ORIGINAL ARTICLE

International Dental Journal 2012; 62: 127–131

doi: 10.1111/j.1875-595X.2011.00103.x

Academic stress as a risk factor for dental caries

Cynthia Mejía-Rubalcava[1], Jorge Alanís-Tavira[1], Liliana Argueta-Figueroa[1] and Alejandra Legorreta-Reyna[2]

[1]*Centre of Research and Advanced Studies in Dentistry (CIEAO), Autonomous University of the State of Mexico (UAEMex), Toluca, Mexico;* [2]*Department of Psychometrics, Behavioural Sciences Faculty, UAEMex, Toluca, Mexico.*

Objectives: To evaluate the associations between dental caries classified according to the index for decayed, missing and filled teeth (DMFT) and stimulated salivary flow, salivary capacity for oxidation reduction and academic stress in undergraduate dental surgery students aged 18–22 years. **Methods:** This research was performed at three time-points: March 2010, September 2010 and March 2011. The sample was composed of 73 students, including 15 male and 58 female subjects. Data were obtained using the DMFT index to detect incident dental caries, the RD test Showa for salivary capacity for oxidation reduction, the Sisco academic stress inventory, and sterile polyethylene to stimulate salivary flow. **Results:** Logistic regression analysis showed that: subjects with stimulated salivary flow of < 1 ml/min are at increased risk for developing caries compared with those with stimulated salivary flow of ≥ 1 ml/min; those with moderate or high levels of academic stress are at greater risk for developing carious lesions than those with low academic stress; women are at greater risk for developing carious lesions than men, and, of the subjects studied, younger students were more likely to develop caries. **Conclusions:** Moderate to high levels of academic stress, younger age and lower salivary flow rate represent risk factors for the development of dental caries in students.

Key words: *Academic stress, incident caries, stimulated salivary flow, salivary capacity for oxidation reduction*

Because of its high prevalence, dental caries is considered one of the major public health issues worldwide. According to the World Health Organization (WHO), 95% of the world population is affected by dental caries[1].

Although this disease has been studied using several models, little research has examined risk factors such as stress as causes of dental caries. Individuals in psychologically stressful circumstances are subject to the secretion of catecholamines (epinephrine and norepinephrine), which causes a decrease in salivary flow and thereby modifies salivary capacity for oxidation reduction[2–4].

The decrease in salivary flow reduces the protective function afforded by saliva and, in consequence, increases the risk for dental decay[3,5].

Although stress produces psychological and biological responses that allow an organism to adapt and survive in difficult situations, it can have detrimental effects when it remains constant[6,7]. Stress can occur in any environment and may affect any individual at any social level, although the degree to which people are affected varies from one person to another; in the educational environment, academic stress is recognised as a cause of variation in the habits of affected persons[8–10].

According to Glaser and Kiecolt-Glaser[9], health problems related to academic stress include the suppression of T lymphocytes and a reduction in the activity of natural killer (NK) cells (a type of lymphocyte that belongs to the immune system) during examination periods (which are perceived as highly stressful situations). These changes are indicative of immune system depression and cause the body to become more vulnerable to disease[3,10,11].

In addition, students tend to modify their lifestyles prior to and during examination periods, often in unhealthy ways, such as by increasing their intake of carbohydrates, caffeine, tobacco, psychoactive substances and sometimes by using tranquilisers, which can eventually lead to the emergence of health problems[3,12,13].

The aim of this study was to analyse the associations among dental caries, stimulated salivary flow rate, salivary capacity for oxