrak B, Willershausen B. The effect of examination stress conditions on the cortisol content of saliva - a study of students from clinical semesters. European journal of medical research 2004;9(5):256-60.

79.   O'Sullivan D, Hooper S, McNally L, Jagger D. The introduction of a new assessment system in restorative dentistry: the undergraduate and patient experience. European Journal of Dental Education 2007;11(1):54-9.

80.   Sukotjo C, Thammasitboon K, Howell H, Karimbux N. The impact of targeted shortened preclinical exercises on student perceptions and outcomes. Journal of Dental Education 2007;71(8):1070-9.

81.   Sukotjo C, Thammasitboon K, Howell H, Karimbux N. Students' perceptions of prosthodontics in a PBL hybrid curriculum. Journal of Prosthodontics 2008;17(6):495-501.

82.   Rowland ML, Naidoo S, AbdulKadir R, Moraru R, Huang B, Pau A. Perceptions of intimidation and bullying in dental schools: a multi-national study. International Dental Journal 2010;60(2):106-12.

83.   Acharya S. The ethical climate in academic dentistry in India: faculty and student perceptions. Journal of Dental Education 2005;69(6):671-80.

84.   Grandy TG, Westerman GH, Mitchell RE, Lupo JV. Stress among first-year dental students. Journal of Dental Education 1984;48(10):560-2.

85.   Grandy TG, Westerman GH, Lupo JV, Combs CG. Stress symptoms among third-year dental students. Journal of Dental Education 1988;52(5):245-9.

86.   Mutlu N, Herken H, Guray E, Oz F, Kalayci A. Evaluation of the prevalence of temporomandibular joint disorder syndrome in dental school students with psychometric analysis. Turkish Journal of Medical Sciences 2002;32 (4):345-50.

87.   Barberia E, Fernandez-Frias C, Suarez-Clua C, Saavedra D. Analysis of anxiety variables in dental students. International Dental Journal 2004;54(6):445-9.

88.   Azimi S, AsgharNejad Farid AA, Kharazi Fard MJ, Khoei N. Emotional intelligence of dental students and patient satisfaction. European Journal of Dental Education 2010;14(3):129-32.

89.   Henning K, Ey S, Shaw D. Perfectionism, the imposter phenomenon and psychological adjustment in medical, dental, nursing and pharmacy students. Medical Education 1998;32(5):456-64.

90.   Stewart DW, de Vries J, Singer DL, Degen GG, Wener P. Canadian dental students' perceptions of their learning environment and psychological functioning over time. Journal of Dental Education 2006;70(9):972-81.

91.   Stecker T. Well-being in an academic environment. Med Educ 2004;38(5):465-78.

92.   Dyrbye LN, Thomas MR, Shanafelt TD. Systematic review of depression, anxiety, and other indicators of psychological distress among U.S. and Canadian medical students. Acad Med 2006;81(4):354-73.

93.   Shapiro SL, Shapiro DE, Schwartz GE. Stress management in medical education: a review of the literature. Acad Med 2000;75(7):748-59.

94.   Alzahem AM, van der Molen HT, Alaujan AH, Schmidt HG, Zamakhshary MH. Stress amongst dental students: a systematic review. Eur J Dent Educ 2011;15(1):8-18.

95.   Dean DH. How stressed is the dental student? Dental student 1978;57:30-31.

96.   Zucker SB, Odom JG, Cheney HG, Fretwell LD. Contract grading in community dentistry. Journal of Dental Education 1978;42(12):668-70.

97.   Goldstein MB. Sources of stress and interpersonal support among first-year dental students. Journal of Dental Education 1979;43(12):625-9.

98.   Goldstein MB. Interpersonal support and coping among first-year dental students. Journal of Dental Education 1980;44(4):202-5.

99.   Sachs RH, Zullo TG, Close JM. Concerns of entering dental students. Journal of Dental Education 1981;45(3):133-6.

100.   Morse DR, Schacterle GR, Furst ML. The effect of stress and meditation on salivary protein and bacteria: A review and pilot study. Journal of Human Stress 1982;8 (4):31-39.

101.   Richards VK. Perceived psychological stress and personality profiles in dental students. Dissertation Abstracts International 1982;43(6-A):1796-97.

102.   Bjorksten OJ, Sutherland SE, Miller MC, 3rd, Stewart TJ. Perceptions of dental students' problems. Journal of the American College of Dentists 1983;50(3):11-5.

103.   Yablon P, Maykow KP, Rosner JF, Levy AI. Dental student stress as measured by life event change. Journal of the New Jersey Dental Association 1983;54 (1):20-21, 23, 27.

104.   Cecchini JG. Differences in anxiety and dental stressors between dental students and dentists. International Journal of Psychosomatics 1985;32(2):6-11.

105.   Freeman RE. Dental students as operators: emotional reactions. Medical Education 1985;19(1):27-33.

106.   Lloyd C, Musser LA. Stress in dental students. Journal of the American College of Dentists 1985;52(2):11-9.

107.   Musser LA, Lloyd C. The relationship of marital status and living arrangement to stress among dental students. Journal of Dental Education 1985;49(8):573-8.

108. Reeve PE, Watson CJ. An exploration of the attitudes, personality and performance of dental students. Medical Education 1985;19(3):226-37.

109. Cecchini JJ, Friedman N. Investigative study of dental hygiene students' and dental students' anxiety and dental stressors. International Journal of Psychosomatics 1986;33(2):43-47.

110. Sturdevant JR, George JM, Lundeen TF. An interactional view of dental student stress. Journal of Dental Education 1987;51 (5):246-49.

111. Sgan-Cohen HD, Lowental U. Sources of stress among Israeli dental students. Journal of American College Health 1988;36 (6):317-21.

112. Bradley IF, Clark DC, Eisner JE, De Gruchy K, Singer DL, Hinkleman K, et al. The student survey of problems in the academic environment in Canadian dental faculties. Journal of Dental Education 1989;53(2):126-31.

113. Kolosowski-Gager PE. Stress and the spouses of dental students. Dissertation Abstracts International 1989;50(5-B):2206.

114. Rubenstein LK, et al. Physical Health and Stress in Entering Dental Students. Journal of Dental Education 1989;53(9):545-47.

115. Sgan-Cohen HD. Stress among Israeli dental students: a two-year longitudinal study. International Journal of Psychosomatics 1989;36(1-4):69-71.

116. Mozer JE, Lloyd C, Puente ES. The relationship of Bi/Polar personality patterns with self-esteem, stress, and satisfaction in dental school. Journal of Dental Education 1990;54(2):153-7.

117. Hendricks SJ, Joshi A, Crombie K, Moola MH. Perceived sources of stress among black dental students in South Africa. Journal of Dental Education 1994;58(6):406-10.

118. Jacobsen N. Causes and outcomes of discontinued dental studies. Journal of Dental Education 1994;58(10):771-4.

119. Peretz B, Rosenblum A, Zadik D. Stress levels and related variables among dental students in Jerusalem, Israel. European Journal of Dental Education 1997;1(4):162-6.

120. Marucha PT, Kiecolt-Glaser JK, Favagehi M. Mucosal wound healing is impaired by examination stress. Psychosomatic Medicine 1998;60(3):362-5.

121. Heath JR, Macfarlane TV, Umar MS. Perceived sources of stress in dental students. Dental update 1999;26(3):94-8.

122. Rice CD, Glaros AG, Shouman R, Hlavacek M. Career choice and occupational perception in accelerated option and traditional dental students. Journal of Dental Education 1999;63(4):354-8.

123. Benjakul P, Cheunarrom C. Student adjustment problems in two dental schools in Thailand. Journal of Dental Education 2000;64(5):365-9.

124. Kieser J, Herbison P. Clinical anxieties among dental students. New Zealand Dental Journal 2000;96(426):138-9.

125. Chuang SY. Incidence of temporomandibular disorders (TMDs) in senior dental students in Taiwan. Journal of Oral Rehabilitation 2002;29(12):1206-11.

126. Skelly AM, Fleming GJ. Perceptions of a dental career among successful applicants for dentistry compared with those of fifth-year dental students. Primary dental care : journal of the Faculty of General Dental Practitioners (UK) 2002;9 (2):41-46.

127. Acharya S. Factors affecting stress among Indian dental students. Journal of Dental Education 2003;67(10):1140-8.

128. Flores RIG, Baba K, Haketa T, Sasaki Y, Kino K, Ohyama T. Risk Factors for Sleep Bruxism in Japanese Dental Students. Journal of Applied Research 2003;3 (4):420-28.

129. Snelling J, Sahai A, Ellis H. Attitudes of medical and dental students to dissection. Clinical Anatomy 2003;16(2):165-72.

130. Cardoso CL, Loureiro SR, Nelson-Filho P. Pediatric dental treatment: manifestations of stress in patients, mothers and dental school students. Pesquisa odontologica brasileira = Brazilian oral research 2004;18(2):150-5.

131. Peretz B, Nazarian Y, Bimstein E. Dental anxiety in a students' paediatric dental clinic: children, parents and students. International Journal of Paediatric Dentistry 2004;14(3):192-8.

132. Al-Omari WM. Perceived sources of stress within a dental educational environment. Journal of Contemporary Dental Practice [Electronic Resource] 2005;6(4):64-74.

133. Burk DT, Bender DJ. Use and perceived effectiveness of student support services in a first-year dental student population. Journal of Dental Education 2005;69(10):1148-60.

134. Harris MJ, Zwane NP. Expectations and perceptions of professional satisfaction in a cohort of Medunsa dental graduates in compulsory community service. SADJ : journal of the South African Dental Association = tydskrif van die Suid-Afrikaanse Tandheelkundige Vereniging 2005;60 (10):438, 40, 42 passim.

135. Naidoo S, Pau A. Emotional intelligence and perceived stress. SADJ 2008;63(3):148-51.

136. Murphy RJ, Gray SA, Sterling G, Reeves K, DuCette J. A comparative study of professional student stress. Journal of Dental Education 2009;73(3):328-37.

Table 1: Overview of outcomes investigated by all included studies (N=124)

Study ID (1st Author)	Publication year	Level	Sources	Consequences	Intervention	Other
Fredericks MA[53]	1967	X		X		
Fredericks MA[41]	1968	X	X			
Fredericks MA[54]	1969	X		X		
Martin RT[48]	1971		X			
Dean DH[95]	1978	X	X			
Horton PS[55]	1978			X		
Zucker SB[96]	1978					X
Goldstein MB[97]	1979		X			
Garbee WH[49]	1980		X			
Goldstein MB[98]	1980					X
Hoyle JD[51]	1980		X			
Garbee WH[23]	1981		X			
Sachs RH[99]	1981		X			
Shugars DA[69]	1981				X	
Cohen H[56]	1982	X	X	X		
Morse DR[100]	1982				X	
Richards VK[101]	1982	X	X			
Bjorksten OJ[102]	1983		X			
Jemmott III JB[64]	1983	X		X		
Yablon P[103]	1983	X				X
Grandy TG[84]	1984					X
Tisdelle DA[70]	1984				X	
Cecchini JG[104]	1985		X			
Freeman RE[105]	1985					X
Hicks JL[67]	1985				X	
Liyod C[106]	1985		X			
Musser LA[107]	1985	X	X			
Reeve PE[108]	1985		X			
Cecchini JJ[109]	1986	X				
Howard CE[73]	1986				X	
Register J[42]	1986	X	X			
Tedesco LA[57]	1986	X	X	X		
Cecchini JJ[59]	1987			X		
George JM[63]	1987		X	X		
MacInnis WA[58]	1987		X	X		
Sturdevant JR[110]	1987	X				
Grandy TG[85]	1988					X
Sgan-Cohen HD[111]	1988		X			
Bradley IF[112]	1989		X			
Davis EL[39]	1989		X	X		
Grandy TG[50]	1989		X			X
Kolosowski-Gager[113]	1989					X
Lloyd C[3]	1989					X
Mouton C[74]	1989					X
Rubenstein LK[114]	1989					X
Sgan-Cohen HD[115]	1989		X			
Mozer JE[116]	1990	X				
Dodge WW[68]	1993				X	
Westerman GH[43]	1993		X			
Hendricks SJ[117]	1994		X			
Newton JT[33]	1994	X	X			

Study ID (1st Author)	Publication year	Level	Sources	Consequences	Intervention	Other
		Outcomes				
Jacobsen N[118]	1994		X	X		
Bosch JA[76]	1996					X
Gross AJ[40]	1996		X			
Yap AU[16]	1996	X	X			
Peretz B[119]	1997	X	X			
Bosch JA[75]	1998					X
Henning K[89]	1998					X
Marucha PT[120]	1998					X
Heath JR[121]	1999		X			
Rice CD[122]	1999					X
Sanders AE[38]	1999		X			
Benjakul P[123]	2000					X
Freeman R[62]	2000		X	X		
Kieser J[124]	2000					X
Plasschaert AJM[66]	2001			X		
Rajab LD[44]	2001		X			
Chuang SY[125]	2002	X				
Humphris G[15]	2002	X		X		
Mutlu N[86]	2002					X
Naidu RS[17]	2002	X	X			
Newbury-Birch D[34]	2002	X				
Sanders AE[20]	2002	X		X		
Skelly AM[126]	2002	X	X			
Tervit SL[31]	2002	X		X		
Acharya S[127]	2003		X			
Flores RIG[128]	2003	X				
NG V[77]	2003					X
Pau AK[25]	2003	X				
Piazza-Waggoner CA[71]	2003				X	
Snelling J[129]	2003					X
Barberia E[87]	2004					X
Cardoso CL[130]	2004					X
Krahwinkel Th[78]	2004					X
NG V[26]	2004	X	X	X		
Pau AKH[52]	2004	X		X		
Peretz B[131]	2004					X
Stecker T[91]	2004	X				
Acharya S[83]	2005					X
Al Omari WM[132]	2005		X			
Burk DT[133]	2005					X
Harris MJP[134]	2005	X				
Pohlmann K[60]	2005		X	X		
Polychronopoulou A[24]	2005		X			
Rosli TI[46]	2005		X			
Sugiura G[13]	2005	X				
Sofola O[19]	2006	X	X			
Stewart DW[90]	2006					X
Dumitrescu AL[27]	2007	X				
Morse Z[21]	2007	X	X			
Muirhead V[47]	2007		X			
O'sullivan D[79]	2007					X
Pau A[30]	2007	X				
Sukotjo C[80]	2007					X

Study ID (1st Author)	Publication year	Outcomes				
		Level	Sources	Consequences	Intervention	Other
Gorter R[14]	2008	X	X	X		
Muirhead V[18]	2008	X	X			
Naidoo S[135]	2008	X				
Schmitter M[4]	2008					X
Sukotjo C[81]	2008					X
Birks Y[29]	2009	X				
Kumar S[37]	2009		X			
Laurence B[28]	2009	X				
Murphy RJ[136]	2009		X			
Peker I[22]	2009	X	X			
Polychronopoulou A[45]	2009		X			
Al-Nimer[32]	2010	X				
Azimi S[88]	2010					X
Badran DH[61]	2010			X		
Dahan H[35]	2010	X	X	X		
Gordon NA[65]	2010			X		
Lopez N[72]	2010				X	
Polychronopoulou A[36]	2010		X			
Rowland ML[82]	2010					X
Silverstien ST[12]	2010	X	X	X		

Table 2: Descriptive characteristics of studies investigating stress level in dental students (N=44)

Study ID (Author, year)	Country	Study design	Sample size	Response rate	Dental student population	Instrument	Quality assessment NOS*
Fredericks MA, 1967[53]	US	C-S	86	100	1st	Taylor's personality scale of manifest anxiety	3/6
Dean DH, 1978[95]	US	C-S	19	86.4	Senior	Questionnaire	1/4
Cohen H, 1982[56]	South Africa	C-S	193	97	3,4,5,6	Questionnaire	2/6
Richards VK, 1982[101]	US	C-S	153	61.2	1,2,3,4	Scale of stressful life events	4/6
Yablon P, 1983[103]	US	C-S	204	NR	1,2,3	Holme's social readjustment rating scale	1/6
Musser LA, 1985[107]	US	C-S	298	62	1,2,3,4	Questionnaire	2/6
Cecchini JJ, 1986[109]	US	C-S	160	69.6	1st, senior	Scale of dental stressors	2/6
Tedesco LA, 1986[57]	US	C-S	163	NR	NR	Derogatis symptom checklist	0/4
Sturdevant JR, 1987[110]	US	C-S	263	84.3	1,2,3,4	Derogatis stress profile	3/6
Mozer JE, 1990[116]	US	C-S	127	62	Senior	Questionnaire	3/6
Newton JT, 1994[33]	UK	C-S	271	77.9	1,2,3,4	GHQ	2/6
Yap AU, 1996[16]	Singapore	C-S	137	98	1,2,3,4	DES	2/6
Peretz B, 1997[119]	Israel	C-S	112	93.3	4,5,6	Questionnaire	2/6
Chuang SY, 2002[125]	Taiwan	C-S	254	NR	Senior	Questionnaire	2/6
Humphris G, 2002[15]	Netherlands, UK, Ireland, Germany, Finland	C-S	331	79.1	1st	GHQ, DES	3/6
Naidu RS, 2002[17]	West indies	C-S	94	83	1,2,3,4,5	DES	4/6
Sanders AE, 2002[20]	Australia	C-S	202	91.8	1,2,3,4,5	DES	4/6
Skelly AM, 2002[126]	UK	C-S	188	100	Applicants, 5	Questionnaire	2/6
Tervit SL, 2002[31]	US	C-S	78	NR	3,4	PSS	1/4
Pau AK, 2003[25]	UK	C-S	213	70	1,2,3,4,5	PSS	4/6
NG V, 2004[26]	Singapore	C-S	110	82.1	1,2,3,4	PSS	4/6
Sugiura G, 2005[13]	Japan	C-S	320	91	2,3,4,5,6	DES	4/6
Sofola O, 2006[19]	Nigeria	C-S	105	76.6	3,4,5,6	DES	4/6
Dumitrescu AL, 2007[27]	Romania	C-S	344	100	1,2,3,4,5,6	PSS	4/6
Morse Z, 2007[21]	Fiji	C-S	115	84	1,2,3,4,5	DES	3/6
Pau A, 2007[30]	England, Romania, South Africa, Australia, US, Greece, Malaysia	C-S	596	69.3	1st	PSS	4/6
Muirhead V, 2008[18]	Canada	C-S	171	62	1,2,3,4	DES	4/6
Naidoo S, 2008[135]	West indies	C-S	98	96	1st	PSS	4/6
Laurence B, 2009[28]	US	C-S	126	40	1,2,3,4	PSS	1/4
Peker I, 2009[22]	Turkey	C-S	308	66.2	1,2,3,4,5	DES	4/6
Al-Nimer, 2010[32]	Iraq	C-S	176	NR	1,2,3,4,5	GHQ	2/6
Fredericks MA, 1969[54]	US	Cohort	85,81	100, 95.3	1,2	Taylor's personality scale of manifest	2/8

Study ID (Author, year)	Country	Study design	Sample size	Response rate	Dental student population	Instrument	Quality assessment NOS*
						anxiety	
Jemmott III JB, 1983[64]	US	Cohort	64	NR	1st	Questionnaire	3/8
Newbury-Birch D, 2002[34]	UK	Cohort	47,53,49	71.2, 80.3, 79	2,5, after grad.	GHQ	3/8
Flores RIG, 2003[128]	Japan	Cohort	94	NR	NR	College life experience scale	3/8
Stecker T, 2004[91]	US	Cohort	24,38	NR	NR	Questionnaire	2/8
Harris MJP, 2005[134]	South Africa	Cohort	37,21	86	Final year, after grad.	Visual analogue scale	0/8
Gorter R, 2008[14]	Netherlands, Ireland, Finland, UK	Cohort	331,132	79.1, 51	1, 5	GHQ, DES	5/8
Birks Y, 2009[29]	UK	Cohort	68, 25	62, 22.9	1st	PSS	2/8
Silverstien ST, 2010[12]	US	Cohort	383,228	94.1,56	1st	DES, PSS, Self rating of stress levels	5/8
							CASP**
Fredericks MA, 1968[41]	US	Qual-observation	86	100	1st	Qual.	3/10
Register J, 1986[42]	US	Qual-interviews	2	NR	2, 4	Qual.	5/10
Pau AKH, 2004[52]	UK	Qual-interviews	20	-	1,2,3,4,5	Qual.	10/10
Dahan H, 2010[35]	Canada	Qual-interviews	12	-	NR	1-10 scale	10/10

NB: C-S "Cross-sectional study"; Qual "Qualitative"; Questionnaire (refers to those developed by study authors); GHQ "General Health questionnaire"; DES "Dental Environment Stress questionnaire"; PSS "Perceived Stress Scale".

*Newcastle-Ottawa Scale score (NOS): Total stars score range from 0-4 for cross-sectional studies with one group, 0-6 for cross sectional studies with group/sub-group comparison and 0-8 for cohort studies.

** Critical Appraisal Skills Program tool (CASP): Total score range 0-10, numbers reported in table for "yes" items.

Table 3: Descriptive characteristics of studies investigating sources of stress in dental students (N=55)

Study ID (Author, year)	Country	Study design	Sample size	Response rate	Dental student population	Instrument	Quality assessment NOS*
Martin RT, 1971[48]	NR	C-S	NR	59	NR	Questionnaire	1/4
Dean DH, 1978[95]	US	C-S	19	86.4	Senior	Questionnaire	1/4
Goldstein MB, 1979[97]	US	C-S	63	60	1st	Mod medical instrument	2/6
Garbee WH, 1980[49]	US	C-S	152	35	1,2,3,4	Questionnaire	1/6
Garbee WH, 1981[23]	US	C-S	217	61.8	1,2,3,4	DES	3/6
Sachs RH, 1981[99]	US	C-S	NR	95, 99, 82	1st	Student concerns inventory	2/6
Cohen H, 1982[56]	South Africa	C-S	193	97	3,4,5,6	Questionnaire	2/6
Richards VK, 1982[101]	US	C-S	153	61.2	1,2,3,4	Scale of stressful life events	4/6
Bjorksten OJ, 1983[102]	US	C-S	181	100	1,2,3	Bjorksten student problem inventory	2/6
Cecchini JG, 1985[104]	US	C-S	160	66	1,4	Dental stressor scale	1/6
Liyod C, 1985[106]	US	C-S	298	62	1,2,3,4	Questionnaire	4/6
Musser LA, 1985[107]	US	C-S	298	62	1,2,3,4	Questionnaire	2/6
Reeve PE, 1985[108]	UK	C-S	219, 134	NR	1,2,3,4,5	Questionnaire	0/4
Tedesco LA, 1986[57]	US	C-S	163	NR	NR	Inventory of dental education stressors	0/4
George JM, 1987[63]	US	C-S	300	95.2	1,2,3,4	Questionnaire	2/6
MacInnis WA, 1987[58]	Canada	C-S	NR	NR	1,2,3,4	Delphi technique	1/6
Sgan-Cohen HD, 1988[111]	Israel	C-S	104	72.7	5,6	Questionnaire	3/6
Bradley IF, 1989[112]	Canada	C-S	1255	63	1,2,3,4	Dental student problem questionnaire	2/6
Davis EL, 1989[39]	NR	C-S	46	57.5	1st	Inventory of dental educational stressors	0/4
Grandy TG, 1989[50]	US	C-S	263	87.7	3rd	DES	2/6
Westerman GH, 1993[43]	US	C-S	244	90.4	1,2,3,4	DES	3/6
Hendricks SJ, 1994[117]	South Africa	C-S	64	77	3,4,5,6	DES	2/6
Newton JT, 1994[33]	UK	C-S	271	78	1,2,3,4	Questionnaire	2/6
Jacobsen N, 1994[118]	Norway	C-S	95	72	NR	Questionnaire	0/4
Gross AJ, 1996[40]	US	C-S	732	77	1,2,3,4	Inventory of dental education stressors	3/6
Yap AU, 1996[16]	Singapore	C-S	137	98	1,2,3,4	DES	2/6
Peretz B, 1997[119]	Israel	C-S	112	93.3	4,5,6	Questionnaire	2/6
Heath JR, 1999[121]	UK	C-S	201	65	1,2,3,4,5	DES	4/6
Sanders AE, 1999[38]	Australia	C-S	205	93.2	1,2,3,4,5	DES	4/6
Freeman R, 2000[62]	UK	C-S	179	97.3	3 clinical years	Occupational stress indicator	4/6
Rajab LD, 2001[44]	Jordan	C-S	266	92	2,3,4,5	DES	4/6
Naidu RS, 2002[17]	West Indies	C-S	94	83	1,2,3,4,5	DES	4/6

Study ID (Author, year)	Country	Study design	Sample size	Response rate	Dental student population	Instrument	Quality assessment NOS*
Skelly AM, 2002[126]	UK	C-S	188	100	Applicants, 5th	Questionnaire	2/6
Acharya S, 2003[127]	India	C-S	256	88.2	1,2,3,4	DES	4/6
NG V, 2004[26]	Singapore	C-S	110	82.1	1,2,3,4	DES	4/6
Al Omari WM, 2005[132]	Jordan	C-S	144	70.6	3,4,5	DES	4/6
Pohlmann K, 2005[60]	Germany, Switzerland	C-S	161	85.6	4,5	Psychological stress inventory	3/6
Polychronopoulou A, 2005[24]	Greece	C-S	571	94.4	1,2,3,4,5	DES	1/4
Rosli TI, 2005[46]	Malaysia	C-S	325	88.8	1,2,3,4,5	DES	4/6
Sofola O, 2006[19]	Nigeria	C-S	105	76.6	3,4,5,6	DES	4/6
Morse Z, 2007[21]	Fiji	C-S	115	84	1,2,3,4,5	DES	3/6
Muirhead V, 2007[47]	Canada	C-S	171	62	1,2,3,4	DES	3/6
Muirhead V, 2008[18]	Canada	C-S	171	62	1,2,3,4	DES	4/6
Kumar S, 2009[37]	India	C-S	275	74	1,2,3,4	DES	4/6
Murphy RJ, 2009[136]	US	C-S	115	23	1,2,3,4	DES	2/6
Peker I, 2009[22]	Turkey	C-S	308	66.2	1,2,3,4,5	DES	4/6
Polychronopoulou A, 2009[45]	Greece, Croatia, Spain, Slovenia, Sweden, Ireland	C-S	1492	80.9	1,2,3,4,5-6	DES	4/6
Hoyle JD, 1980[51]	US	Cohort	93, 82	100,89	1st	Dental School Environment Scale	2/8
Sgan-Cohen HD, 1989[115]	Israel	Cohort	17, 14,23	42.5, 35, 57.5	4, 5	Questionnaire	3/8
Gorter R, 2008[14]	Netherlands, Ireland, Finland, UK	Cohort	331, 132	79.1, 51	1, 5	DES	5/8
Polychronopoulou A, 2010[36]	Greece	Cohort	109-70	97-61	1,2,3,4,5	DES	4/8
Silverstien ST, 2010[12]	US	Cohort	383, 228	94.1,56	1st	DES	5/8
							CASP**
Fredericks MA, 1968[41]	US	Qual-observation	86	100	1st	-	3/10
Register J, 1986[42]	US	Qual-interviews	2	NR	2,4	-	5/10
Dahan H, 2010[35]	Canada	Qual-interviews	12	NR	NR	Semi-structured interviews	10/10

NB: C-S "Cross-sectional study"; Qual "Qualitative"; Questionnaire (refers to those developed by study authors); DES "Dental Environment Stress questionnaire".
*Newcastle-Ottawa Scale score (NOS): Total stars score range from 0-4 for cross-sectional studies with one group, 0-6 for cross sectional studies with group/sub-group comparison and 0-8 for cohort studies.
** Critical Appraisal Skills Program tool (CASP): Total score range 0-10, numbers reported in table for "yes" items.

Table 4: Descriptive characteristics of studies investigating consequences of stress in dental students (N=24)

Study ID (Author, year)	Country	Study design	Sample size	Response rate	Dental student population	Outcome	Measure	Quality assessment NOS*
Fredericks MA, 1967[53]	US	C-S	86	100	1st	Academic performance	GPA	3/6
Horton PS, 1978[55]	US	C-S	27	-	NR	Leaving school	Students records	3/6
Cohen H, 1982[56]	South Africa	C-S	193	97	3,4,5,6	Response to stress	Questionnaire	2/6
Tedesco LA, 1986[57]	US	C-S	163	NR	NR	Academic performance	GPA	0/4
George JM, 1987[63]	US	C-S	300	95.2	1,2,3,4	Drug use-health problems	Questionnaire	2/6
MacInnis WA, 1987[58]	Canada	C-S	NR	NR	1,2,3,4	Academic performance	Clinical & didactic GPA	1/6
Davis EL, 1989[39]	NR	C-S	46	57.5	1st	Burnout	Meier Burnout Assessment	0/4
Jacobsen N, 1994[118]	Norway	C-S	95	72	NR	Dropout	Questionnaire	1/4
Freeman R, 2000[62]	UK	C-S	179	97.3	3 clinical years	Mental and Physical ill-health	Occupational Stress Indicator	4/6
Plasschaert AJM, 2001[66]	Netherlands	C-S	375	62	1,2,3,4,5	Substance use	Questionnaire	2/4
Humphris G, 2002[15]	Netherlands, UK, Ireland, Germany, Finland	C-S	331	79.1	1st	Burnout	MBI	3/6
Sanders AE, 2002[20]	Australia	C-S	202	91.8	1,2,3,4,5	Academic performance	Course grades	4/6
Tervit SL, 2002[31]	US	C-S	78	NR	3, 4	Clinical performance	Clinic grade	1/4
NG V, 2004[26]	Singapore	C-S	110	82.1	1,2,3,4	Immune function	Salivary IgA	4/6
Pohlmann K, 2005[60]	Germany, Switzerland	C-S	161	85.6	4,5	Burnout	MBI	3/6
Badran DH, 2010[61]	Jordan	C-S	307	100	4,5	Burnout	MBI - Human Services Survey	3/6
Gordon NA, 2010[65]	South Africa	C-S	308	NR	NR	Smoking	Questionnaire	2/6
Fredericks MA, 1969[54]	US	Cohort	85,81	100, 95.3	1,2	Academic performance	Grade point average	2/8
Jemmott III JB, 1983[64]	US	Cohort	64	NR	1	Immune function	Salivary IgA	3/8
Cecchini JJ, 1987[59]	NR	Cohort	74	61.7	1st	Academic performance	GPA (Technical, didactic, total)	1/8
Gorter R, 2008[14]	Netherlands, Ireland, Finland, UK	Cohort	331, 132	79.1, 51	1, 5	Burnout, Physical health	MBI, Physical symptoms questionnaire	5/8
Silverstien ST, 2010[12]	US	Cohort	383, 228	94.1, 56	1st	Performance, Health and Stress symptoms	GPA, Questionnaire	5/8
								CASP**
Pau AKH, 2004[52]	UK	Qual-interviews	20		1,2,3,4,5	Qual-themes	Semi-structured interviews	10/10
Dahan H, 2010[35]	Canada	Qual-interviews	12	-	-	Qual-themes	Semi-structured interviews	10/10

NB: C-S "Cross-sectional study"; Qual "Qualitative"; Questionnaire (refers to those developed by study authors); GPA "Grade point average"; MBI "Maslach Burnout Inventory".

*Newcastle-Ottawa Scale score (NOS): Total stars score range from 0-4 for cross-sectional studies with one group, 0-6 for cross sectional studies with group/sub-group comparison and 0-8 for cohort studies.

** Critical Appraisal Skills Program tool (CASP): Total score 0-10, numbers reported in table for "yes" items.

Table 5: Descriptive characteristics of studies testing stress management interventions in dental students (N=8)

Study ID (author, year)	Country	Study design	Sample size	Dental student population	Description of management	Quality assessment Cochrane summary risk of bias
Tisdelle DA, 1984[70]	US	RCT	32	1,2	Stress management training	Medium
Hicks JL, 1985[67]	US	RCT	124	Senior	Reducing clinical requirements	Low
Howard CE, 1986[73]	US	RCT	23	NR	Effectiveness of Synchro-Energizer device	Medium
Dodge WW, 1993[68]	US	RCT	80	Senior	Eliminating clinical requirement	Low
Piazza-Waggoner CA, 2003[71]	US	RCT	26	2nd	Stress management for 1st pediatric procedure	High
						NOS*
Shugars DA, 1981[69]	US	Cohort	80, 41	Junior	Fitness course	4/6
Morse DR, 1982[100]	NR	Cohort	12	1st	Meditation	1/8
Lopez N, 2010[72]	US	Mixed methods	256	1,2,3,4	Peer mentoring program	2/8

NB: RCT "Randomized Controlled Trial".
 *Newcastle-Ottawa Scale score (NOS): Total stars score range from 0-6 for cross sectional studies with group/sub-group comparison and 0-8 for cohort studies.

Table 6: Descriptive characteristics of studies investigating stress in relation to specific stressors in dental students (N=12)

Study ID (Author, year)	Country	Study design	Sample size	Response rate	Dental student population	Specific stressor	Quality assessment NOS*
Marucha PT, 1998[120]	US	C-S	11	100	NR	Exam	2/6
Rice CD, 1999[122]	US	C-S	164	56	Junior and senior	Accelerated degree program	1/6
Acharya S, 2005[83]	India	C-S	47	69	Final year	Ethical climate in private dental school	2/6
O'sullivan D, 2007[79]	UK	C-S	50	NR	NR	New restorative assessment system	0/6
Sukotjo C, 2008[81]	US	C-S	70	100	3rd	Prosthodontics in Problem based learning curriculum	3/4
Rowland ML, 2010[82]	Romania, South Africa, Australia, USA, Malaysia	C-S	471	71.9	1st	Bullying and intimidation	4/6
Mouton C, 1989[74]	NR	Cohort	46, 46, 44,44	NR	NR	Exam	4/8
Bosch JA, 1996[76]	Amsterdam	Cohort	28, 25, 28	70	NR	Exam	2/8
Bosch JA, 1998[75]	Amsterdam	Cohort	28	70	NR	Exam	2/8
NG V, 2003[77]	Singapore	Cohort	31	96.9	3rd	Exam	3/8
Krahwinkel Th, 2004[78]	Germany	Cohort	38	NR	Internship	Exam	2/8
Sukotjo C, 2007[80]	US	Cohort	70	100	3,4	Problem based learning curriculum	4/8

NB: C-S "Cross-sectional study".
*Newcastle-Ottawa Scale score (NOS): Total stars score range from 0-4 for cross-sectional studies with one group, 0-6 for cross sectional studies with group/sub-group comparison and 0-8 for cohort studies.

Table 7: Descriptive characteristics of studies investigating other outcomes related to stress in dental students (N=20)

Study ID (Author, year)	Country	Study design	Sample size	Response rate	Dental student population	Outcome	Measurement	Quality assessment NOS*
Zucker SB, 1978[96]	US	C-S	NR	NR	1st	Anxiety	Questionnaire	0/4
Goldstein MB, 1980[98]	US	C-S	63	60	1st	Psychological well being	Questionnaire	2/6
Freeman RE, 1985[105]	UK	C-S	99	100	Clinical	State-Trait anxiety	Multiple affect adjective check list	3/6
Lloyd C, 1989[3]	US	C-S	298	61	1,2,3,4	Psychiatric symptomatology	Hopkins symptoms checklist	4/6
Kolosowski-Gager, 1989[113]	US	C-S	84	NR	NR	State-Trait anxiety	STAI	0/4
Rubenstein LK, 1989[114]	NR	C-S	84	100	1st	State-Trait anxiety, Depression, General well-being	STAI, BDI, General well-being index	3/4
Henning K, 1998[89]	US	C-S	102	NR	NR	Psychological adjustment	Brief Symptom Inventory	3/6
Benjakul P, 2000[123]	Thailand	C-S	523	100	1,2,3,4,5,6	Adjustment problems	Mooney Problem Checklist	2/6
Kieser J, 2000[124]	New Zealand	C-S	102	85	2, 3	Anxiety related to clinic	Questionnaire	2/6
Mutlu N, 2002[86]	NR	C-S	261	NR	NR	State-Trait anxiety, Depression	STAI, BDI	2/6
Barberia E, 2004[87]	Spain	C-S	110	NR	1,3,5	Anxiety level	Inventory of anxiety situations and responses	3/6
Cardoso CL, 2004[130]	Brazil	C-S	35	NR	4	Stress symptoms	Lipp Stress Symptom Inventory	1/6
Peretz B, 2004[131]	Israel	C-S	88	NR	5, 6	Level of anxiety prior to treating a child	Visual analogue scale	3/6
Burk DT, 2005[133]	US	C-S	97	71	1st	Severity of problems	Questionnaire	4/6
Azimi S, 2010[88]	Iran	C-S	123	87.9	5, 6	Emotional intelligence	Emotional quotient inventory	3/6
Grandy TG, 1984[84]	US	Cohort	40	54.8	1st	State-Trait anxiety, Depression	STAI, BDI	1/8
Grandy TG, 1988[85]	US	Cohort	86	56.2	3rd	State-Trait anxiety, Depression	STAI, BDI	2/8
Snelling J, 2003[129]	UK	Cohort	122,120,129	NR	1st	Concerns related to dissection	Questionnaire	4/8
Stewart DW, 2006[90]	Canada	Cohort	28	NR	1st	Psychological functioning and symptoms	Questionnaire	4/8
Schmitter M, 2008[4]	NR	Cohort	96, 94	100, 97.9	NR	Categories of chronic stress	Tier Inventory	3/8

NB: C-S "Cross Sectional study"; Questionnaire (refers to those developed by study authors); STAI "State-Trait Anxiety"; BDI "Beck Depression Inventory".
*Newcastle-Ottawa Scale score (NOS): Total stars score range from 0-4 for cross-sectional studies with one group, 0-6 for cross sectional studies with group/sub-group comparison and 0-8 for cohort studies.

Table 8: Results from qualitative synthesis of included studies

Outcome		N (%)					
Stress level (N=44)							
	Low		**Moderate**		**High**		
	5 (11.4)		24 (54.5)		15 (34.1)		
Stress consequences (N=24)							
	Academic	**Psychological**		**Behavioral**		**Biological**	
	10 (41.7)	9 (37.5)		4 (16.7)		7 (29.2)	
Sources of stress (N=55)							
	Pre-clinical years (n=40)			Clinical years (n=44)			
	Academic	**Faculty**	**Personal**	**Academic**	**Clinical**	**Faculty**	**Personal**
Not reported	1 (2.5)	15 (37.5)	14 (35.0)	1 (2.3)	5 (11.4)	13 (29.6)	11 (25.0)
Weak	1 (2.5)	7 (17.5)	20 (50.0)	1 (2.3)	3 (6.8)	6 (13.6)	15 (34.1)
Medium	1 (2.5)	8 (20.0)	2 (5.0)	5 (11.4)	8 (18.2)	8 (18.2)	13 (29.5)
Strong	37 (92.5)	10 (25.0)	4 (10.0)	37 (84.0)	28 (63.6)	17 (38.6)	5 (11.4)

Figure 1: Flow diagram of study selection process

Identification

Records identified through database searching
(Medline-Medline in process-ERIC-Embase-Psychinfo-
Cochrane-web of science-SCOPUS)
N=4720
Additional records identified through other sources
N=7

Duplicates removed
N=1641

Screening

Records screened after duplicates removed
N=3086

Records excluded according to
selection criteria
N=2850

Eligibility

Full text articles assessed for eligibility
N=236

Full text articles excluded
N=112
Not original studies (n=48)
Not dental students (n=18)
General irrelevance (n=19)
No separate data (n=5)
Duplicate data (n=10)
Non-English (n=6)
Abstracts (n=6)

Included

Studies included in qualitative synthesis
N=124

Studies included in quantitative synthesis
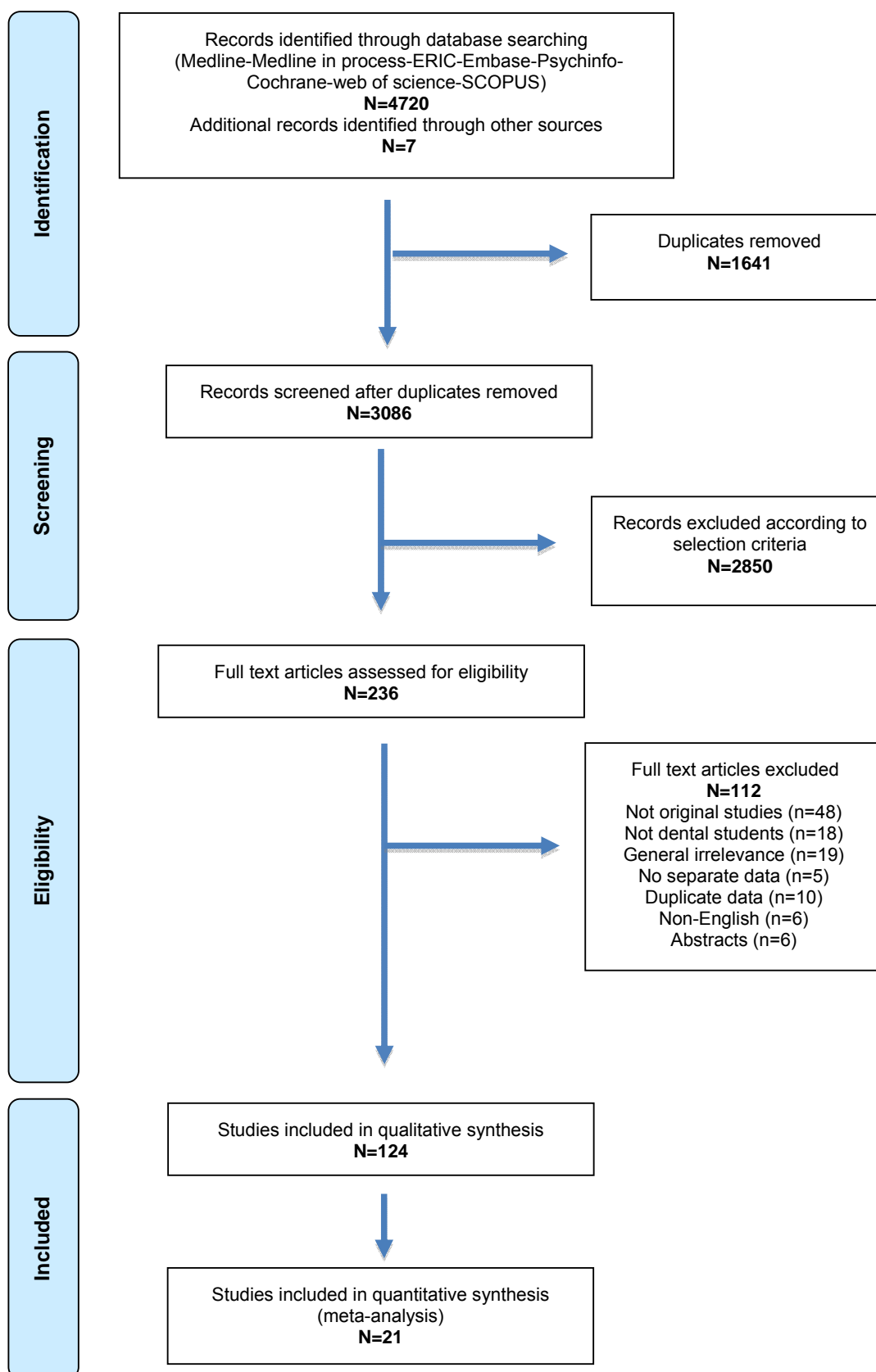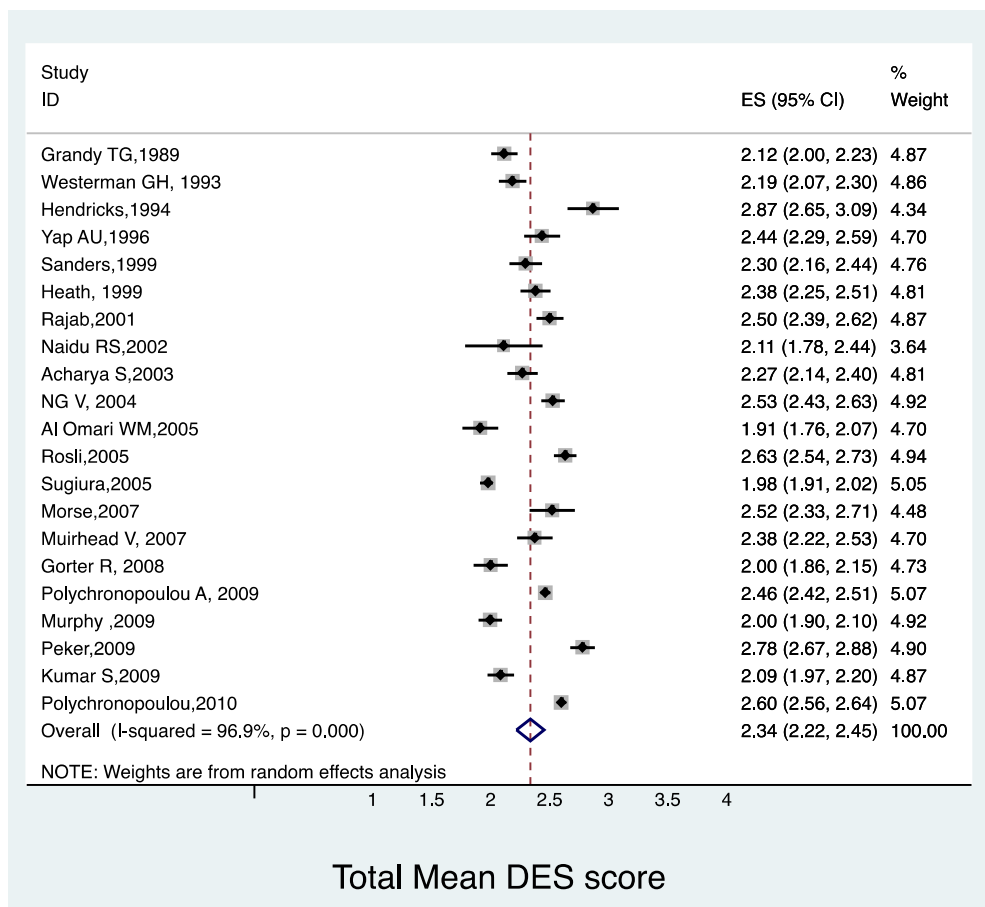(meta-analysis)
N=21

Figure 2: Forest plot of the overall mean stress level for studies that used the Dental Environment Stress (DES) questionnaire in a random-effects model meta-analysis

Study ID	ES (95% CI)	% Weight
Grandy TG,1989	2.12 (2.00, 2.23)	4.87
Westerman GH, 1993	2.19 (2.07, 2.30)	4.86
Hendricks,1994	2.87 (2.65, 3.09)	4.34
Yap AU,1996	2.44 (2.29, 2.59)	4.70
Sanders,1999	2.30 (2.16, 2.44)	4.76
Heath, 1999	2.38 (2.25, 2.51)	4.81
Rajab,2001	2.50 (2.39, 2.62)	4.87
Naidu RS,2002	2.11 (1.78, 2.44)	3.64
Acharya S,2003	2.27 (2.14, 2.40)	4.81
NG V, 2004	2.53 (2.43, 2.63)	4.92
Al Omari WM,2005	1.91 (1.76, 2.07)	4.70
Rosli,2005	2.63 (2.54, 2.73)	4.94
Sugiura,2005	1.98 (1.91, 2.02)	5.05
Morse,2007	2.52 (2.33, 2.71)	4.48
Muirhead V, 2007	2.38 (2.22, 2.53)	4.70
Gorter R, 2008	2.00 (1.86, 2.15)	4.73
Polychronopoulou A, 2009	2.46 (2.42, 2.51)	5.07
Murphy ,2009	2.00 (1.90, 2.10)	4.92
Peker,2009	2.78 (2.67, 2.88)	4.90
Kumar S,2009	2.09 (1.97, 2.20)	4.87
Polychronopoulou,2010	2.60 (2.56, 2.64)	5.07
Overall (I-squared = 96.9%, p = 0.000)	2.34 (2.22, 2.45)	100.00

NOTE: Weights are from random effects analysis

Total Mean DES score

NB: "ES" indicate the overall mean for each study

1.3 Study rationale

Findings from the systematic review (manuscript I), reported in section 1.2, indicated that dental training is a stressful experience. Most previous investigators primarily focused on examining the general level of stress in undergraduate dental students. However, findings from most of these studies were based on cross sectional designs; and thus the reported levels of stress were based on single time assessment. Although few cohort studies were conducted, they were based on very limited number of evaluations, which did not allow a detailed description of how stress varies over-time. Therefore further longitudinal studies are needed to better understand the progress of stress along the dental curriculum.

In addition, there is still a need to document sources of stress in undergraduate dental students and to describe how they may vary during the academic program. This is essential to enable researchers and dental educators to develop and implement appropriate stress management strategies and to promote healthy learning environment for dental students.

Finally, few researchers suggested that elevated levels of stress might affect dental students' physical and mental health. Unfortunately our knowledge in regard to this matter is still limited, partly due to the fact that most studies were based on quantitative methods that did not favor in-depth understanding of students' experience of stress. Further research in this area is thus needed to clarify and confirm these findings.

In view of theses limitations in the dental literature, our study aimed at describing the variations of stress levels and sources of that stress overtime in undergraduate dental students and to better understand the consequences of that stress on students.

1.4 Theoretical framework

Based on the work of Lazarus and Folkman in stress and coping [1], Giancola et al recently proposed a model for adult college students in an attempt to understand their stress experience and its relation to their psychological outcomes [27]. The first component of the model consists of persons' perception of stressors. These stressors include demands within work, school and personal life and interrole conflict between these variables. The outcomes of the model are general life satisfaction and mental well-being. Findings from that study supported the hypothesis that positive appraisals of stressors predict adaptive coping and thus positive outcomes. In addition, work stressors were shown to be the greatest source of students' stress and direct predictor of their well-being. In another work, Lisa Tedesco [28] proposed a more specific model related to dental students. This theoretical model relates dental students' psychosocial perspective to their well-being and performance. The model suggests that students' distress/well-being and performances are affected by their self-cognition and stress appraisal.

To illustrate our study objectives, we hypothesized a model that explains the relationship between exposure variables and the study outcomes (Figure 1). This model is adapted from the previously cited work of Giancola et al [27] and Lisa Tedesco [28]. Additional variables included in the model were guided by published literature about factors that can predict stress in undergraduate dental students [29-32]. The model hypothesizes that academic and clinical related stressors, students' sociodemographic and dentistry related characteristics, and behaviors affect their appraisal and coping strategies. The outcomes are stress level, performance and quality of life. The model proposes that according to the way students appraise and cope with the situation (adaptive or maladaptive coping) outcomes can vary. Therefore if students appraise the stressors positively and use adaptive coping they could experience better outcomes. On the other hand, if they appraise the situation as a negative and use maladaptive coping strategies then

they could experience high levels of stress and their performance and quality of life might be affected. In addition, we are taking time factor in consideration. We are proposing that this model is dynamic and thus factors affecting students in one year of the program might not necessarily be the same factors affecting students in a different year.

Figure 1: Hypothesized study model
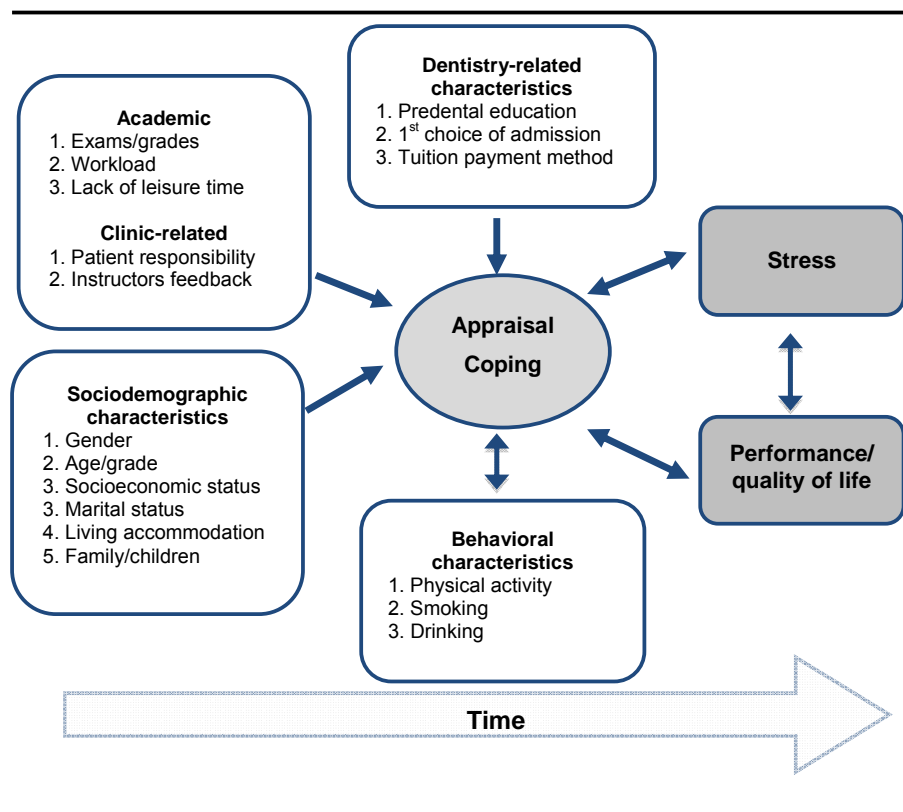
1.5 Study objectives

1) To describe and compare stress levels in cohorts of 1st, 2nd, 3rd and 4th year dental students and first year residents at monthly intervals over a period of 1 year.

2) To describe sources of that stress and to understand how these sources evolve during the 4-year curriculum and in the first year after graduation.

3) To describe the impact of stress on undergraduate dental students and first year residents and to better understand its consequences on their well-being.

2. METHODS

2.1 Overall research design and study population

In order to achieve our study objectives, we used a mixed methods design. Mixed methods research is defined as "The type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration" [33].

The choice of mixed methods design depends on timing, weighing and mixing of both the quantitative and qualitative components [34]. Based on our study objectives we decided to take the sequential explanatory mixed methods approach. This design consists of two phases, starting with the quantitative component and followed by a qualitative part that aims at providing an in-depth understanding of the quantitative findings. In this approach, quantitative and qualitative data are connected between the two phases and the final interpretation of the study findings is based on both quantitative and qualitative results. Since the quantitative part of the study provided the basis for the qualitative element, our design is mainly quantitative with an embedded qualitative component [34].

Our target population was undergraduate dental students enrolled in McGill University, Faculty of Dentistry. McGill 4-year D.M.D program consists of two preclinical years, including 16 months of fundamental sciences with medical students, 6 months preclinical training and two clinical years. We also included first year dental residents (GPR) because we wanted to know if their stress experience differs from undergraduate dental students who are under the pressure of requirements and exams.

2.2 First Quantitative Phase

2.2.1 Study design

For the quantitative component we used a prospective longitudinal design. We collected information from undergraduate dental students enrolled in McGill's 4-year D.M.D program and first year general practice (dental) residents for a period of one year based on monthly evaluations. Our longitudinal design consisted of five different cohorts rather than following the same cohort over the 5 years and thus we assumed that the dental curriculum at McGill did not change over that period (which it did not) and that individual characteristics of students enrolled at McGill dental program are fairly constant. Baseline data was collected from participants at the beginning of the study (September 2010) and follow-up data was collected for the next 11 months. The frequency of follow-up questionnaires was chosen as once per month to allow monitoring stress levels and study outcomes regularly overtime. In addition, we considered students' convenience into account, as we did not want to burden students with demanding participation that may affect their response rate.

2.2.2 Data collection

The Dean of dental school, the president of dental students society and class presidents for each year were informed with the purpose of the study. All registered students in 1st, 2nd, 3rd and 4th year at McGill's D.M.D program and first year-registered residents were then invited to participate. The study was introduced to all students and residents in the orientation week through presentation of the project objectives.

Data collection was through a web survey and in-class questionnaires. For 1st year and 2nd year students at their first semester, when they are mixed with medical students in fundamental sciences, data was collected through a web survey. The participants accessed the web

survey through a study link that was provided to them in a monthly email invitation [Appendix I]. In addition, a reminder email was sent five days after each monthly invitation. For 3rd and 4th year students and residents, we collected data through self-administered questionnaires that they completed in a classroom. These questionnaires were distributed at the beginning or at the end of a lecture after professors responsible of the class had granted permission. In order to improve the response rate, we also sent the email link every month to each class list for those students who were absent at the time of the questionnaire distribution. Students had an access to an email address to ask any questions they have about the study and to report any technical problems they face with the survey.

Data was collected at the last week of every month. Time required to complete each questionnaire varied according to questions included in each survey. For baseline survey the average time ranged between 8 and 10 minutes and for follow-up questionnaires it varied between 6 and 8 minutes.

2.2.3 Variables and measurements

According to the study objectives and our hypothesized model, our primary outcome was stress level. Stress was measured by a Visual Analogue Scale (VAS) at baseline and at each follow up to monitor stress changes over-time. The VAS consists of 100-millimeter horizontal line with two anchors at both ends of the line describing the extremes of the condition being examined [35]. Because of its simplicity and ease of administration, the VAS has been used widely to assess different outcomes. For example, it has been used to assess mood, pain intensity, anxiety and curriculum outcome [36-38]. The VAS has been shown to be reliable and valid instrument as well [36, 39]. To assess stress levels the two ends of the VAS represented the extremes of stress level as "not at all stressed (0)" and "extremely stressed (100)".

The VAS was introduced with the following question, "Please place a mark on the scale below (0-100) that best describes how much stress you have been experiencing in the past week including today". The VAS score is calculated by measuring the distance from point 0 "not at all stressed" to the point at which the mark is placed on the line so that the higher the score, the higher is the stress level.

Our second outcome was sources of stress. We used the Dental Environment Stress Questionnaire (DES) to assess the causes of stress. The DES questionnaire consists of 38 items related to stressors associated with undergraduate dental training. The response to each item is rated on 4-point Likert scale (1=not stressful, 2=slightly stressful, 3=moderately stressful, 4=very stressful) with a fifth possible response of "not pertinent". The mean score is calculated for each item of the DES [40]. We administered the full version to 3rd and 4th year students and a shorter modified one excluding questions related to dealing with patients (30-item) for students in the preclinical years (first and second). In addition, we used another modified DES (20-item) for residents without questions related to exams and requirements, which were irrelevant to them. We used the DES since it has been widely used across different countries to explore sources of stress with dental students [41-44] and thereby permitting comparison with previous research. We administered the DES twice at the end of each semester. For each follow up month, we evaluated sources of stress using questions that emerged from DES factor analysis in the previous literature [45-47]. These questions were: lack of confidence in self to be a successful dental student/dentist, relationship with professors and staff, workload, examination and grades, patient treatment, learning clinical and/or pre-clinical skills and personal issues. In addition, there was an open-ended question included so that participants could report any additional sources of stress. Finally, participants were asked to indicate their most important source of stress on each month's questionnaire.

Our last outcome was the impact of stress. Also using the VAS, we asked participants the following question: "Please place a mark on the scale below (0-100) that best describes how this stress has affected you in the past week including today". The two anchoring responses were "not at all (0)" and "too much (100)". In addition, to further evaluate the consequences of stress, participants were asked about stress-related symptoms and other behavioral characteristics. The stress-related symptoms were adapted from Stecker et al [48]; they included information about students' feelings, appetite, sleeping habits, weight changes and problems in concentration. Additional information about students' behaviors included their smoking, alcohol drinking habits and physical activity. We used the Godin Leisure-Time Exercise Questionnaire (GLTEQ) that assesses the frequency of exercise during a week to monitor participants physical activity [49]. Questions about the impact of stress were included at baseline and each follow-up survey.

Baseline information included students' sociodemographic characteristics (age, gender, living arrangements, marital status, part time job, having children and resident status), dentistry related characteristics (first choice of program admission, predental education and year of study).

2.2.4 Data analyses

We used simple descriptive statistics to illustrate the demographic characteristics and the distribution of the outcome variables in the study. Means and frequencies were used for continuous and categorical variables respectively. The following data analyses details are presented to address our research objectives according to their occurrence in the manuscripts of this thesis.

For our 1st research objective (manuscript II), which aimed at describing and comparing stress levels over a one-year period among

the 5 cohorts in the study, the dependent variable was stress level and was treated as a continuous variable (0-100). We first used descriptive statistics computing mean stress scores and standard deviations for stress level at each monthly evaluation for the 5 cohorts. Normality distribution was assessed using histograms and the Shapiro-Wilk test. Mean stress scores were presented graphically to demonstrate changes in stress over-time. To investigate the relationship between time of the year and students/residents year and stress level, we fitted linear regression model using a Generalized Estimating Equation (GEE) [50] approach that accounts for the within-subject correlation of repeated measurements data. We chose to use a marginal model since our aim was to make population specific conclusions regarding changes of stress over-time and across years of study. Guided by previous literature and according to our preliminary bivariate analyses, we adjusted for age and gender in the model. Interaction terms between year of study and time of the year, and year of study and gender were also examined since we hypothesized that stress experience over-time might be different for each year of study or depending on gender. Final model selection was based on best model fit assessed by lowest Quasi-likelihood information criteria (QIC).

Manuscript III investigated changes in sources of stress over-time. To accomplish this, we conducted a factor analysis to examine the underlying structure of the DES questionnaire. We used principal component analysis (PCA) with oblique rotation (Promax) and we retained factors with Eigenvalues greater than or equal to one. We additionally assessed the internal consistency of the emerging factors using Cronbach's alpha. Normality distribution of each DES factor was assessed using the Shapiro-Wilk test (each factor is considered as a continuous variable that range between 0 and 4). Accordingly we used parametric (ANOVA) and non-parametric tests (Kruskal Wallis) to investigate the differences in DES factors between years of study. In addition, post-hoc analysis, using Scheffe's test, were carried out to identify statistically significant associations. To examine the differences

in DES factors over-time between the two evaluations, we explored pairwise comparison differences for each DES factor using paired t-test and Wilcoxon signed rank test depending on the normality of the factors.

To address the objective of manuscript IV (determining the relationship between stress-related symptoms and students' demographic and behavioral characteristics with stress level), we used a subject-specific (random effects) modeling approach [51]. This approach accounts for the repeated measurements on the same participants and allows for student level inferences. A preliminary fixed effect model was first created to explore the association between explanatory variables with the outcome stress. Explanatory variables entered in the model were based on examination of previous literature, and on our bivariate analyses. We also examined interaction terms between year of study and time of the year, and year of study and gender. We reached a preliminary fixed effect model based on lowest Akaikes' Information Criterion (AIC). Next, we examined the effect of adding a random intercept and random slopes to the model. The addition of random intercept was used to account for individual variability in experiencing stress and random slope was considered for selected variables to permit exploring cluster-to-cluster variation in the relationship between explanatory variables (e.g. between years of study) and stress level. We first examined the addition of random intercept and random slopes separately, then jointly in the model. Our choice for random intercept and random slope covariates was based on theoretical considerations and best model fit. We reduced the model using backward elimination technique, removing non-significant variables one at a time while assessing the effect on the model estimates and AIC, until the AIC did not improve or all non-significant variables were removed. Finally we examined the correlation structure to determine which covariance structure best suited our model, and again our model choice was guided by lowest AIC. We then checked residuals from the final model to check assumption of normal distribution and constant variance.

We used STATA statistical package version 11.0 [52] for all statistical analyses presented in this study. For all tests, statistical significance was set at 0.05 levels.

2.3 Second Qualitative Phase

2.3.1 Sampling design

The aim of this phase was to explain, clarify and confirm the quantitative findings. Accordingly we adopted a qualitative descriptive approach based on individual interviews. We relied on typical case selection for sampling strategy [53] since the purpose of the interviews was to illustrate the average findings from all participants. In addition, results from the first quantitative phase were anonymous so we could not identify individual students based on their personal monthly evaluation of stress level.

2.3.2 Data collection

Following the completion of the quantitative phase, email invitations were sent to all students who graduated from McGill dentistry program and had participated in the first quantitative phase of this study to recruit participants to be interviewed for the qualitative part. Interviews were semi-structured with open-ended questions to permit students to express their opinion about their stress experience and how that stress affected their quality of life and learning experience. The same study researcher conducted the interviews between September and December, 2011. Interviews, which lasted between 45 and 60 minutes, took place in a quiet and convenient location outside McGill University, according to the preferences of the participants. We also used Skype to interview participants who had left Montreal after their graduation and lived too far from the city to be interviewed in person. All interviews were audio-recorded in order to be transcribed and analyzed.

2.3.3 Interview guide

Based on preliminary analyses of the quantitative results we developed an initial draft for the interview guide that was modified after piloting with two senior dentists that were not part of the study population. Questions in the final interview guide covered three main themes; stress levels, causes of stress and the consequences of that stress. Participants were provided with a graph describing the results of the first phase; that showed how stress level evolved along the years of the academic program. Each interview began with an opening general question: "what do you think of the stress levels shown in this graph?" it was followed by more specific probing questions about the three themes such as "what do you think happened during that specific stress peak in third year?". Questions were modified and developed during the interviews depending on participant's response and reaction to the questions.

2.3.4 Data analyses

In this qualitative phase, analyses included peer debriefing, transcripts coding and data display. With respect to peer debriefing, the interviewer met one of the senior researchers after each interview in order to critically reflect on the data collection process; those sessions also allowed us to analyze the collected data and to prepare the next interview. In several occasions, it leads us to make minor modifications to the interview guide. Each interview was transcribed verbatim in order to be coded (i.e. we assigned codes to segments of the transcripts). We generated an initial list of codes that were later refined throughout the coding process. Similar codes were grouped into themes and we created matrices and tables to display and interpret the data. We relied on triangulation to validate the data by having another research member reviewing the codes and interpretations.

2.4 Overall interpretation

To better understand our study objectives, we mixed findings from both quantitative and qualitative components. We first connected the two data by using preliminary quantitative results to guide the qualitative phase. Then for the final interpretation of the study findings, we merged quantitative and qualitative data [34].

2.5 Ethical consideration

Ethical approval for the study was obtained from the Institutional Review Board (IRB) of McGill University, Faculty of Medicine before the start of data collection [Appendix III]. In addition, all participants agreeing to participate signed a consent form before enrolling in either the quantitative or the qualitative phase of the study.

In the quantitative phase, students used the last three digits of their McGill identification numbers (ID) so that we could pair each student baseline data with follow-up questionnaires. However data are still considered anonymous since no one can identify students' ID except for University administration. To insure further confidentiality, after completion of data collection and matching baseline data with the follow up, students' IDs were replaced with randomly assigned numbers for the study records and data analyses. When introducing the study at the orientation week it was explained to participants that their participation was voluntary and that they could withdraw from the study at anytime. Participants were also assured that their refusal or withdrawal from the study would have no negative consequences on them and that the data would be aggregated and so no individual information would be divulged.

We provided a compensation for subjects to complete the questionnaires. A draw was made each month among students from

each cohort who submitted the questionnaire, and winners received a set of movie tickets. In addition, participants who completed at least 6 surveys were included in another draw for completers. Since the data were anonymous, we provided a third party member with winner's ID numbers each month to deliver the prizes.

For the qualitative interviews, participants were insured that their participation was confidential and what they would say would not be related to their identity. In addition, participants' names were replaced by pseudonyms in the analysis to insure anonymity.

3.RESULTS

The results for each of our research objectives are presented as manuscripts prepared based on data analyses from this project. In each manuscript we mixed results from both quantitative and qualitative components to provide an overall interpretation of the study findings.

3.1 Manuscript II: "Longitudinal Appraisal of Stress in Dental Students and Residents: A Mixed Methods Study"

Abstract

It has been shown that dental students demonstrate high level of psychological distress. However, most previous research was based on cross sectional studies that ignore the progress of stress over-time. Therefore, this study aimed to describe and compare stress levels over a one-year period among cohorts of 1st, 2nd, 3rd and 4th year dental students and dental residents using a mixed methods design. Quantitative data were collected from participants once per month over a period of one year. We used a Visual Analogue Scale (VAS) to monitor stress levels through the year. The VAS consists of a 100-millimeter horizontal line with anchors at each end of the line describing extremes of stress level. Qualitative data were collected based on one-on-one semi-structured interviews. Our findings demonstrate a gradual increase in dental students' stress levels throughout the four-year curriculum with a decline after their graduation. The lowest mean stress point score was reported by second year students in December and highest was reported by fourth year students in February, 2-3 months prior to graduation. Our study suggests that stress levels vary among dental students depending on their year of study and the time during the academic year.

INTRODUCTION

Dental undergraduate training is a challenging learning experience. Students are expected to learn both theoretical and technical aspects of the dental curriculum in addition to dealing with patients to qualify as responsible dental professionals. As a result, for the last three decades many researchers have been interested in studying stress in undergraduate dental students. Researchers have used a wide range of methods to assess stress levels; from self-reported questionnaires, such as the Perceived Stress Scale [1, 2] and the Dental Environment Stress questionnaire (DES) [3, 4] to methods like examining biological markers [5]. It has been shown that dental students demonstrate higher level of psychological distress in comparison to the general population [6] and to medical students [7, 8]. Moreover, previous studies demonstrated that stress levels vary across the undergraduate years where students in senior years frequently report different levels of stress from junior students [9].

However, most previous research was based on cross sectional studies [1, 3, 10]. In addition, the few cohort studies that investigated changes in stress over-time had few follow-ups [2, 9]. So there is a considerable amount of information regarding the progress of stress levels that is missing between the assessments. Therefore, to be able to evaluate changes in stress level over-time we conducted a prospective cohort study that aims to 1) describe stress levels in cohorts of 1st, 2nd, 3rd and 4th year dental students and first year residents at one dental school at monthly intervals over a period of one year; and 2) evaluate the differences in stress levels over-time between students in the different cohorts.

MATERIALS & METHODS

Study population

This mixed methods study consisted of a quantitative followed by a qualitative phase to provide in-depth understanding of the quantitative findings [11]. We conducted the study at McGill University, Faculty of Dentistry. McGill's 4-year D.M.D program consists of two preclinical years, including 16 months of fundamental sciences, 6 months preclinical training and two clinical years (3rd and 4th). All undergraduate dental students enrolled in the D.M.D program and first year dental residents (GPR) were invited to participate in the 1st phase of the study. In the qualitative part, participants were recruited using a typical case sampling approach [12]. Ethical approval was obtained from the Institutional Review Board of McGill University Faculty of Medicine before the start of data collection. In addition, all participants agreeing to participate signed a consent form before enrolling in the study. Students were assured that data were anonymous and their participation was voluntary.

Data collection

Baseline data were collected from all participants at the beginning of the academic year (September 2010) and follow-up data were collected once per month for the following 11 months. For first and second year students (first semester), data were collected through web surveys that were sent to students' university email address. For 2nd year students (second semester), 3rd, 4th students and residents data were collected through questionnaires distributed prior to class lecture. At all times student data were identified in a way that was independent of formal University identification systems to ensure anonymity, while enabling coupling of data sets from the same students over-time.

Following the completion of the quantitative phase, email invitations were sent to previous 4th year class list to recruit participants for the qualitative part. We recruited only finishing 4th year students, who

graduated from McGill and participated in the quantitative phase, as the aim was to have experienced students comment on the quantitative data gathered from all years. The same researcher conducted one-on-one interviews with all participants in a location outside McGill University and through Skype. Interviews were semi-structured with open-ended questions and were guided by a graph of the results obtained from quantitative part. Each interview was tape-recorded and lasted 45-60 minutes.

Variables

At baseline we collected information about students' sociodemographic characteristics including their age, gender, living arrangements, marital status and having children. Also, we collected information about participants' year of study and predental education.

Our outcome was stress level. We used a Visual Analogue Scale (VAS) at baseline and at each follow up to monitor stress changes overtime. The VAS consists of a 100-millimeter horizontal line with anchors at each end describing the extremes of the condition being examined. For the purpose of our study, the two ends represented the extremes of stress level as "Not at all stressed (0)" and "Extremely stressed (100)". The VAS stress level score was calculated by measuring the distance from point zero to the point at which the mark was placed on the line so that the higher the score, the higher the stress level [13]. We relied on the VAS because of its simplicity and ease of administration given our study design with frequent data collection. The VAS has been used to assess different outcomes repeatedly overtime like depression and change in mood [14, 15]. In dental education, the VAS was used to assess students' confidence and anxiety levels in relation to pediatric procedures [16, 17]. The VAS has been shown to be a reliable and valid instrument [18, 19].

Analyses

Simple descriptive statistics were used to illustrate the demographic characteristics and the distribution of the outcome variable. We used means and frequencies to describe continuous and categorical variables respectively. To demonstrate changes of stress overtime, mean stress levels were plotted graphically for each cohort. In addition, to investigate the relationship between stress, time of the year and student/resident year, we fitted linear regression model using Generalized Estimating Equation (GEE) approach, which accounts for within-subject correlation of repeated measurements [20]. We specified within-subject correlation to be autoregressive first order and used robust standard errors when conducting GEE, to be able to obtain valid estimates of the association between stress levels and time of year and student/resident year and their 95% confidence intervals (CI). We also adjusted for age and gender as possible confounders based on previous literature and guided by our preliminary bivariate analyses. We used STATA statistical package version 11.0 for the data analysis[21].

Qualitative interviews were transcribed verbatim and data were coded into themes. Matrices were produced for emerging themes and data validation was based on triangulation.

RESULTS

Apart from the summer holiday period when response rates were virtually zero, overall study response rates ranged from 50-82% (Table 1). The mean age of participants was 24.4 years, the majority was female (63.4%) and most students had a Bachelor degree before starting dental school (62.0%) (Table 2).

Figure 1 represents the mean stress level for participants from the different years of the program. First and second year students reported their highest mean stress scores in January (1st year mean=59.0, SD=23.6 and 2nd year mean=66.0, SD=19.6) and lowest scores in

December (1st year mean=35.6, SD=25.8 and 2nd year mean=25.5, SD=26.2) during which they are on holiday for much of the month. Third year students had their highest mean stress levels in October (mean=66.8, SD=20.0) and lowest mean in June (mean=31.6, SD=25.2), when at McGill they are on holiday. Fourth year students showed the highest peak of mean stress level in February (mean=84.4, SD=14.5) and lowest mean in May (mean=36.8, SD=27.5), a period between finishing studies and final exams and just before graduating. For the residents, the highest mean stress scores were reported in May (mean=55.2, SD=23.3) and lowest mean in June (mean=34.4, SD=18.4).

The results of GEE analysis indicated a significant association between participants' average stress level and their age, time of the year, and year of study (Table 3). Students' and residents' stress levels varied over the year. In comparison to baseline (September), there was a significant decline in mean stress level at the holiday months adjusted for age, gender and year of study (December β=-24.9, 95%CI=-35.4,-14.5, July β=-21.0, 95%CI=-34.2,-7.7 and August β=-13.3, 95%CI=-26.0,-0.7). There was also an association between adjusted mean stress level and the age of participants (β=1.4, 95% CI= 0.4, 2.4) with older students reporting greater stress levels. In addition, average stress level varied according to year of study. Second, third and fourth year students adjusted mean stress levels were significantly different from first year students with third year students demonstrating highest adjusted mean stress level compared to those in first year (β=19.6, 95%CI=5.3,33.9).

We conducted a total of six qualitative interviews (4 females, 2 males). Generally participants agreed that their stress level increased as they progressed through the program.

> ST3: *"The graph does make sense, I think… The first year, I remember being really stressed out but no it's not comparable. It got exponentially more stressful in third and fourth year".*

Furthermore, participants described the stress peak observed in second year as part of a stress period that extended during January and February (in January of the 2nd year, students move from fundamental studies with medical students to preclinical studies in the dental school).

>ST1: **"Yeah, I would definitely kind of agree with that peak in January and the June stress, I really, really agree with that. I thought that was a really stressful time. It was more stress in June. I felt everybody had shared that stress. June was a high stress period for everyone, I would agree with that".**

>ST3: **"The graph makes perfect sense. It was overwhelming at the beginning of dentistry for sure. Those 6 months at pre-clinic were probably the busiest in my four years, the most time consuming. It was so different like going from med school to pre-clinic; it was completely different. It was unlike anything I had ever done".**

Interviewees also explained the two high peaks in stress levels observed in third year.

>ST4: *"Third year was one of my highest… I hated the beginning of third year. I would say by November it was fine. But September and October were very tough".*

>ST3: *"Third year for me, the start November, December, I was really stressed. And end of May and June was like probably the most stressful period of my entire life that I can think of. I think everyone was stressed".*

As well, participants expressed strong feelings regarding the particularly elevated stress they experienced in fourth year.

>ST2: *"I was very stressed at that point. This graph is real, its real. Some stress is very beneficial…but when it starts affecting what you need to survive, like sleep and eating, when it brings down your productivity, I think that's bad".*

The subjects who were residents, looking back on their previous experience, also compared their current stress level with the presentation of the quantitative data.

> *ST5: "I think the fact that it goes down during residency makes sense too, you know I love it. You start to feel a lot more competent and confident, and that really makes it go down, but in school, I felt like I was more stressed. It was like I was very stressed, and then not stressed, and then very stressed, not stressed. Now I feel like I have this basal stress level. You know, it's not super high, but it's there all the time, it's not as high, it's not as peaked".*

DISCUSSION

This cohort study documents stress levels longitudinally among undergraduate dental students and 1st year residents. Our findings, using quantitative and qualitative data, demonstrate a gradual increase in dental students' stress levels throughout the four-year curriculum with a decline after their graduation. In addition, there was variation in stress levels throughout the year for each cohort of students. Generally, there was a decrease in stress levels for all participants around the holiday times. The lowest mean stress point score was reported by second year students in December and highest was reported by fourth year students in February, 2-3 months prior to graduation.

Very few studies have investigated the progress of stress level over-time in dental students. In the United States, dental students from four dental schools showed an increase in their stress level towards the end of the year when they were followed over their first year of dental school [2]. In Europe, another longitudinal study demonstrated changes in stress levels, through the five year undergraduate curriculum, by comparing final year students stress levels to their first year scores [9]. Although these previous studies are in general agreement with our results, they did not provide details on the fluctuations of students' stress level over the year and throughout the program. The US study

compared stress levels between the beginning and the end of first year only, while in the European study, stress levels of the same cohort of students were simply compared twice; at entrance and exit of dental school.

Despite the fact that most previous studies examining stress in undergraduate dental students were based on cross sectional designs, our findings support their reported variations in students' stress levels according to year of study. It has been shown that students in clinical years experience different stress levels compared to preclinical students. This was reported by studies that utilized general measurement of stress [1, 10] and studies that used total DES score which is widely used to report perceived stress levels in relation to different dental stressors [3, 4]. Furthermore, our analysis indicated that students in third year had higher levels of stress in comparison to those in their first year. This replicates previous research in that students in the transition from preclinical to clinical training tended to report high levels of psychological distress [1, 3, 10, 22].

The main strength of our study lies in its design. This is the first study that describes variations of stress level based on monthly assessment over the year for dental students and residents at different stages of their training. In addition we improved our analysis by adding the qualitative element, which verified and confirmed the pattern of stress level that we observed from the quantitative data. On the other hand, several limitations need to be considered when interpreting findings from this study. First, the study population was based on students attending a single Canadian dental school and thus findings may not be generalizable to dental students in other schools. Second, our sample size is relatively small which might have limited our statistical inferences, although one could argue that we intended to have data from a whole population (students and residents in a dental school), so our data are representative of that population. Thirdly, as is commonly the case with such a cohort study with many data collection points, we

have many missing data, however we decided not to impute data for the analyses given the very high participation rates by individual student subjects and our sense that we have good representation for most data points. Finally, although the VAS has been shown to be reliable and valid instrument in different settings it has never previously been used to measure stress levels in studies of stress in dental students.

Despite these limitations, our study suggests that stress levels vary a lot among dental students depending on their year of study and the time during the academic year. Overall, 1st year students and residents reported lowest levels of stress and 4th year students had the highest peak. Similar work in other dental schools needs to be performed to confirm our findings and compare stress levels in similar professional programs such as medicine and law. If our results are confirmed, they could enable future research to develop and implement effective stress management strategies to improve students' well-being at the necessary times throughout the curriculum.

REFERENCES

1.   Pau AKH, Croucher R. Emotional intelligence and perceived stress in dental undergraduates. Journal of Dental Education 2003;67(9):1023-8.

2.   Silverstein ST, Kritz-Silverstein D. A longitudinal study of stress in first-year dental students. Journal of Dental Education 2010;74(8):836-48.

3.   Naidu RS, Adams JS, Simeon D, Persad S. Sources of stress and psychological disturbance among dental students in the West Indies. Journal of Dental Education 2002;66(9):1021-30.

4.   Sofola OO, Jeboda SO. Perceived sources of stress in Nigerian dental students. European Journal of Dental Education 2006;10(1):20-3.

5.   Ng V, Koh D, Mok BYY, Chia S-E, Lim L-P. Salivary biomarkers associated with academic assessment stress among dental undergraduates. Journal of Dental Education 2003;67(10):1091-4.

6.   Lloyd C, Musser LA. Psychiatric symptoms in dental students. Journal of Nervous & Mental Disease 1989;177(2):61-9.

7.   Birks Y, McKendree J, Watt I. Emotional intelligence and perceived stress in healthcare students: a multi-institutional, multi-professional survey. BMC Medical Education 2009;9:61.

8.   Schmitter M, Liedl M, Beck J, Rammelsberg P. Chronic stress in medical and dental education. Medical Teacher 2008;30(1):97-99.

9.   Gorter R, Freeman R, Hammen S, Murtomaa H, Blinkhorn A, Humphris G. Psychological stress and health in undergraduate dental students: fifth year outcomes compared with first year baseline results from five European dental schools. European Journal of Dental Education 2008;12(2):61-8.

10.   Sugiura G, Shinada K, Kawaguchi Y. Psychological well-being and perceptions of stress amongst Japanese dental students. European Journal of Dental Education 2005;9(1):17-25.

11.   Creswell J, W, Plano Clark V, L. Designing and conducting Mixed Methods Research. ed. California: Sage Publications, Inc; 2007.

12.   Patton M. Qualitative Research and Evaluation Methods. 3rd ed: Sage Publication Inc; 2002.

13.   Aitken RC. Measurement of feelings using visual analogue scales. Proc R Soc Med 1969;62(10):989-93.

14.   Zealley AK, Aitken RC. Measurement of mood. Proc R Soc Med 1969;62(10):993-6.

15.   Litte JC, McPhail NI. Measures of depressive mood at monthly intervals. Br J Psychiatry 1973;122(569):447-52.

16.   Rodd HD, Farman M, Albadri S, Mackie IC. Undergraduate experience and self-assessed confidence in paediatric dentistry: comparison of three UK dental schools. Br Dent J 2010;208(5):221-5.

17.   Piazza-Waggoner CA, Cohen LL, Kohli K, Taylor BK. Stress management for dental students performing their first pediatric

restorative procedure. Journal of Dental Education 2003;67(5):542-8.

18. Ahearn EP. The use of visual analog scales in mood disorders: a critical review. J Psychiatr Res 1997;31(5):569-79.

19. Luria RE. The validity and reliability of the visual analogue mood scale. J Psychiatr Res 1975;12(1):51-7.

20. Zeger SL, Liang KY, Albert PS. Models for longitudinal data: a generalized estimating equation approach. Biometrics 1988;44(4):1049-60.

21. StataCorp. Stata Statistical Software: Release 11: College Station, TX: StataCorp LP.; 2009.

22. Dahan H, Bedos C. A typology of dental students according to their experience of stress: a qualitative study. Journal of Dental Education 2010;74(2):95-103.

Table 1: Participants response rates at each data collection time

Year	Total	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
							N (%)						
1st year	34	29 (85.3)	26 (76.5)	27 (79.4)	21 (61.8)	24 (70.6)	23 (67.6)	19 (55.9)	13 (38.2)	14 (41.2)	11 (32.4)	0	14 (41.2)
2nd year	35	34 (97.1)	34 (97.1)	33 (94.3)	30 (85.7)	28 (80.0)	34 (97.1)	35 (100)	34 (97.1)	35 (100)	29 (82.9)	19 (54.3)	28 (80.0)
3rd year	29	29 (100)	26 (89.7)	28 (96.6)	24 (82.8)	24 (82.8)	27 (93.1)	26 (89.7)	26 (89.7)	26 (89.7)	10 (34.5)	20 (69.0)	28 (96.6)
4th year	35	22 (62.9)	23 (65.7)	28 (80.0)	20 (57.1)	25 (71.4)	18 (51.4)	22 (62.9)	20 (57.1)	9 (25.7)	0	0	6 (17.1)
Residents	22	10 (45.5)	18 (81.8)	10 (45.5)	11 (50.0)	17 (77.3)	22 (100)	19 (86.4)	5 (22.7)	19 (86.4)	5 (22.7)	3 (13.6)	1 (4.5)
All	155	124 (80.0)	127 (81.9)	126 (81.3)	106 (68.4)	118 (76.1)	124 (80.0)	121 (78.1)	98 (63.2)	103 (66.5)	55 (35.5)	42 (27.1)	77 (49.7)

**Table 2:** Demographic Characteristics of study participants

	N (%)					
	Total	**1st year**	**2nd year**	**3rd year**	**4th year**	**Residents**
Sample size	142	33	35	29	25	20
Age						
Mean (SD)	24.4 (3.1)	22.7 (3.2)	23.9 (2.4)	25.8 (3.9)	25.5 (2.6)	24.7 (1.2)
Gender						
Female	90 (63.4)	19 (57.6)	21 (60.0)	20 (69.0)	17 (68.0)	13 (65.0)
Male	52 (36.6)	14 (42.4)	14 (40.0)	9 (31.0)	8 (32.0)	7 (35.0)
Living arrangements						
Alone	45 (31.9)	5 (15.2)	15 (42.9)	14 (48.3)	9 (36.0)	2 (10.5)
With friend/s	13 (9.2)	5 (15.2)	3 (8.6)	1 (3.5)	1 (4.0)	3 (15.8)
With partner	23 (16.3)	4 (12.1)	4 (11.4)	5 (17.2)	5 (20.0)	5 (26.3)
With relative/s	60 (42.6)	19 (57.6)	13 (37.1)	9 (31.0)	10 (40.0)	9 (47.4)
Marital status						
Single	87 (61.3)	20 (60.6)	26 (74.3)	17 (58.6)	13 (52.0)	11 (55.0)
Have a partner	46 (32.4)	11 (33.3)	6 (17.1)	10 (34.5)	11 (44.0)	8 (40.0)
Married	9 (6.3)	2 (6.1)	3 (8.6)	2 (6.9)	1 (4.0)	1 (5.0)
Have children						
No	140 (98.6)	32 (97.0)	35 (100.0)	28 (96.6)	25 (100.0)	20 (100.0)
Yes	2 (1.4)	1 (3.0)	0 (0.0)	1 (3.5)	0 (0.0)	0 (0.0)
Previous education						
College	33 (23.2)	9 (27.3)	7 (20.0)	7 (24.1)	7 (28.0)	3 (15.0)
Bachelor	88 (62.0)	19 (57.6)	23 (65.7)	16 (55.2)	14 (56.0)	16 (80.0)
Master	20 (14.1)	5 (15.2)	5 (14.3)	6 (20.7)	4 (16.0)	0 (0)
PhD	1 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.0)

Table 3: The association of stress level and time of data collection and year of study based on Generalized Estimation Equation analysis

Variable	Coefficient (95% CI)	Standard error*	Pr<z
Intercept	5.90 (-20.14,31.94)	13.29	0.66
Month			
September	Reference		
October	0.30 (-8.14,8.74)	4.31	0.94
November	0.38 (-7.36,8.12)	3.95	0.92
December	-24.92 (-35.36,-14.49)	5.32	<0.001
January	2.31 (-7.22,11.84)	4.86	0.64
February	-1.52 (-11.52,8.49)	5.10	0.77
March	-2.28 (-12.74,8.18)	5.34	0.67
April	-10.64 (-21.49,0.21)	5.54	0.06
May	-0.03 (-10.53,10.48)	5.36	1.00
June	-2.17 (-14.10,9.76)	6.09	0.72
July	-20.95 (-34.23,-7.67)	6.78	<0.001
August	-13.34 (-26.00,-0.69)	6.46	0.04
Age	1.38 (0.42,2.35)	0.49	0.01
Gender			
Male	Reference		
Female	6.93 (-0.67, 14.53)	3.88	0.07
Year of study			
1st year	Reference		
2nd year	15.88 (2.90,28.87)	6.63	0.02
3rd year	19.62 (5.32,33.92)	7.30	0.01
4th year	14.38 (2.14,26.62)	6.25	0.02
Residents	7.41 (-6.68,21.50)	7.19	0.30

NB: *SE based on "robust" variance estimator

Figure 1: Longitudinal changes in mean stress levels according to year of study
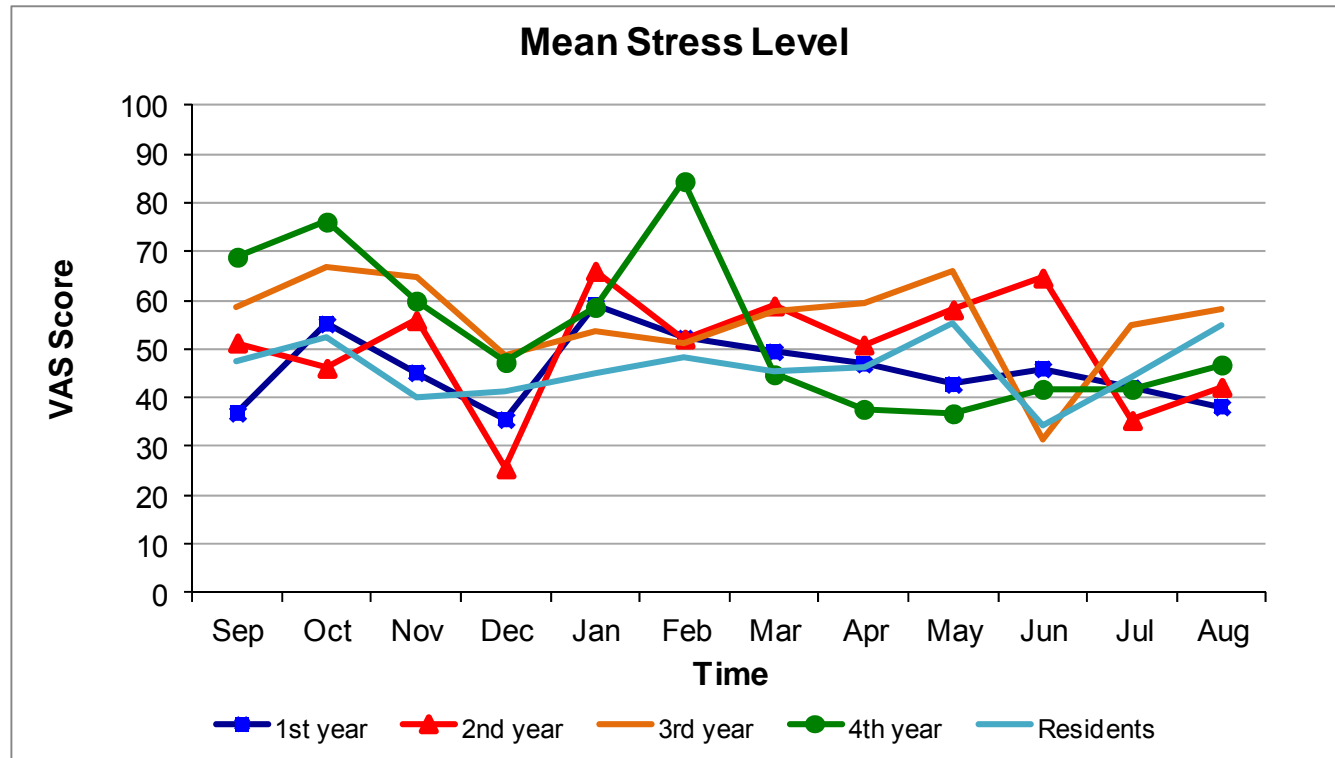
3.1.1 Summary of results from manuscript II investigating stress level in dental students

Analyses from this manuscript II clarified our first research objective that aims to describe and compare stress levels in cohorts of 1st, 2nd, 3rd and 4th year dental students and first year residents at monthly intervals over a period of 1 year. We relied on Generalized Estimating Equation (GEE) modeling approach to be able to test the association between stress levels at the different years of the program and between the different data collection points. We showed that stress levels statistically differ between students in the different years of the program and between the data collection points (months). Furthermore, we confirmed these findings using qualitative data. Participants constantly confirmed the quantitative results when presented to them as a graph during the interviews.

Although several previous investigations reported similar levels of stress, our findings provided a detailed description of how stress evolves throughout the curriculum. The results of this manuscript II were used to aid in addressing our next manuscript III in which we wanted to understand the causes for those peaks of stress.

3.2 Manuscript III: "Sources of Stress in Canadian Dental Students: A Prospective Mixed Methods Study"

Abstract

The objectives of this study were to describe sources of stress in undergraduate dental students and first year residents, and to understand how these sources evolve during the 4-year curriculum and in their first year after graduation. We used a mixed methods design. Quantitative data were collected from subjects in each of the 5 cohorts of students and residents, every month for a period of one year. Sources of stress were measured using the Dental Environment Stress questionnaire (DES). We administered the DES twice in total, once at the end of each academic semester. We used DES categories that emerged from factor analysis to assess monthly sources of stress. Qualitative data were collected through individual interviews and aimed at understanding the main sources of stress during each year of the curriculum. Results from both quantitative and qualitative phases demonstrated that the main stressors for all undergraduate dental students throughout the year are "examinations and grades", and "workload". Students in the clinical years were also concerned about "patient treatment". The residents and final year students reported "future plans" as an additional stressor. Furthermore, over the year there was a significant increase for "workload" stress source category in 4th year ($P<0.05$), and in third year there was a significant increase for the "patient treatment" factor ($P<0.05$) with a significant decrease related to "personal factors" ($P<0.05$). In conclusion, our study demonstrated that sources of stress in undergraduate dental students and first year residents vary according to their stage in the program and the period of the year.

Key words: Dental Education, Dental students, Stress, Longitudinal study.

INTRODUCTION

Previous research has demonstrated a high prevalence of psychological distress in undergraduate dental students[1-3]. In response to that, several studies in different countries focused on understanding the sources of that stress and despite different study designs, stress was associated with the nature of students' training and the demanding course load. However, most of the existing literature is based on cross-sectional studies and very few investigated variations in sources of stress overtime. Findings from the few existing longitudinal reports demonstrated changes throughout the curriculum, although their designs did not permit evaluation of variations within the year [4]. In addition to these limitations with the previous research, most researchers have used the Dental Environment Stress questionnaire [5-7], and few have adopted qualitative methods to better understand students' stress experience [8].

Consequently, we conducted a prospective investigation using a mixed methods approach focusing on levels, causes and impacts of stress in cohorts of 1st, 2nd, 3rd and 4th year dental students and 1st year residents, at the same Canadian dental school. In a previous paper we reported a gradual increase in dental students' stress levels throughout the four-year curriculum with a decline after their graduation, during residency. We noted that the highest stress point occurred among fourth year students in February, 2-3 months prior to their graduation. Accordingly, this paper reports the findings of that element of the project whose objective was to describe sources of stress in undergraduate dental students and to understand how these sources evolve during the 4-year curriculum and in the first year after graduation (i.e. residency program).

METHODS

All first, second, third and fourth year undergraduate dental students and first year general practice residents registered at McGill University

were invited to participate in the study. Data collection for the first phase, which was that quantitative part, started in September 2010 and continued for 11 months. Data collection for the second phase, which was qualitative, started in September 2011 and finished in December 2011. The Institutional Review Board (IRB) of McGill University Faculty of Medicine approved the study and all participants agreeing to participate signed a consent form before enrolling in either phase of the study. As part of the informed consent process, students and residents were assured of the anonymity of the data, that their participation was voluntary and that participation or not would have no effect on their undergraduate dental or residency programs.

For the quantitative phase, we used both web surveys and questionnaires to collect the data each month. Data were collected through a web survey from all participants during the holidays and from students in the preclinical years when they were mixed with medical students in fundamental sciences (1st year and first semester of the 2nd year). In-class questionnaires were used for second year students once they started the dental curriculum (2nd semester), as well as for third and fourth year students and for the residents.

The questionnaire included information about age, gender, marital status and year of study. To assess participants' sources of stress, we administered the Dental Environment Stress Questionnaire (DES) twice in total, including once at the end of each semester (December and April). The DES consists of 38 items related to stressors associated with undergraduate dental training. The response to each item is rated on a 4-point Likert scale (1=not stressful, 2=slightly stressful, 3=moderately stressful, 4=very stressful) with a fifth possible response of "not pertinent". The mean score is calculated for each item of the DES [9]. We used the full questionnaire (38-item) for third and fourth year dental students. A shorter modified version (30-item), without questions related to clinic and patient treatment, was administered to students in the preclinical years (first and second). For first year

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residents we used another modified DES (20-item) that excluded items related to requirements and exams, which were not relevant to them. The reliability of DES has been demonstrated in several previous studies that investigated stress in dental students [2, 10, 11].

In addition to using the DES as described above, to monitor monthly sources of stress throughout the year, we asked students to indicate among a list of seven categories what caused their stress levels at each particular month. These categories were based on DES scales that emerged from factor analysis reported by previous research [4, 12, 13]. The categories included were: 1) Lack of confidence in self to be a successful dental student/dentist; 2) Relationship with professors and staff; 3) Workload; 4) Examination and grades; 5) Patient treatment; 6) Learning clinical and /or preclinical skills; and 7) Personal issues. In addition, there was an open-ended option for participants to add any additional stressors. Finally, students were asked to specify the single stressor that contributed the most to their stress level at each particular month.

We used the STATA statistical package version 11.0 for data analyses. To describe the study outcomes we used simple descriptive statistics computing mean stress scores and standard deviations for each item and factor of the DES. We also calculated frequency distributions for the monthly stressor categories to demonstrate the most frequently cited stressor over the year for each cohort. Secondly, to confirm and permit comparison of the DES structure with previous literature, we conducted factor analysis using principal component analysis (PCA) with oblique rotation (Promax). We retained factors with Eigenvalues greater than or equal to one. Finally, to investigate differences in DES factors between years of study, we used parametric (ANOVA) and non-parametric tests (Kruskal Wallis) depending on the normality of distribution of each of the DES categories. Post-hoc analysis, using Scheffe's test, were carried out to identify statistically significant associations. In addition, for pairwise comparison differences for DES

factors between the two assessments, we used paired t-test and Wilcoxon signed rank test depending on the normality of distribution of DES factors. Normality of distributions was tested using the Shapiro-Wilk test. In addition, we assessed the internal consistency of the DES using Cronbach's alpha. For all tests, statistical significance was set at 0.05 levels. For the open-ended question, included to monitor monthly sources of stress, students' answers were coded and accordingly themes were generated.

For the qualitative phase, the purpose of which was to enhance the interpretation and meaningfulness of the results of the quantitative phase, we sent email invitations to previous 4th year students who had graduated from the McGill D.M.D program and who had participated in the first (quantitative) phase of this study. We conducted one-on-one semi-structured interviews that lasted 45-60 minutes each. An interview guide was developed to facilitate the discussions and included questions about the main stressor for each year in the curriculum, particularly at high stress peaks. All interviews were audio-recorded then transcribed verbatim for the analysis. We assigned initial codes to the transcripts and modified them through the coding process. We then grouped similar codes into themes and produced matrices to present the data. Finally we relied on the concept of triangulation to validate the data by having another research member checking the cods and the interpretations. Final interpretation of the study findings was based on results from both quantitative and qualitative phases.

RESULTS

At McGill during 2010-11 there were a total of 133 undergraduate dental students and 22 first year residents. We had a relatively good response rate with an average of 65.7% for the 12 months. The sample consisted of 142 participants, of which 90 were female students (63.4%), the majority was single (61.3%) and the age of participants ranged from 20-36 years with a mean of 24.4 ±3.1 years. In the

qualitative phase, we interviewed 6 participants including 4 females and 2 males.

The full DES showed good internal reliability with Cronbach's' alpha=0.93. We identified seven factors from DES items based on principal component analysis. We initially had eight factors with Eigenvalues >1, however we decided to eliminate factor eight since it had very few items loading. The 7 factors accounted for 93.6% of the total variance. Although we had some minor differences in some items loading, the factors that emerged were generally similar to those reported by previous studies[12, 13] and they had good internal reliability. The scales were: Self-efficacy beliefs (6 items, Cronbach's' alpha= 0.84); Faculty and administration (9 items, Cronbach's' alpha= 0.82); Workload (4 items, Cronbach's' alpha= 0.79); Personal factors (11 items, Cronbach's' alpha= 0.76); Performance pressure (2 items, Cronbach's' alpha= 0.81); Patient treatment (4 items, Cronbach's' alpha= 0.55) and Preclinical and clinical training (2 items, Cronbach's' alpha= 0.79).

Tables 1 and 2 demonstrate the six stressors with the highest mean DES item scores in the two semesters (T1 and T2). Results showed that in the first semester "examination and grades" and "lack of time for relaxation" (mean range = 2.9-3.3, 2.4-3.0) were among the main stressors for all undergraduate students. Fourth year students added "completing graduation requirements" as another important stressor (mean=3.4). At the end of the year, "examination and grades" were constantly the primary source of stress for all students (mean range= 3.1-3.4). Clinical students also reported "completing graduation requirements" (mean range=2.9-3.0) and shared the residents concern about "financial responsibilities" (mean range=2.8-2.9) and "responsibilities of comprehensive patient care" (mean range= 2.4-2.8).

When assessing the most important sources of stress each month over the year we identified one additional theme that emerged from coding

the open-ended questions, mainly from 4th year students and residents, which was "concern about future planning". Based on frequency distribution of those stressors we found that sources of stress varied depending on the time of the year, even though all students reported "examination and grades", and "workload" throughout the year. In particular clinical students mentioned "patient treatment", and residents and 4th year students reported concerns about their future plans towards the end of their academic year (Table 3).

When examining the difference in sources of stress as indicated by DES factors at T1 and T2, there was a significant increase in stress ratings over time for "workload" category in 4th year students [t (14)= -2.2, $P<0.05$]. Also, in the third year cohort, there was also a significant increase in stress levels for "patient treatment" factor [t (19)= -2.3, $P<0.05$] and a significant decrease related to "personal factors" over the year [z=2.2, $P<0.05$]. While comparison of DES factors across years of study revealed no significant differences at the second evaluation, at the beginning of the year there was a significant difference for "self-efficacy beliefs" [H (4)= 10.6, $P<0.05$] and "patient treatment" factors [F (2,50)=3.7, $P<0.05$] between years of study (Table 4).

Examining with more detail the most important source of stress over the year for each cohort (Table 5) indicated that students in the pre-clinical years (1st and 2nd year) reported examination and grades as the most frequent main stressor (60% and 45.5% respectively). This was confirmed by the qualitative interviews in which participants described the first year as a marathon, characterized by a repetition of stressful exams intersected with short periods of relative calm:

> ST1: "It's the amount that needed to be learned. You had an exam, and then 3 weeks of class, another exam. So it'd sort of be a marathon. So it kind of became a cycle of, relaxation for 1 week, and intense studying for 2 weeks, relaxation sort of for one week, and then intense studying for 2 weeks, and it's like long".

In the third year of the program, which is a transition period to the clinic, students most frequently cited workload (45.5%) as their main stressor. In the qualitative interviews, participants related this finding to the pressure they face from finishing requirements and finding specific patient cases. As one participant explained:

> *ST1:" At the end of the year, we're all trying to finish a lot of stuff. We had to finish all our restorations and there was like an astronomical number of restorations we all had to finish. There's the credits and finishing the credits, it's stressful, granted that, you know you get what you get, if patients don't need a filling, you don't get the root canal, you don't get the crown like, you're not going to finish. And it's not really your fault. So that's stressful… when it's out of your hands".*

Final year students seemed to accumulate the stressors that were reported in pre-clinical years (examination and grades) and in 3rd year (workload) in addition to patient treatment and planning their future. Interviewees expressed how they felt about those stressors and explained the difficulty of balancing all these aspects that increased their stress level, particularly when they were approaching graduation.

> *ST4 "I think it's really the stress of balancing everything, patient coordination, residency applications, exams and studying. October is right around when applications and everything for residency are going on and exams are kind of starting. We also had the Board exams in March so you're thinking about that. Then you're realising that the lab work takes about a month to come back, so its February, you only have 2 months left".*

For residents, workload (72.7%) was the main stressor reported throughout the year. Although during residency there is no pressure of exams or credits, which was a major stressor during undergraduate years, there was a constant stress coming from patient-related responsibilities and managing the clinic.

> *ST5: " There's always something that has to be done, charts to be filled, things to be sent to the lab and you feel like you have many more things to think of, so you're constantly thinking, is there*

something that I've missed, is there something that I should be doing?
So I think it's, kind of like a baseline stress, whereas before it was
more sporadic stress, you know".

DISCUSSION

This is the first study that used both quantitative and qualitative data to identify sources of stress in undergraduate dental students and first year general practice residents longitudinally over-time. Our results illustrate that causes of stress vary with the stage of the program they are in (i.e. which year) and with time during each academic year. In addition, the findings confirm the heavy demand of the program demonstrated by the constant occurrence of workload stressor over the years.

In our study, the most frequently reported main stressors cumulatively over the year for students in preclinical years were related to workload, and examination and grades. Students in clinical years added patient treatment as another stressor. Residents and fourth year students were also concerned about their future planning. This may reflect the structure of the curriculum at McGill, where the first two years are mainly theoretical and preclinical training and patient contact largely starts in third year. Furthermore, personal factors were always a concern for all participants such as family and relationship problems that may be caused by difficulty of balancing career and personal life. Similar sources of stress were identified by previous cross-sectional studies that also used the DES. Examination and grades were the main stressor reported among Australian[13] and Indian dental students[12]. In Jordan and the US, patient treatment was also among the highly ranked stressors by clinical students[14, 15].

In addition, comparison of DES factors between the two evaluation-points in December and April indicated that two stressors increased

overtime: "workload" increased among 4th year students as they approached the end of the academic year, when they are expected to complete their credits before graduation; besides "patient treatment" factor increased significantly among 3rd year students, who transition to the clinic at this stage at McGill. We also need to mention that we observed a decrease in stress level for "personal factors" in 3rd year over-time.

Comparison of DES factor mean scores by year of study revealed that 4th year students were significantly more stressed about "patient treatment" in comparison to residents. This could be explained by the lack of credit-pressure during residency to complete certain numbers and types of clinical cases. Additionally, we found that 3rd and 4th year students had significantly higher scores for the "self-efficacy beliefs" factor as a stressor than residents; this reflects the increase in confidence among students once they graduate and become residents. This was also consistent with the findings of Polychronopoulou et al that undergraduate dental student concerns about self-efficacy tended to decrease as students progressed in the program[16].

When comparing our findings with the previous literature, we were limited due to the lack of longitudinal data investigating changes in sources of stress throughout the year. Another longitudinal study demonstrated variation of sources of stress across the curriculum using DES. Preclinical students were more likely to report the amount and difficulty of class work as their main stressors and clinical students were more likely to be concerned about neglect of personal life [4]. However, although in this study the same cohort of Greek dental students were followed throughout the five-year program, students were only surveyed yearly which did not permit evaluation of changes in sources of stress within the year.

The main limitation of our study is the generalizability of its findings since it is based on a relatively small population of one Canadian

dental school. Nevertheless our findings support previous literature exploring stress in other dental schools. In addition, although generally the study had a good response rate, the monthly response varied with relatively low rates during the summer holidays.

CONCLUSION

Using a mixed methods approach, this study suggests that sources of stress in undergraduate dental students vary depending on their year in the program and time during the year. Examination and grades, and workload are the main sources of stress for dental students in the pre-clinical years. Clinical students added patient treatment and final year students and the residents had additional concerns about their future plans. Further research needs to investigate factors like personality traits that could influence perception of stress and how stress impacts the behavior and performance of students and residents as both trainees and health care professionals. In addition, knowledge about the main sources of stress experienced by students and residents could be used by dental schools to develop interventions to reduce stress and to educate students on how to deal and cope with the anticipated pressure of workload and patient management that are inevitable part of their learning experience and future careers.

REFERENCES

1.   Pau AKH, Croucher R. Emotional intelligence and perceived stress in dental undergraduates. Journal of Dental Education 2003;67(9):1023-8.

2.   Gorter R, Freeman R, Hammen S, Murtomaa H, Blinkhorn A, Humphris G. Psychological stress and health in undergraduate dental students: fifth year outcomes compared with first year baseline results from five European dental schools. European Journal of Dental Education 2008;12(2):61-8.

3.   Humphris G, Blinkhorn A, Freeman R, Gorter R, Hoad-Reddick G, Murtomaa H, et al. Psychological stress in undergraduate dental students: baseline results from seven European dental schools. European Journal of Dental Education 2002;6(1):22-9.

4.   Polychronopoulou A, Divaris K. A longitudinal study of Greek dental students' perceived sources of stress. Journal of Dental Education 2010;74(5):524-30.

5.   Acharya S. Factors affecting stress among Indian dental students. Journal of Dental Education 2003;67(10):1140-8.

6.   Morse Z, Dravo U. Stress levels of dental students at the Fiji School of Medicine. European Journal of Dental Education 2007;11(2):99-103.

7.   Yap AU, Bhole S, Teo CS. A cross-cultural comparison of perceived sources of stress in the dental school environment. Journal of Dental Education 1996;60(5):459-64.

8.   Dahan H, Bedos C. A typology of dental students according to their experience of stress: a qualitative study. Journal of Dental Education 2010;74(2):95-103.

9.   Garbee WH, Jr. Sources of stress in the dental school environment. LDA journal 1981;39(4):9-14.

10. Silverstein ST, Kritz-Silverstein D. A longitudinal study of stress in first-year dental students. Journal of Dental Education 2010;74(8):836-48.

11. Sugiura G, Shinada K, Kawaguchi Y. Psychological well-being and perceptions of stress amongst Japanese dental students. European Journal of Dental Education 2005;9(1):17-25.

12. Kumar S, Dagli RJ, Mathur A, Jain M, Prabu D, Kulkarni S. Perceived sources of stress amongst Indian dental students. European Journal of Dental Education 2009;13(1):39-45.

13. Sanders AE, Lushington K. Sources of stress for Australian dental students. Journal of Dental Education 1999;63 (9):688-97.

14. Westerman GH, Grandy TG, Ocanto RA, Erskine CG. Perceived sources of stress in the dental school environment. Journal of Dental Education 1993;57(3):225-31.

15. Rajab LD. Perceived sources of stress among dental students at the University of Jordan. Journal of Dental Education 2001;65(3):232-41.

16. Polychronopoulou A, Divaris K. Dental students' perceived sources of stress: a multi-country study. Journal of Dental Education 2009;73(5):631-9.

Table 1: Mean and standard deviations for the six highest ranked stressors from DES at T1 (end of first semester)

Rank	Pre-Clinical years		Clinical years		Residents (N=11)
	1st year (N=21)	2nd year (N=24)	3rd year (N=24)	4th year (N=20)	
1	Examination and grades 3.0±1.1	Amount of assigned class work 3.0 ±0.8	Examination and grades 3.3 ±1.0	Completing graduation requirements 3.4 ±0.8	Financial responsibilities 2.9 ±0.9
2	Lack of time for relaxation 2.8 ±1.1	Examination and grades 2.9 ±0.9	Lack of time for relaxation 3.2 ±0.7	Examination and grades 3.0±0.8 Lack of time for relaxation 3.0±1.0 Insecurity concerning professional future 3.0±1.0 Financial responsibilities 3.0±1.1	Lack of time for relaxation 2.8 ±1.0
3	Financial responsibilities 2.7± 1.1	Lack of time to do assigned school work 2.8 ±0.9	Financial responsibilities 2.9 ±1.2	Responsibilities of comprehensive patient care 2.9±1.0	Responsibilities of comprehensive patient care 2.5 ±0.9
4	Amount of assigned class work 2.6 ±1.2 Fear of being unable to catch up if behind 2.6 ±1.1	Difficulty of class work 2.5 ±0.8 Financial responsibilities 2.5±1.2	Competition for grades 2.8 ±1.1	Patients being late or not showing for their appointments 2.8 ±1.0 Lack of confidence in self to be a successful dentist 2.8 ±1.2	Receiving criticism about work 2.4 ±0.9
5	Difficulty of class work 2.5 ±1.0	Lack of time for relaxation 2.4 ±1.0	Fear of being unable to catch up if behind 2.7±1.0 Completing graduation requirements 2.7±1.0	Fear of being unable to catch up if behind 2.6 ±1.0	Lack of time to do assigned school work 2.3±0.9
6	Fear of failing course or year 2.4 ±1.1 Insecurity concerning professional future 2.4 ±1.1	Fear of being unable to catch up if behind 2.3 ±0.9	Amount of assigned class work 2.6±1.0 Responsibilities of comprehensive patient care 2.6 ±1.1 Lack of time to do assigned school work 2.6 ±0.9 Personal physical health 2.6±0.9	Personal physical health 2.5 ±1.1 Lack of confidence to be a successful dental student 2.5±1.1	Expectations of dental school and what in reality it is like 2.2 ±1.2 Insecurity concerning professional future 2.2 ±0.9

Table 2: Mean and standard deviations for the six highest ranked stressors from DES at T2 (end of second semester)

Rank	Pre-Clinical years		Clinical years		Residents (N=19)
	1st year (N=13)	2nd year (N=35)	3rd year (N=26)	4th year (N=20)	
1	Examination and grades 3.3 ±0.9	Examination and grades 3.1±0.7	Examination and grades 3.4±0.8	Examination and grades 3.1±0.9	Financial responsibilities 2.8±0.9
2	Amount of assigned class work 2.8 ±1.0	Amount of assigned class work 2.9 ±0.9	Completing graduation requirements 2.9±1.1 Patients being late or not showing for their appointments 2.9 ±1.1	Completing graduation requirements 3.0±1.1	Lack of time for relaxation 2.6 ±0.9
3	Lack of time for relaxation 2.6 ±1.0	Lack of time for relaxation 2.7±1.0	Amount of assigned class work 2.8 ±0.9 Responsibilities of comprehensive patient care 2.8±0.9	Amount of assigned class work 2.9 ±0.8 Financial responsibilities 2.9±1.2	Responsibilities of comprehensive patient care 2.4±1.0 Lack of time to do assigned school work 2.4 ±1.0
4	Financial responsibilities 2.5±1.1	Difficulty of class work 2.6 ±0.9	Competition for grades 2.7±1.1	Responsibilities of comprehensive patient care 2.8±1.1 Lack of time for relaxation 2.8 ±1.0 Personal physical health 2.8 ±1.1	Patients being late or not showing for their appointments 2.3±0.9 Difficulty in learning clinical procedures 2.3±1.0 Atmosphere created by clinical faculty 2.3±1.1 Insecurity concerning professional future 2.3±1.0 Personal physical health 2.3±1.0
5	Difficulty of class work 2.4 ±0.9	Fear of being unable to catch up if behind 2.5 ±1.0	Financial responsibilities 2.6±1.2	Lack of time to do assigned school work 2.7±1.0	Receiving criticism about work 2.2±1.0 Lack of confidence in self to be a successful dentist 2.2 ±1.0
6	Insecurity concerning professional future 2.3 ±1.0 Lack of time to do assigned school work 2.3 ±1.0	Receiving criticism about work 2.4±0.9 Lack of confidence to be a successful dental student 2.4±1.0 Lack of time to do assigned school work 2.4 ±1.1	Lack of time for relaxation 2.5±0.9 Lack of time to do assigned school work 2.5 ±1.0	Patients being late or not showing for their appointments 2.6 ±1.0	Difficulty in learning precision manual skills 2.1±1.0 Fear of being unable to catch up if behind 2.1±0.8

Table 3: Most important cause of stress at each follow-up month by year of study

	(%)				
	Pre-Clinical years		Clinical years		
	1st year	2nd year	3rd year	4th year	Residents
Oct	Workload (55.6)	Workload (38.1)	Workload (31.6)	Workload (42.1)	Workload / Personal issues (25.0)
Nov	Workload (44.4)	Workload (52.4)	Examination & grades (45.0)	Examination & grades (33.3)	Workload (66.7)
Dec	Examination & grades (70.0)	Personal issues (70.6)	Examination & grades (43.8)	Examination & grades / Personal issues (31.3)	Workload (50.0)
Jan	Examination & grades (62.5)	Examination & grades (80.0)	Personal issues (44.4)	Workload (36.8)	Workload / Patient treatment (41.7)
Feb	Personal issues (38.9)	Personal issues (35.3)	Workload (38.9)	Examination & grades (93.3)	Workload (43.8)
Mar	Examination & grades (37.5)	Examination & grades (66.7)	Workload / Patient treatment (28.6)	Future planning / Patient treatment (27.8)	Workload (40.0)
Apr	Examination & grades (44.4)	Workload (37.5)	Workload / Personal issues (37.5)	Workload (46.7)	Patient treatment (50.0)
May	Examination & grades (44.4)	Examination & grades (70.0)	Examination & grades (50.0)	Future planning / Personal issues (50.0)	Workload (53.9)
Jun	Examination & grades (83.3)	Examination & grades (55.0)	Personal issues (50.0)		Workload / Future planning (50.0)
Jul		Examination & grades (58.3)	Workload (33.3)		Future planning / Patient treatment (50.0)
Aug	Personal issues (50.0)	Workload (28.6)	Relationship with professors and staff (40.9)	Patient treatment / Future planning (40.0)	Patient treatment (100.0)

Table 4: Mean and standard deviations for DES factors by year of study at T1 (end of 1st semester) and T2 (end of 2nd semester)

	T1						T2					
	1st year	2nd year	3rd year	4th year	Residents	P-value Year	1st year	2nd year	3rd year	4th year	Residents	P-value Year
1. Self-efficacy beliefs	2.2±0.8	2.0±0.8	2.3±0.8	2.6±0.8	1.8±0.6	0.03[*2]	1.8±0.6	2.2±0.7	2.2±0.7	2.1±0.8	2.0±0.8	NS[2]
2. Faculty and administration	1.7±0.6	1.7±0.6	1.9±0.5	2.0±0.6	1.8±0.6	NS[2]	1.6±0.6	1.9±0.7	1.9±0.5	1.9±0.7	1.9±0.7	NS[2]
3. Workload	2.6±0.9	2.5±0.9	2.7±0.6	2.4±0.7[**a]	2.6±0.8	NS[1]	2.5±0.7	2.6±0.8	2.5±0.7	2.6±0.6[**a]	2.5±0.8	NS[1]
4. Personal factors	1.9±0.5	1.8±0.7	2.1±0.5[**b]	2.2±0.5	1.9±0.6	NS[2]	1.9±0.7	1.9±0.7	1.8±0.6[**b]	2.1±0.7	2.1±0.6	NS[2]
5. Performance pressure	2.6±1.1	2.5±1.0	3.0±0.9	2.6±0.8		NS[1]	2.7±0.8	2.7±0.8	3.0±0.9	2.6±0.8		NS[1]
6. Patient treatment			2.0±0.6[**a]	2.3±0.6	1.8±0.4	0.03[*1]			2.3±0.6[**a]	2.3±0.7	2.1±0.7	NS[1]
7. Preclinical and clinical training			2.3±0.9	2.1±0.8	2.0±0.9	NS[1]		2.3±0.9	2.0±0.8	1.9±0.7	2.2±1.0	NS[1]

NB: Comparison between years of study based on [1] ANOVA, [2] Kruskal-Wallis tests.

*Significance post-hoc tests for "self-efficacy" (4>2,3>5,4>5) and for "patient treatment" (4>5) factors.

**Significance difference between two evaluations time, based on [a] paired t-test and [b] Wilcoxon signed rank test.

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Table 5: Most frequently reported cause of stress over the year

Rank	Ranking by class (%)				
	Pre-Clinical years		Clinical years		
	1st year	2nd year	3rd year	4th year	Residents
1	Examination & grades	Examination & grades	Workload	Examination & grades	Workload
				Workload	
				Future planning	
	(60)	(45.5)	(45.5)	(33.3)	(72.7)
2	Personal issues	Workload	Personal issues	Personal issues	Patient treatment
	Workload		Examination & grades	Patient treatment	
	(20)	(36.4)	(27.3)	(22.2)	(36.4)
3		Personal issues	Patient treatment		Future planning
			Relationship with professors and staff		
		(18.2)	(9.1)		(18.2)
4					Personal issues
					(9.1)

3.2.1 Summary of results from manuscript III investigating sources of stress in dental students

In manuscript III we explained our second research objective that is to describe sources of stress, in undergraduate dental students and 1st year residents, and to understand how these sources evolve during the 4-year curriculum and in their first year after graduation. Our findings, using mixed methods data, illustrated the variations in sources of stress across the different years in the program. Although most students are mainly stressed from the heavy demand of their training, clinical students had additional concerns regarding dealing with their patients and graduating students and residents were worried about their future plans. Furthermore, using statistical analyses we demonstrated that causes of stress also varies over the year (results of factor analysis for the DES presented in Appendix IV).

These findings suggest that students experience different stress levels according to the type of stressors they encounter at each stage of the curriculum. Although we are not suggesting eliminating basic elements of dental training, that is perceived as stressors by students such as patient treatment; we propose that students need to learn how to manage and deal with those stressors that are fundamental part of their training and future practice.

3.3 Manuscript IV: "Stress and Well-being in Dental Students: A Mixed Methods Investigation"

Abstract

Objective: The aim of this study was to better understand the consequences of stress on undergraduate dental students' and first year residents' well-being in a Canadian University using a mixed methods approach. **Methods:** We collected quantitative data once every month from participants for a period of one year. Information about study outcomes, stress levels and the impact of that stress, were collected using a Visual Analogue Scale. In addition, we collected other information regarding participants' stress-related symptoms, smoking, alcohol dinking and physical activity. At the end of the quantitative phase of the study, we also collected qualitative data using semi-structured, one-on-one interviews. **Results:** High stress levels were significantly associated with students' gender (β=5.6, 95% CI=1.0,10.2), age (β=1.0, 95% CI=0.2,1.8) and year of study (for 4th year β=10.4, 95% CI=3.0,17.9), with female, older and more advanced students experiencing higher stress levels than male, younger and less advanced students. In addition, quantitative and qualitative data demonstrated an association between students' stress-related symptoms, alcohol drinking habits and their stress levels. **Conclusions:** Findings from this study indicate that elevated stress levels experienced by students in their undergraduate dental education had a negative impact on their health and psychological well-being.

Key words: Psychological stress; dental education, dental students, longitudinal studies

INTRODUCTION

Prolonged stress can result in detrimental consequences on health and well-being [1, 2]. Considering the high stress levels documented in undergraduate dental students, there is a growing concern about the mental and physical health consequences of that stress. Previous investigations demonstrated that burnout, depression, poor self-esteem and maladaptive coping are among the psychological effects of stress in dental students [3-7]. Changes in life style behaviors such as alcohol drinking and smoking were also related to students' stress [8, 9]. In addition, it has been shown that highly stressed dental students more frequently report health consequences that range from fatigue to severe digestive problems [7, 10]. Therefore, in attempt to recognize high-risk individuals, many studies identified variables that could predict stress in dental students such as gender, general well-being and whether dentistry was the first choice of program admission [11, 12]. Although evidence from previous investigations suggests a negative effect of high stress levels on dental students, variations in those consequences through the curriculum remain unclear. In addition, very little research has used qualitative methodologies to better understand the effect of stress on students' quality of life and learning experience, which could complement previous quantitative findings.

We aimed to build on this previous research in the literature by conducting a longitudinal mixed methods study; we investigated stress in undergraduate dental students and general practice residents over 1 year, based on monthly quantitative evaluations followed by a series of qualitative interviews at the end of the study. In a previous publication, we demonstrated variations in stress levels and sources of that stress depending on students' year in the program and time of the year. The objective of the work reported in this article was to better understand the consequences of stress on undergraduate dental students' and first year residents' well-being and to assess the health-related and sociodemographic factors associated with stress.

METHODS

Participants and data collection

We used a mixed methods design with a sequential explanatory approach [13]. This design consisted of two phases; it started with a longitudinal quantitative component followed by a qualitative part that provided in-depth understanding of the quantitative findings. For the quantitative phase, all undergraduate dental students registered in McGill University's D.M.D program and first year dental residents (GPR) at the same institution were invited to participate in the study. McGill's 4-year D.M.D program consists of two preclinical and two clinical years. We collected monthly data from participants for a period of 1 year starting in September 2010. We used questionnaires delivered in class and online to collect data from participants. After completion of the quantitative phase we sent email invitations to the recently graduating class (4th year) to be interviewed for the qualitative phase of the study. Interviews for this qualitative phase were one-on-one, semi-structured; we conducted them in a location outside McGill Faculty of Dentistry or through Skype for participants who were located outside the city. Each interview, which lasted between 45-60 minutes, was audio-taped for the purpose of the analysis. Ethical approval from the Institutional Review Board of McGill University, Faculty of Medicine was obtained before the start of data collection. In addition, participants signed a consent form before enrolling in both phases of the study. All participants were assured that their participation was voluntary and that data would remain anonymous.

Data collection instruments

Each month we collected data about the study outcomes, the stress level and the impact of that stress. In addition, we collected monthly information about participants' stress-related symptoms and behavioral characteristic's (physical activity, smoking and alcohol drinking). We used a Visual Analogue Scale (VAS) to assess stress levels and the impact of that stress on participants. The VAS is a 100-millimeter line

with two ends indicating the extremes of the outcome examined [14]. For evaluating stress levels, the two anchoring responses were "Not at all stressed" and "Extremely stressed". For evaluating the impact of stress, the two end-points were "Not at all" affected and "Too much" affected. The VAS has been shown to be a reliable and valid tool to evaluate subjective experiences in studies of different phenomena such as depression and pain [15, 16]. Questions about stress-related symptoms were adapted from Stecker et al [17] and they included students' feelings, appetite, sleeping habits, weight changes and problems in concentration. Finally, for assessing physical activity, we used the Godin Leisure-Time Exercise Questionnaire (GLTEQ) that measures the frequency of strenuous, moderate and mild exercise for more than 15 minutes during a week [18]. A total leisure activity score can be calculated by multiplying the weekly frequencies by nine, five and three metabolic equivalents (METs) and according to established cut-offs; males are considered physically active if they consumed 38 METs/week and females if they used 35 METs/week [19, 20].

In addition to that, we collected information at baseline about participants' sociodemographic characteristics (age, gender, living arrangements, marital status, having children, resident status and part time job) and dentistry-related characteristics (year of study, first choice of admission, predental education).

For the qualitative phase, we used the results of the first quantitative phase to facilitate the interviews: we showed participants graphic and tabular representation of the results and invited them to react and comment on them. We also used an interview guide with questions that explored the consequences of stress on students throughout the years of the curriculum. Examples of questions asked of participants were; "how did you feel during the high stress period" and "how did stress affect your life or learning experience?" Additional probing questions were posed in response to participant's answers.

Analyses

In the quantitative phase, we conducted preliminary analyses using mean and frequency distributions to describe study variables. To describe changes in stress levels and the impact of that stress over-time, we plotted graphically the monthly VAS scores for each of those outcomes. To test the association between stress-related symptoms, behavioral characteristics and stress level we used a subject-specific (random effects) modeling approach [21]. We fitted the mixed model with stress level, as the dependent variable, random intercept for students and random slope for year of study. Our choice for the random intercept and the random slope variables was based on theoretical considerations, covariance parameter estimates and best model fit. Predictor covariates entered in the model were based on previous literature and guided by our bivariate analyses. We reduced the model using a backward elimination technique and we specified the covariance structure to be autoregressive first order to account for the repeated measurements on the same participants overtime. STATA statistical package version 11.0 was used for the data analysis [22].

In the qualitative phase, after each interview, we transcribed the data verbatim then assigned codes to segments of the transcripts. We generated an initial list of codes inductively (i.e. based on available data) and later modified this throughout the coding process. Finally we grouped similar codes into broader themes and created matrices to illustrate and describe the findings. Another research team member revised the codes and themes to validate the final interpretations.

RESULTS

The overall study response rate for the first (quantitative) phase ranged from 50-82%, ignoring the summer holiday when response rates were low. Participants' characteristics are presented in Table 1: The mean age was 24.4 years; most participants were female (63.4%), single (61.3%), and had a Bachelors degree before starting dentistry (62%).

After completing the quantitative phase, in September 2011, we interviewed 6 participants (4 females and 2 males) that were residents at the time and had been participating 4th year students during the quantitative phase of the project

Examining mean stress levels and the impact of stress over-time showed that high stress peaks coincided with high impact periods. First year students demonstrated their highest stress level (mean= 59 on a 0-100 scale) and impact (mean= 53 on a 0-100 scale) in January. Second year students also reported their highest stress peak in January (mean=66) but the highest impact was in June (62.9), which corresponded to another stress peak. With respect to third year students, October was the month with highest stress (mean=66.8) and impact (61.6) level, whereas fourth year students experienced their highest peak for stress (84.4) and impact (76.4) in February. Residents, who showed the lowest levels of stress of the 5 cohorts, reported their highest stress (55.2) and impact levels (50.5) in May (Figure 1).

Table 2 demonstrates participants' exercise, alcohol consumption and smoking behaviors, plus other potentially stress-related signs and symptoms at peak stress periods. Overall, in our sample the prevalence of smoking was very low, and based on the recognized cut-offs values, participants could be considered to be engaged in a good level of physical activity, with 3rd year and residents showing levels slightly below those values. In addition, most participants reported not drinking alcohol during high stress periods. This finding was clarified during the qualitative interviews when participants mentioned how they felt socially isolated; they explained that they had to "cut" family and friends from their lives, mainly due to lack of time and fatigue, and this situation may have reduced their social drinking occasions.

> St1: "I think I was just tired and I felt pretty worked out. I'd go home, make lunch and dinner for the next day, go to sleep, go back to school. I just felt it sort of wasn't really ending. And definitely that

really did affect sort of my time to do stuff regularly like go to the gym or see friends for sure".

ST4: "Stress really did affect my daily life. I remember I didn't get the chance to see as many as my out of school friends and everything like that because I was just so busy. And in times when I was stressed, I would cut my friends and my family out which affected me a lot in a really bad way".

Regarding stress-related signs and symptoms at the peak stress periods, the highest prevalence of feeling sad occurred among first year students (20.8%). Third year students reported the highest prevalence for appetite change (30.8%), and fourth year students demonstrated the highest prevalence for weight change (22.2%), difficulty sleeping (38.9%) and trouble concentrating (33.3%). These findings were confirmed and further explained during the qualitative interviews. Participants indeed described how they felt emotionally exhausted and sometimes desperate from the stress they faced. They also mentioned being sad and upset as a result of that stress.

ST1: " I think I was just like tired and almost sad about it. And, I don't know, I can't really explain it. I was just like really tired and upset for a long time. I mean not like physically exhausted, but had enough. I just really wanted to stop, I think that had a big effect on me too".

ST3: "The stress I experienced was something I was uncomfortable with and it bothered me. It was so mentally draining. I do remember like literally sitting and wanting to pull my hair out and just being to the point that I was so miserable that I regretted going into it. But I never wanted to quit".

ST4: "Fourth year I very much seriously considered not doing dentistry anymore, because it wasn't fun and I didn't enjoy it anymore because of all the stress…because I was very close to not wanting to continue or not wanting to finish".

In addition, participants reported being physically tired and exhausted from their demanding work. They explained that stress and lack of personal time prevented them from engaging in extracurricular activity like going to the gym, this had a negative impact on their physical activity, and added to the fact that stress affected their appetite and their diet, which lead to substantial changes in their weight. Moreover, participants mentioned how stress affected their sleep, which in turn decreased their ability to study and perform well.

> ST2: " Sleep issues for me are the worst thing. That's how the stress impacts me. Stress affects my sleep and that's a big problem cause it's a vicious cycle. If I'm stressed I have trouble sleeping. If I have trouble sleeping I'm going to be more tired the next day. It's awful ".

> ST3: "I also found the work extremely exhausting. I lost 14 pounds, which is insane. I wasn't exercising there was no time. I didn't have the energy and I wasn't eating properly. I became so nervous that I wasn't eating. I was just really a mess".

> ST4: "I lost a lot of sleep because I'm the type that worries about things. So I'd come home and I'd be thinking I hope that patient shows up, I hope the lab work comes in, I hope it goes okay. It just kind of cycled to the point where I couldn't get over it. I definitely gained weight too. I think it's because in second year we spend a lot of time in the pre-clinic and it's very sedentary. So I remember that I felt so stressed and that just kind of locks you to your chair. So you're not moving as much and you're eating a lot of junk food to kind of cope and it's just a bad combination".

> ST5: "If you look in terms of physical activity, I felt that as soon as I started working with patients and working in the dental lab, I started doing a lot less exercise. I think that did take a toll on me because I used to be someone who's very active, so I felt a little bit more tired all the time, it was probably one of the things that I did notice".

Moreover, the results of the linear mixed model indicated that several variables were significantly associated with stress level (Table 3). Older

age (β=1.0, 95% CI=0.19,1.83) of participants and female gender (β=5.6, 95% CI=1.0,10.2) were associated with increased stress levels. In addition, year of study was significantly related to stress. Following a subject specific interpretation of the estimates, a participant in fourth year would have on average a stress level 10.4 points higher than if the same person was in 1st year. Similarly a participant reporting feeling sad, experiencing changes in appetite, difficulty sleeping or trouble concentration on average would have an increase in stress level of 12.0, 4.7, 8.1 and 10.3 points respectively. On the other hand, time of the year (December which is a Christmas holiday) was associated with decline in stress level (β=-13,8, 95% CI=-19.2, -8.3). Finally, alcohol drinking habits was also associated with lower stress levels, where estimates indicated that if the same participant consumes more than 6 drinks in an occasion, versus not drinking, would have an average decline of 13 points in stress level.

DISCUSSION

Our study demonstrates the impact of stress on undergraduate dental students. Using quantitative analyses, we found an association between students' stress levels and various stress-related signs and symptoms and behaviors. These findings were further clarified by the qualitative data, which clearly illustrated the negative consequences of stress on students' overall well-being.

Our longitudinal observations of stress levels and the impact of that stress indicated that participants demonstrated similar patterns of stress and impact levels. This may suggest the direct influence of stress on students. Moreover, our results from the quantitative and qualitative analysis showed that stress level was associated with participants' psychological well-being and their stress-related signs and symptoms. We found an association between participants' negative feelings, difficulty sleeping, appetite changes, problems in concentration and their stress level. During the interviews, participants

described the effects of stress on their physical and emotional health. They mentioned that they frequently could not sleep due to stress and thinking about their responsibilities, particularly those related to patient care. In addition, they related the stress experienced to changes in their appetite and also to weight changes. Participants also emphasized the social consequences of stress, which prevented them from spending time with family and friends. On the other hand, we found a protective association between drinking habits and stress levels. Particularly we noted those participants who drank alcohol tended to report less stress levels. Although no previous association has been reported in the literature in regards to dental students stress and alcohol drinking, it has been shown that dental undergraduate students frequently engage in binge drinking habits [8, 23]. Another explanation could be that stressed students lack time to go out and socialize and thus drink less so that stress is the cause rather than the effect.

The physical and emotional impacts of stress identified in our study are consistent with the previous literature [24]. In a longitudinal study among first year dental students, Silverstein et al also reported that in their sample, lack of sleep, over-eating, difficulty concentrating and feeling down were associated with students' stress levels [10]. In addition, a qualitative study demonstrated that highly stressed dental students reported physical symptoms, burnout, depression and lack of social time as an impact of stress [7].

We also found an association between participants' sociodemographic characteristics (age, gender) and year of study and their stress levels. Female students tended to report higher stress levels. Similar gender differences in perception of stress were also reported by previous studies in Japan, Australia and Greece [11, 25, 26]. These differences were related to the tendency of females to express and report their emotions in comparison to males [12]. In addition, year of study was associated with stress level. This may be explained by the nature of various

stressors students experienced at different stages of the curriculum such as learning the manual skills, transition to the clinic and exams and grades [7, 25, 27].

This study has a number of limitations. It is based on relatively small sample size from one Canadian dental school, which limits generalizability of its findings. In addition, concerns about instruments used to assess the study outcomes need to be considered. We used the VAS to measure stress levels and the impact of that stress, which was not validated previously in this particular context, although it has been used and validated in many very similar settings [16]. Finally, although this is a longitudinal investigation, it is difficult to conclude whether the factors associated with stress levels that we have labeled as "impacts" are in fact consequences or causes of stress, since both the stress and the "impact" were measured at the same time. In this sense, while the study is longitudinal in design, the evaluation of associations is essentially a series of sequential cross-sectional studies. Nevertheless, we were able to explain those findings using the qualitative data that implied those factors associated with stress might be consequences of stress. However, further longitudinal research is still required to confirm those interpretations.

CONCLUSION

Although certain levels of stress could be motivating for better performance, elevated levels could have negative consequences. Our study suggests that high stress levels are associated with negative psychological and health consequences in undergraduate dental students. We identified variables that were significantly associated with stress that might predict vulnerable students. In addition, our results provide a comparison between residents and students reaction to the stress experienced in the dental environment. Residents constantly reported fewer consequences. These findings could benefit dental faculties to better understand how students perceive and react to the

stress they experience during their undergraduate dental training. In addition, this information could be used to identify students who are more susceptible to that stress so that proper support and attention could be directed to them.

REFERENCES

1.   Stansfeld SA, Fuhrer R, Shipley MJ, Marmot MG. Psychological distress as a risk factor for coronary heart disease in the Whitehall II Study. Int J Epidemiol 2002;31(1):248-55.

2.   Olff M. Stress, depression and immunity: the role of defense and coping styles. Psychiatry Res 1999;85(1):7-15.

3.   Pohlmann K, Jonas I, Ruf S, Harzer W. Stress, burnout and health in the clinical period of dental education. European Journal of Dental Education 2005;9(2):78-84.

4.   Gorter R, Freeman R, Hammen S, Murtomaa H, Blinkhorn A, Humphris G. Psychological stress and health in undergraduate dental students: fifth year outcomes compared with first year baseline results from five European dental schools. European Journal of Dental Education 2008;12(2):61-8.

5.   Laurence B, Williams C, Eiland D. Depressive symptoms, stress, and social support among dental students at a historically black college and university. Journal of American College Health 2009;58(1):56-63.

6.   Stewart DW, de Vries J, Singer DL, Degen GG, Wener P. Canadian dental students' perceptions of their learning environment and psychological functioning over time. Journal of Dental Education 2006;70(9):972-81.

7.   Dahan H, Bedos C. A typology of dental students according to their experience of stress: a qualitative study. Journal of Dental Education 2010;74(2):95-103.

8.   Newbury-Birch D, Lowry RJ, Kamali F. The changing patterns of drinking, illicit drug use, stress, anxiety and depression in dental students in a UK dental school: a longitudinal study. British Dental Journal 2002;192(11):646-9.

9.   Gordon NA, Rayner CA. Smoking practices of dental and oral health students at the University of the Western Cape. SADJ 2010;65(7):304-8.

10.   Silverstein ST, Kritz-Silverstein D. A longitudinal study of stress in first-year dental students. Journal of Dental Education 2010;74(8):836-48.

11.   Sugiura G, Shinada K, Kawaguchi Y. Psychological well-being and perceptions of stress amongst Japanese dental students. European Journal of Dental Education 2005;9(1):17-25.

12.   Pau A, Rowland ML, Naidoo S, AbdulKadir R, Makrynika E, Moraru R, et al. Emotional intelligence and perceived stress in

dental undergraduates: a multinational survey. Journal of Dental Education 2007;71(2):197-204.

13. Creswell J, W, Plano Clark V, L. Designing and conducting Mixed Methods Research. ed. California: Sage Publications, Inc; 2007.

14. Aitken RC. Measurement of feelings using visual analogue scales. Proc R Soc Med 1969;62(10):989-93.

15. Zealley AK, Aitken RC. Measurement of mood. Proc R Soc Med 1969;62(10):993-6.

16. Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. Pain 1983;17(1):45-56.

17. Stecker T. Well-being in an academic environment. Med Educ 2004;38(5):465-78.

18. Godin G, Shephard RJ. A simple method to assess exercise behavior in the community. Can J Appl Sport Sci 1985;10(3):141-6.

19. Garcia Bengoechea E, Spence JC, McGannon KR. Gender differences in perceived environmental correlates of physical activity. Int J Behav Nutr Phys Act 2005;2:12.

20. Jacobs DR, Jr., Ainsworth BE, Hartman TJ, Leon AS. A simultaneous evaluation of 10 commonly used physical activity questionnaires. Med Sci Sports Exerc 1993;25(1):81-91.

21. Laird NM, Ware JH. Random-effects models for longitudinal data. Biometrics 1982;38(4):963-74.

22. StataCorp. Stata Statistical Software: Release 11: College Station, TX: StataCorp LP.; 2009.

23. Underwood B, Fox K. A survey of alcohol and drug use among UK based dental undergraduates. Br Dent J 2000;189(6):314-7.

24. George JM, Whitworth DE, Sturdevant JR, Lundeen TF. Correlates of dental student stress. Journal of Dental Education 1987;51(8):481-5.

25. Sanders AE, Lushington K. Sources of stress for Australian dental students. Journal of Dental Education 1999;63 (9):688-97.

26. Polychronopoulou A, Divaris K. Perceived sources of stress among Greek dental students. Journal of Dental Education 2005;69(6):687-92.

27. Acharya S. Factors affecting stress among Indian dental students. Journal of Dental Education 2003;67(10):1140-8.

Table 1: Demographic Characteristics of the sample for the quantitative phase of the study

|	N (%)					
	Total	**1st year**	**2nd year**	**3rd year**	**4th year**	**Residents**
Sample size	**142**	33	35	29	25	20
Age						
Mean (SD)	**24.4 (3.1)**	22.7 (3.2)	23.9 (2.4)	25.8 (3.9)	25.5 (2.6)	24.7 (1.2)
	20-36	20-36	21-31	21-36	23-33	23-27
Gender						
Female	**90 (63.4)**	19 (57.6)	21 (60.0)	20 (69.0)	17 (68.0)	13 (65.0)
Male	**52 (36.6)**	14 (42.4)	14 (40.0)	9 (31.0)	8 (32.0)	7 (35.0)
Living arrangements						
Alone	**45 (31.9)**	5 (15.2)	15 (42.9)	14 (48.3)	9 (36.0)	2 (10.5)
With friend/s	**13 (9.2)**	5 (15.2)	3 (8.6)	1 (3.5)	1 (4.0)	3 (15.8)
With partner	**23 (16.3)**	4 (12.1)	4 (11.4)	5 (17.2)	5 (20.0)	5 (26.3)
With relative/s	**60 (42.6)**	19 (57.6)	13 (37.1)	9 (31.0)	10 (40.0)	9 (47.4)
Student status						
Resident	**131 (92.3)**	32 (97.0)	33 (94.3)	24 (82.8)	23 (92.0)	19 (95.0)
International	**11 (7.8)**	1 (3.0)	2 (5.7)	5 (17.2)	2 (8.0)	1 (5.0)
Marital status						
Single	**87 (61.3)**	20 (60.6)	26 (74.3)	17 (58.6)	13 (52.0)	11 (55.0)
Have a partner	**46 (32.4)**	11 (33.3)	6 (17.1)	10 (34.5)	11 (44.0)	8 (40.0)
Married	**9 (6.3)**	2 (6.1)	3 (8.6)	2 (6.9)	1 (4.0)	1 (5.0)
Have children						
No	**140 (98.6)**	32 (97.0)	35 (100.0)	28 (96.6)	25 (100.0)	20 (100.0)
Yes	**2 (1.4)**	1 (3.0)	0 (0.0)	1 (3.5)	0 (0.0)	0 (0.0)
First choice of admission						
Dentistry	**137 (96.5)**	33 (100.0)	34 (97.1)	29 (100.0)	23 (92.0)	18 (90.0)
Other	**5 (3.5)**	0 (0.0)	1 (2.9)	0 (0.0)	2 (8.0)	2 (10.0)
Previous education						
College	**33 (23.2)**	9 (27.3)	7 (20.0)	7 (24.1)	7 (28.0)	3 (15.0)
Bachelor	**88 (62.0)**	19 (57.6)	23 (65.7)	16 (55.2)	14 (56.0)	16 (80.0)
Master	**20 (14.1)**	5 (15.2)	5 (14.3)	6 (20.7)	4 (16.0)	0 (0.0)
PhD	**1 (0.7)**	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.0)
Working status						
Not working	**132 (93.0)**	29 (87.9)	31 (88.6)	28 (96.6)	25 (100.0)	19 (95.0)
Working	**10 (7.0)**	4 (12.1)	4 (11.4)	1 (3.5)	0 (0.0)	1 (5.0)

Table 2: Participants characteristics at highest peak stress periods

Variable	1st year N=24/34	2nd year N=28/35	3rd year N=26/29	4th year N=18/35	Residents N=19/22
Highest stress peak	**Jan**	**Jan**	**Oct**	**Feb**	**May**
	Mean (SD)				
Stress level	59 (23.6)	66.0 (19.6)	66.8 (20.0)	84.4 (14.5)	55.2 (23.3)
Impact level	53 (29.1)	61.1 (21.5)	61.6 (17.9)	76.4 (15.3)	50.5 (24.3)
Total Godin Leisure-Time Exercise	55.6 (54.8)	40.9 (43.5)	27.3 (20.3)	42.1 (125.4)	28.5 (26.9)
	N (%)				
Drinking habit					
None	12 (50.0)	18 (64.3)	8 (30.8)	10 (55.6)	7 (36.8)
1-3 drinks	9 (37.5)	7 (25.0)	8 (30.8)	8 (44.4)	9 (47.4)
4-5 drinks	2 (8.3)	2 (7.1)	5 (19.2)	0	3 (15.8)
More than 6 drinks	1 (4.2)	1 (3.6)	5 (19.2)	0	0
Smoking					
No	23 (95.8)	27 (96.4)	25 (96.2)	18 (100)	19 (100)
Yes	1(4.2)	1 (3.6)	1 (3.9)	0	0
Health-related symptoms					
1. Felt sad, low in spirit or depressed	5 (20.8)	2 (7.1)	5 (19.2)	1 (5.6)	2 (10.5)
2. Appetite was less than or greater than usual	4 (16.7)	4 (14.3)	8 (30.8)	5 (27.8)	1 (5.3)
3. Gained or lost weight without trying	3 (12.5)	2 (7.1)	3 (11.5)	4 (22.2)	0
4. Had difficulty falling asleep	4 (16.7)	8 (28.6)	7 (26.9)	7 (38.9)	3 (15.8)
5. Sleeping too much	3 (12.5)	3 (11.1)	6 (23.1)	4 (22.2)	0
6. Trouble thinking, concentrating or making decisions	7 (29.2)	3 (10.7)	6 (23.1)	6 (33.3)	0
7. Felt hopeless or worthless	2 (8.3)	1 (3.6)	2 (7.7)	1 (5.6)	0

Table 3: Results of linear mixed model of stress level

Variable	Coefficient	Standard error	95% Confidence Interval		P>|z|
			Lower limit	Upper limit	
Intercept	16.54	10.79	-4.60	37.69	0.13
Month					
September	Reference				
October	3.02	2.61	-2.08	8.13	0.25
November	0.58	2.69	-4.69	5.85	0.83
December	-13.76	2.80	-19.24	-8.28	0.00
January	3.40	2.77	-2.02	8.83	0.22
February	2.54	2.70	-2.75	7.83	0.35
March	-0.16	2.75	-5.54	5.22	0.95
April	-2.87	2.86	-8.48	2.73	0.32
May	2.40	2.82	-3.13	7.93	0.40
June	-0.01	3.64	-7.14	7.12	1.0
July	-5.39	3.77	-12.77	2.0	0.15
August	-3.57	3.11	-9.67	2.52	0.25
Age	1.01	0.42	0.19	1.83	0.02
Gender					
Male	Reference				
Female	5.59	2.34	1.01	10.17	0.02
Year of study					
1st year	Reference				
2nd year	7.27	3.35	0.71	13.83	0.03
3rd year	9.75	3.63	2.63	16.88	0.01
4th year	10.43	3.81	2.95	17.90	0.01
Residents	3.63	4.04	-4.28	11.54	0.37
Living arrangements					
Alone	Reference				
With another person	1.77	2.52	-3.16	6.70	0.48
Marital status					
Single	Reference				
Have a partner	3.68	2.43	-1.08	8.45	0.13
Married	2.30	5.17	-7.83	12.44	0.66
Having children					
No	Reference				
Yes	-22.69	11.95	-46.11	0.74	0.06
Total Godin Leisure-Time Exercise	-0.02	0.01	-0.04	0.00	0.06
Drinking habit					
None	Reference				
1-3 drinks	-7.33	1.74	-10.75	-3.91	0.00
4-5 drinks	-11.58	2.38	-16.24	-6.92	0.00
More than 6 drinks	-13.10	2.63	-18.25	-7.94	0.00
Health-related symptoms					
1. Felt sad, low in spirit or depressed	12.02	2.22	7.67	16.37	0.00
2. Appetite was less than or greater than usual	4.71	2.30	0.20	9.22	0.04
3. Gained or lost weight without trying	0.34	2.50	-4.57	5.25	0.89
4. Had difficulty falling asleep	8.06	1.94	4.26	11.87	0.00
5. Sleeping too much	-2.05	1.93	-5.84	1.74	0.29
6. Trouble thinking, concentrating or making decisions	10.33	2.11	6.19	14.46	0.00
7. Felt hopeless or worthless	5.13	3.29	-1.32	11.58	0.12

Figure 1: Mean stress and impact level over-time by year of study
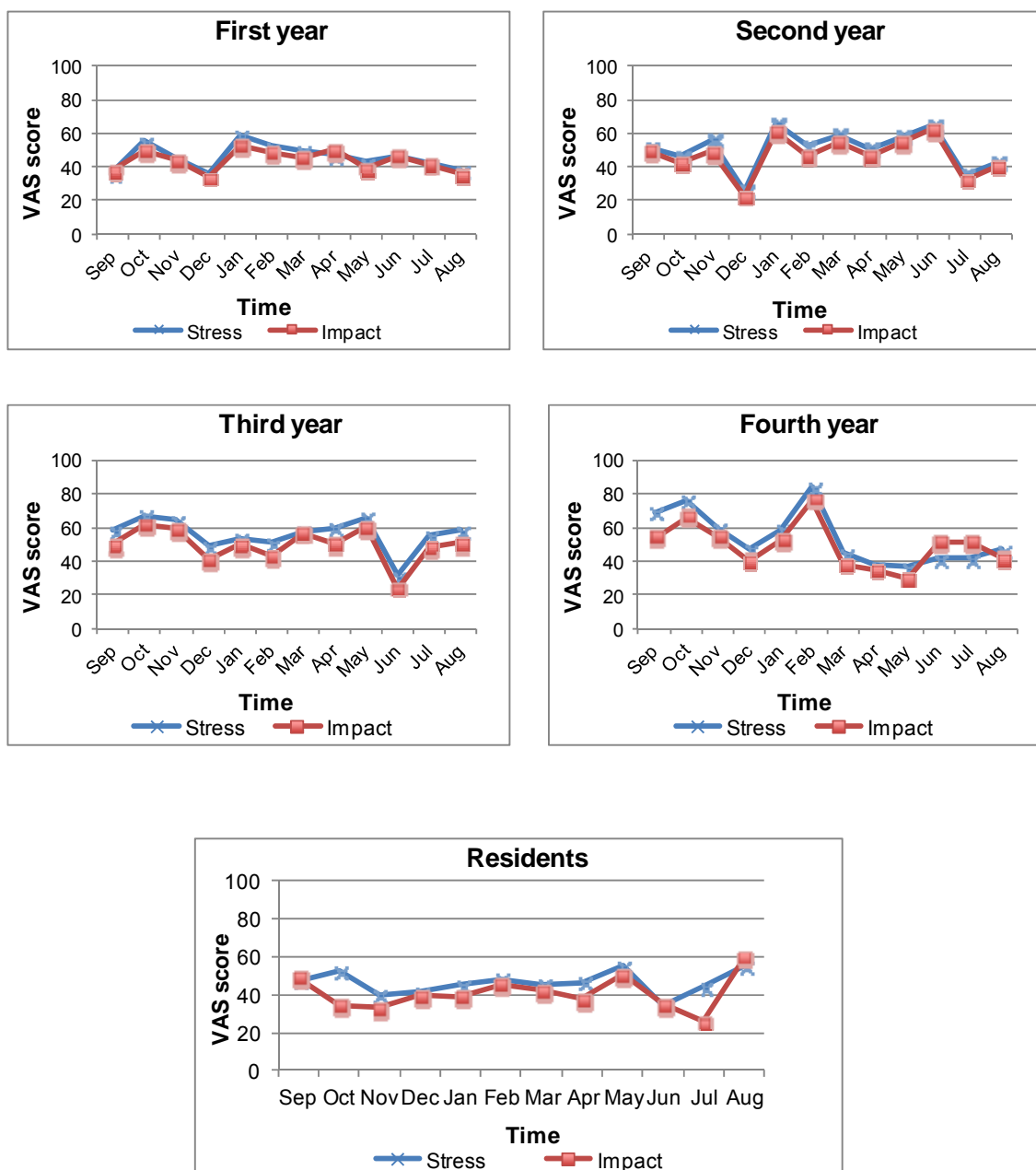
3.3.1 Summary of results from manuscript IV investigating the impact of stress on dental students

Findings from manuscript IV, responded to our last research objective that aims to describe the impact of stress on undergraduate dental students and first year residents and to better understand its consequences on their well-being. In view of our findings from manuscript II and III we anticipated negative consequences from the high stress levels on students. Although in this manuscript we suggested an adverse effect of stress on students, demonstrated by various symptoms of stress and serious negative consequences on their well-being, the methodological limitation should be considered when interpreting those findings. Although we used a random mixed model using random intercept and slope to allow subject-specific interpretation, our small sample size could have reduced the statistical power of the study. Nevertheless, we were able to demonstrate statistically significant associations between stress levels and students' demographic characteristics, year of study, dinking behaviors and stress-related signs and symptoms but we could not rely on these associations alone to infer causality. So the main strength of this manuscript comes from the qualitative element that reinforced these findings when, in the interviews, participants expressed how they felt during the high stress peaks implying these associations to be consequences of stress rather than causes.

4. SUMMARY, CONCLUSION AND IMPLICATIONS FOR FUTURE WORK

4.1 Summary of research findings

The aim of this study was to explore and better understand the stress experience in undergraduate dental students over-time and throughout the different years in the program.

Regarding stress level, our results demonstrated a gradual increase throughout the four-year curriculum with a decline after graduation. Highest stress levels were reported by fourth year students in February 2-3 months prior to their graduation and lowest stress levels were reported by second year students in December during the holiday. In addition, we found a statistically significant association between time of the year, students' year of study and stress levels, with participants demonstrating decreased stress during the holiday months and senior students experiencing higher stress levels. This variation in stress levels was further confirmed during the qualitative interviews when participants compared their stress levels at each year in their training and explained the peaks.

With respect to sources of that stress, we also showed variations over-time, even though most undergraduate students concerns were related to "examination and grades" and "workload". "Patient treatment" was another stressor reported by students in the clinical years; final year students and residents also reported worries about their "future plans". In addition, we have identified some sources that varied within the year. There was a significant increase for "workload" stressor in fourth year and another significant increase in "patient treatment" factor in third year.

Finally, our results also suggest a detrimental effect of elevated stress levels on students' health and well-being. We observed a significant

association between students' gender, age and year of study and their stress level with female, older and more advanced participants experiencing higher stress levels than male, younger and less advanced students. In addition, quantitative and qualitative data suggested an association between students' stress-related symptoms, alcohol drinking habits and their stress levels.

4.2 Research Limitations

Several limitations need to be considered when interpreting findings from this study. The main methodological limitation is the generalizability of the findings. As we discussed previously in manuscript II, III and IV, this study was conducted in a single Canadian dental school with a relatively small sample size; consequently, our findings may not be representative of students in different schools in Canada and in other countries.

Another limitation is the validity of the measures we used to assess the study outcomes. Considering the frequent data collection points in the study and the very busy schedules of dental students, we relied on a simple single-item instrument (VAS) to assess stress level and the impact of that stress among participants. Although the VAS has not been validated in assessing stress in dental students, it has been shown to have a good reliability and validity in measuring similar outcomes such as pain and depression [37, 54]. In addition, one could argue that participants' might have been accustomed to answering the same questionnaire at each follow up. However, the monthly variations in participants' stress scores could be an indication of their actual stress level.

A third limitation, related to the statistical data analysis, is the missing data. As we anticipated, which is the case with most cohort studies, we had variable response rates throughout the study as some participants

missed few data collection points especially during the summer holidays. However, we had an overall good response rate with very few items non-response. Accordingly we decided not to impute the data and assumed missing data to be completely at random (MCAR) and used appropriate modeling statistical procedures that support this assumption during the analyses.

A fourth limitation concerns our interpretation of the findings in manuscript IV. We cannot make causal inferences from our study despite its longitudinal design, since it is indeed a panel data or a series of cross-sectional studies. Although we suggested that the associations we observed from the quantitative analyses and the qualitative data between stress and health related outcomes to be consequences of that stress, further research is still needed to explore and confirm these findings.

A fifth limitation is related to the sampling strategy of participants in the qualitative part. Due to the anonymity of the quantitative data we were limited in our sampling strategy choices. However, findings from the descriptive analysis for stress data in the first quantitative phase showed that stress levels reported by participants reflect the average of the group with no deviant trend among participants and that may justify our purposeful sampling based on typical case selection to recruit participants.

Finally, in the qualitative interviews we used graphs of the results from the quantitative part to guide the discussion, which might have influenced participants' answers. However, the purpose of using the graphs was to confirm the results we obtained from the quantitative data.

4.3 Conclusion

Our results suggest the following 3 conclusions:

1. Confirming previous research, dental students experience high level of stress during their training. Furthermore, this stress varies over-time and thus students experience different stress levels depending on their stage in the curriculum and the time during the year.

2. Sources of stress reported by undergraduate students mainly reflect the challenging learning experience of the dental education. In addition, our findings demonstrate that sources of stress also vary over-time where clinical students face different stressors compared to those in the pre-clinical years.

3. Our results also suggest an alarming effect of high stress level on dental students' mental and physical health.

According to these findings we modified our hypothesized model that we discussed in section 1.4 to reflect our findings as follows:
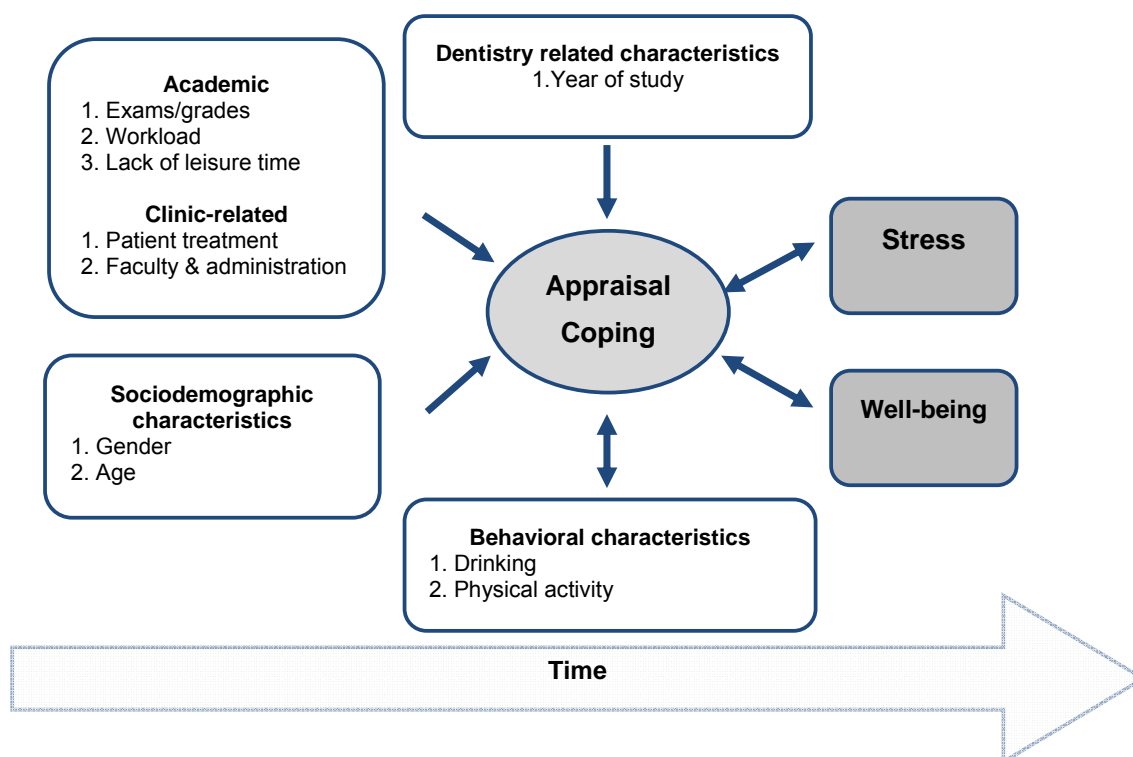
4.4 Original contribution of the work within the thesis

The main originality of this work lies in its design. To our knowledge, this is the first study to date that used mixed methods approach to investigate stress in dental students. In addition, we used a longitudinal prospective approach to follow students from all years in the program to demonstrate how stress evolves throughout the curriculum. Moreover, the inclusion of 1st year residents provided a contrast comparison between students under the pressure of training and those in general practice setting.

We have shown the variation in levels and sources of stress over-time across different years of undergraduate dental training. We also demonstrated the consequences of that stress on students. These findings collectively provide a better understanding of stress experience in dental education according to year of study.

4.5 Implications for future work

Future research is still needed to duplicate and confirm our findings in different dental schools and other health professions. Findings from our study could guide future research to implement and test stress management interventions that are specifically tailored to students needs depending on their year in the program and the time of the year. In addition, further longitudinal studies are needed to examine predictors of stress to identify vulnerable students so that attention and support could be provided to them.

Moreover, faculties and administrators in dental schools could build on outcomes from this research to explore different stress management strategies either through changes in the structure of the curriculum or using more individualized approaches to enhance students' well-being and ensure their healthy learning environment.

REFERENCES

1. Lazarus RS. Stress, Appraisal, and Coping. New York: Springer Publishing Company; 1984.

2. Szabo S. Hans Selye and the development of the stress concept. Special reference to gastroduodenal ulcerogenesis. Ann N Y Acad Sci 1998;851:19-27.

3. Selye H. Confusion and controversy in the stress field. J Human Stress 1975;1(2):37-44.

4. Tsigos C, Chrousos GP. Hypothalamic-pituitary-adrenal axis, neuroendocrine factors and stress. J Psychosom Res 2002;53(4):865-71.

5. Chrousos GP. Stressors, stress, and neuroendocrine integration of the adaptive response. The 1997 Hans Selye Memorial Lecture. Ann N Y Acad Sci 1998;851:311-35.

6. Cohen S, Janicki-Deverts D, Miller GE. Psychological stress and disease. JAMA 2007;298(14):1685-7.

7. Rozlog LA, Kiecolt-Glaser JK, Marucha PT, Sheridan JF, Glaser R. Stress and immunity: implications for viral disease and wound healing. J Periodontol 1999;70(7):786-92.

8. Steptoe A, Kivimaki M. Stress and cardiovascular disease. Nat Rev Cardiol 2012.

9. Gorter R, Freeman R, Hammen S, Murtomaa H, Blinkhorn A, Humphris G. Psychological stress and health in undergraduate dental students: fifth year outcomes compared with first year baseline results from five European dental schools. European Journal of Dental Education 2008;12(2):61-8.

10. Hammen C. Stress and depression. Annu Rev Clin Psychol 2005;1:293-319.

11. Feskanich D, Hastrup JL, Marshall JR, Colditz GA, Stampfer MJ, Willett WC, et al. Stress and suicide in the Nurses' Health Study. J Epidemiol Community Health 2002;56(2):95-8.

12. Crum RM, Muntaner C, Eaton WW, Anthony JC. Occupational stress and the risk of alcohol abuse and dependence. Alcohol Clin Exp Res 1995;19(3):647-55.

13. Sinha R. How does stress increase risk of drug abuse and relapse? Psychopharmacology (Berl) 2001;158(4):343-59.

14. DeLongis A, Folkman S, Lazarus RS. The impact of daily stress on health and mood: psychological and social resources as mediators. J Pers Soc Psychol 1988;54(3):486-95.

15. Stewart SM, Betson C, Lam TH, Marshall IB, Lee PW, Wong CM. Predicting stress in first year medical students: a longitudinal study. Medical Education 1997;31(3):163-8.

16. Luo Y, Wang H. Correlation research on psychological health impact on nursing students against stress, coping way and social support. Nurse Educ Today 2009;29(1):5-8.

17. Caplan RP. Stress, anxiety, and depression in hospital consultants, general practitioners, and senior health service managers. BMJ 1994;309(6964):1261-3.

18. Myers HL, Myers LB. 'It's difficult being a dentist': stress and health in the general dental practitioner. British Dental Journal 2004;197(2):89-93; discussion 83; quiz 100-1.

19. Boswell CA. Work stress and job satisfaction for the community health nurse. J Community Health Nurs 1992;9(4):221-7.

20. Motowidlo SJ, Packard JS, Manning MR. Occupational stress: its causes and consequences for job performance. J Appl Psychol 1986;71(4):618-29.

21. Mawardi BH. Satisfactions, dissatisfactions, and causes of stress in medical practice. JAMA 1979;241(14):1483-6.

22. Richardsen AM, Burke RJ. Occupational stress and job satisfaction among physicians: sex differences. Soc Sci Med 1991;33(10):1179-87.

23. Winwood PC, Winefield AH, Lushington K. The role of occupational stress in the maladaptive use of alcohol by dentists: a study of South Australian general dental practitioners. Aust Dent J 2003;48(2):102-9.

24. Gorter RC, Freeman R. Burnout and engagement in relation with job demands and resources among dental staff in Northern Ireland. Community Dent Oral Epidemiol 2011;39(1):87-95.

25. Denton DA, Newton JT, Bower EJ. Occupational burnout and work engagement: a national survey of dentists in the United Kingdom. British Dental Journal 2008;205(7):E13; discussion 382-3.

26. Rada RE, Johnson-Leong C. Stress, burnout, anxiety and depression among dentists. Journal of the American Dental Association 2004;135(6):788-94.

27.   Giancola JK, Grawitch MJ, Borchert D. Dealing With the Stress of College: A model for Adult Students. Adult Education Quarterly 2009;59:246- 63.

28.   Tedesco LA. A Psychosocial Perspective on the Dental Education Experience and Student Performance. Journal of Dental Education 1986;50(10):601-05.

29.   Pau A, Rowland ML, Naidoo S, AbdulKadir R, Makrynika E, Moraru R, et al. Emotional intelligence and perceived stress in dental undergraduates: a multinational survey. Journal of Dental Education 2007;71(2):197-204.

30.   Muirhead V, Locker D. Canadian dental students' perceptions of stress and social support. European Journal of Dental Education 2008;12(3):144-8.

31.   Bradley IF, Clark DC, Eisner JE, De Gruchy K, Singer DL, Hinkleman K, et al. The student survey of problems in the academic environment in Canadian dental faculties. Journal of Dental Education 1989;53(2):126-31.

32.   Sturdevant JR, George JM, Lundeen TF. An interactional view of dental student stress. Journal of Dental Education 1987;51 (5):246-49.

33.   Johnson RB, Onwuegbuzie AJ, Turner LA. Toward a Definition of Mixed Methods Research. Journal of Mixed Methods Research 2007;1(2):112-33.

34.   Creswell J, W, Plano Clark V, L. Designing and conducting Mixed Methods Research. ed. California: Sage Publications, Inc; 2007.

35.   Aitken RC. Measurement of feelings using visual analogue scales. Proc R Soc Med 1969;62(10):989-93.

36.   Ahearn EP. The use of visual analog scales in mood disorders: a critical review. J Psychiatr Res 1997;31(5):569-79.

37.   Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. Pain 1983;17(1):45-56.

38.   Hornblow AR, Kidson MA. The visual analogue scale for anxiety: a validation study. Aust N Z J Psychiatry 1976;10(4):339-41.

39.   Luria RE. The validity and reliability of the visual analogue mood scale. J Psychiatr Res 1975;12(1):51-7.

40.   Garbee WH, Jr. Sources of stress in the dental school environment. LDA journal 1981;39(4):9-14.

41.   Polychronopoulou A, Divaris K. Dental students' perceived
        sources of stress: a multi-country study. Journal of Dental
        Education 2009;73(5):631-9.

42.   Acharya S. Factors affecting stress among Indian dental
        students. Journal of Dental Education 2003;67(10):1140-8.

43.   Rajab LD. Perceived sources of stress among dental students at
        the University of Jordan. Journal of Dental Education
        2001;65(3):232-41.

44.   Muirhead V, Locker D. Canadian dental students' perceptions of
        stress. Journal 2007;73(4):323.

45.   Polychronopoulou A, Divaris K. A longitudinal study of Greek
        dental students' perceived sources of stress. Journal of Dental
        Education 2010;74(5):524-30.

46.   Kumar S, Dagli RJ, Mathur A, Jain M, Prabu D, Kulkarni S.
        Perceived sources of stress amongst Indian dental students.
        European Journal of Dental Education 2009;13(1):39-45.

47.   Sanders AE, Lushington K. Sources of stress for Australian
        dental students. Journal of Dental Education 1999;63 (9):688-97.

48.   Stecker T. Well-being in an academic environment. Med Educ
        2004;38(5):465-78.

49.   Godin G, Shephard RJ. A simple method to assess exercise
        behavior in the community. Can J Appl Sport Sci
        1985;10(3):141-6.

50.   Zeger SL, Liang KY, Albert PS. Models for longitudinal data: a
        generalized estimating equation approach. Biometrics
        1988;44(4):1049-60.

51.   Laird NM, Ware JH. Random-effects models for longitudinal data.
        Biometrics 1982;38(4):963-74.

52.   StataCorp. Stata Statistical Software: Release 11: College
        Station, TX: StataCorp LP.; 2009.

53.   Patton M. Qualitative Research and Evaluation Methods. 3rd ed:
        Sage Publication Inc; 2002.

54.   Litte JC, McPhail NI. Measures of depressive mood at monthly
        intervals. Br J Psychiatry 1973;122(569):447-52.

APPENDICES

Appendix I: Email invitation

Dear student,

We would like to invite you to participate in our study that aims at understanding stress in undergraduate dental education. We are conducting a survey to collect information about students' stress levels in their undergraduate dental education. You are selected to be part of this project because you are currently registered student at the Faculty of Dentistry, McGill University.

To participate, please click on the survey link below, or cut and paste the entire URL into your browser to access the survey. You will have 7 days to respond to this survey. We estimate that it will take you approximately 6-8 minutes to answer the survey questions.

https://surveys.mcgill.ca/limesurvey/index.php?sid=34951&lang=en

Thank you in advance for your participation. Your opinion is valuable to us. We would like to assure you that your answers to this survey would remain strictly confidential.

If you have any questions or would like to complete a paper survey please contact me at:

Hawazin Elani
PhD students, Faculty of Dentistry, McGill University
3550 University Street
Montreal, QC H3A 2A7
Tel: 514-398-7203 ext -0243-
Email:Hawazin.elani@mail.mcgill.ca

If you experience technical difficulties accessing or submitting the survey please contact support.ist@mcgill.ca

Sincerely,
Hawazin Elani

Appendix II: Quantitative questionnaire

Baseline questionnaire

1. Please enter your year of study and the last 3 numbers of your McGill ID in the format1-123

| |

2. What is your age? "Please enter your age in years"

| |

3. What is your gender?
○ Female
○ Male

4. Are you a non-resident, international student?
○ Yes
○ No

5. Do you currently live alone?
○ Yes ----------------- [Please go to Q.7]
○ No

6. With whom are you living?
○ I live with my partner
○ I live with my relative/relatives
○ I live with a friend/friends
○ Other *"Please specify":* | |

7. What is your current marital status?
○ Single
○ Married
○ Have a partner
○ Separated/Divorced
○ Other *"Please specify":* | |

8. Do you have any children?
○ Yes
○ No ----------------- [Please go to Q.10]

9. How many children do you have?
"Please write the appropriate number"

| |

10. Please indicate your year in the dental program
○ Year 1
○ Year 2
○ Year 3
○ Year 4

◯ Resident

11. Was dentistry your first choice of program?
◯ Yes ----------------- [Please go to Q.13]
◯ No

12. What was your first choice?
"Please write your answer here"

[   ]

13. What was the highest level of education you have completed?
◯ CEGEP
◯ Diploma
◯ Bachelor's degree
◯ Master's Degree
◯ PhD
◯ Other *"Please specify":* [   ]

14. In addition to dental school, are you currently working for money?
◯ Yes
◯ No ----------------- [Please go to Q.16]

15. If you are engaged in paid employment, how many hours/week are you doing this?
"Please write the appropriate number"

[   ]

16. If you are currently not working, are you looking for a job?
◯ Yes
◯ No

17. With respect to your current tuition fees, your payment source is/are? *"Please choose all that apply"*

☐ Scholarships, bursaries, or other non-repayable awards
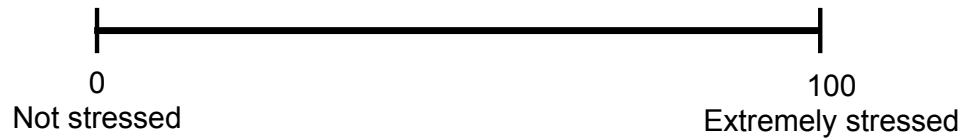☐ Government Student Loans
☐ A bank loan
☐ Personal resources (including family)
☐ Other *"Please specify":* [   ]

Follow-up questionnaire

1. Please place a mark on the scale below (0-100) that best describes how much stress you have been experiencing in the past week including today

|————————————————————————————|

0   100
Not stressed   Extremely stressed

2. Please place a mark on the scale below (0-100) that best describes how this stress has affected you in the past week including today

|————————————————————————————|

0   100
Not at all   Too much
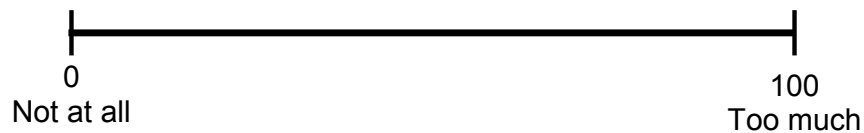
3. In relation to your previous answers to question #1 and #2, what are the most applicable sources of stress?
*"Please choose **all** that apply"*

☐ Lack of confidence in self to be a successful dental student/dentist

☐ Relationship with Professors and staff

☐ Workload

☐ Exams and grades

☐ Patient treatment

☐ Learning clinical and/or preclinical skills

☐ Personal issues

4. Please indicate if there are any other sources of stress or relevant comments that you would like to add
"Please write your answer here"

```
                                                                                
```

5. Please write the most important source of stress during that week
"Please write your answer here"

```
                                                                                
```

6. During the past week, how often have you experienced any of the following? *"Please choose the appropriate response for each item"*

	Always	Often	Sometimes	Rarely	Never
Felt sad, low in spirits or depressed					
Appetite was less than or greater than usual					
Gained or lost weight without trying					
Had difficulty falling asleep					
Sleeping too much					
Trouble thinking, concentrating or making decisions					
Felt hopeless or worthless					

7. On how many occasions have you had a drink of alcohol in the past week including today?

◯ None/ not applicable ----------------- [Please go to Q.9]

◯ Every day

◯ Drink 4-6 times/ week

◯ Drink 1-3 times/ week

◯ Drink less often than each week

8. What is the maximum number of drinks you have consumed in any of those occasions for the past week?

◯ 1-3 drinks

◯ 4-5 drinks

◯ 6-10 drinks

◯ 11 or more drinks

9. Do you currently smoke?

"By smoking we mean, using either cigarettes, pipes, cigars and/or other forms of tobacco inhalation. It can be casual smoking; which is occasional (in social or stressful events), or habitual smoking; that is more frequent"

◯ Yes

◯ No ----------------- [Please go to Q.11]

10. How many cigarettes did you smoke per day for the past week? "on average"

◯ I don't smoke every day

◯ 1-4 cigarettes

◯ 5-10 cigarettes

◯ 11-20 cigarettes

◯ More than 1 pack of cigarettes

11. During the past week including today, how many times on the average did you do the following kinds of exercise for more than 15 minutes during your free time? *"Please write the appropriate number"*

Strenuous exercise "Heart beats rapidly" (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)	
Moderate exercise "Not exhausting" (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)	
Mild exercise "Minimal effort" (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)	

12. During the past week including today, in your leisure time, how often did you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

◯ Often

◯ Sometimes

◯ Never/rarely

Dental Environment Stress Questionnaire (DES)

" Please rate the following as potential causes of stress"

Dental Environment Stress Item	1 Not stressful	2 Slightly stressful	3 Moderately stressful	4 Very stressful	5 Not pertinent
1. Amount of assigned classwork					
2. Lack of cooperation by patients in their home care					
3. Difficulty of classwork					
4. Responsibilities of comprehensive patient care					
5. Competition for grades					
6. Patients being late or not showing for their appointments					
7. Examination and grades					
8. Difficulty in learning clinical procedures					
9. Atmosphere created by clinical faculty					
10. Relations with members with opposite sex					
11. Receiving criticism about work					
12. Difficulty in learning precision manual skills					
13. Lack of confidence to be a successful dental student					
14. Lack of confidence in self to be a successful dentist					
15. Lack of time for relaxation					
16. Amount of cheating in dental school					
17. Rules and regulations of the school					
18. Working on patients with dirty mouths					
19. Lack of home atmosphere in living quarters					
20. Completing graduation requirements					
21. Having children in home					
22. Marital adjustment problems					
23. Expectations of dental school and what in reality it is like					
24. Lack of input into the decision-making process of school					
25. Fear of failing course or year					
26. Insecurity concerning professional future					
27. Financial responsibilities					
28. Lack of time to do assigned school work					
29. Considering entering some other field of work					
30. Forced postponement of marriage or engagement					
31. Personal physical health					
32. Attitudes of school toward women dental students					
33. Necessity to postpone having children					

34. Conflict with partner over career decision					
35. Discrimination due to race, class status, or ethnic group					
36. Having dual role of wife/mother or husband/father and dental students					
37. Inconsistency of feedback on your work between different instructors					
38. Fear of being unable to catch up if behind					

Appendix III: Consent Agreement

Stress in Undergraduate Dental Students

Introduction

It has been shown that dental undergraduate students demonstrate high levels of stress. Although several studies examined the level and sources of stress associated with dental education, findings from these studies generated limited information to help students deal with that stress.

The purpose of our study is to describe sources of stress in undergraduate dental students and to assess the consequences of that stress on students' quality of life and learning experience. We are hoping that results from this study provide the knowledge required to guide other researchers to develop an effective stress management services to ensure students' wellbeing in their learning environment.

Study Procedure

If you agree to participate in this study, your participation will take approximately 12 months from the time you consent to the last time you answer the final survey. Once you agree to participate, the following steps will take place:

1. You will receive an email invitation

Email invitation will be sent to your university email address to invite you to the study. The email has a link to the study survey. You will need to log in to the survey to start the study.

2. Filling out questionnaires

The first time you enter the study, you will be asked to answer some short questions about your background information. You will also be asked about your stress level. Answering the baseline questionnaire may take around 6-8 minutes. After the first survey, at the same time

each month, you will receive an email with the study link inviting you to continue the study.

3. Individual interviews

After the last follow up surveys, you will be invited via email to participate in one-on-one interview conducted by the study researcher. The purpose of these interviews is to let you reflect on your opinion about how is stress affecting your life and learning experience. Each interview will last 45-60 minutes and will be tape-recorded so that we don't miss any information. Once the interviews are transcribed verbatim, that tape will be destroyed.

Benefits and Risks

There are no direct benefits to you from participating in this study. Regarding the individual interviews; the study investigators will keep information discussed in the interviews confidential. There are no blood tests or other physical exams included in this study.

Alternative treatments

Since your answers to the survey will be anonymous, no individual psychological support will be provided. However, information on resources that can provide you with help and information in the university and the community will be sent to you at the beginning of the study in case you think you need them.

Compensation

Although we are not providing you with any compensation, your name will be put in a draw for a set of movie tickets each month you complete the questionnaire. We will make a monthly draw for two winners from participants in each class. In addition, if you complete most of the study (6 surveys); you will be included in another draw for completers. For this draw the prize will constitute of 3 winners from all participants. The prizes are gift certificates from an electronic store (e.g. Future shop);

the first prize will be equivalent to 200$, second prize will be equal to 150$ and the third prize will be equal to 100$.

Subject Rights

Your participation in this study is voluntary. You may withdraw form the study at anytime. However, you are encouraged to answer all the questions in the survey but you are under no pressure from staff members or any one to do so. Your refusal or withdrawal form the study will not affect your academic evaluation or marks by any means. You will be provided with an email address if you need to ask questions about the study at any time or to report any technical problems you may face with survey.

Confidentiality

All information collected about you in this study will be confidential. No individual information will be disclosed. You will need to use the last three digits of your University identification number (ID) to start the study and to allow us to match your answers with each follow up. However, this information is anonymous since no one can identify these ID numbers except for university administration and thus your identity can never be revealed. To insure further confidentiality, after completion of data collection your ID number will be replaced by random numbers for data analysis and storing. Participation in the interviews will be confidential and will not be linked to your ID. Interviews will be conducted outside McGill, Faculty of Dentistry (in a nearby campus or coffee shop). No Faculty or staff member will know who participated in these interviews. The study researcher is the only person who will know the participants and this information will remain strictly confidential. Your name will be replaced by pseudonym to insure no access to your identity.

The data will be securely stored in password-coded computers. No one will have access to these data except the study researcher. Three years after completion of the study, all information will be destroyed.

Researchers will use the results of this study to write scientific papers and to present at scientific conferences.

Contact

If you have any questions regarding your participation rights, contact the office of the Dean of Students by phone: 514-398-XXX or Fax: 514-398-XXXX

If you need any further information about the study you can contact the researcher of this study Hawazin Elani by email or by phone at 514-398-XXXX

Consent Agreement

By agreeing to this consent form, I agree that

1. The study has been explained to me and my questions have been answered to my satisfaction. I agree to participate in this study.

2. I understand the study procedures.

3. My participation is voluntarily. I can withdraw from the study at anytime. In addition, my response to this study, participation, or withdrawal will not affect my academic evaluation.

4. I can print a copy of the consent agreement from the invitation email sent to me from the researchers of the study at any time

☐ <u>Agree to participate</u>

☐ <u>Disagree to participate</u>

Signature:_____   **Date:** _____

Appendix IV: Results of factor analysis for the DES

Component	Eigenvalue	Cumulative %*	Number of items	Cronbach's alpha
Patient treatment	14.5	38.2	4	0.55
Workload	5.9	53.6	4	0.79
Faculty and administration	4.1	64.4	9	0.82
Pre-clinical and clinical training	3.7	74.0	2	0.79
Self-efficacy beliefs	3.1	82.1	6	0.84
Personal factors	2.5	88.6	11	0.76
Performance pressure	1.9	93.6	2	0.81

NB: * Cumulative percentage of the variance explained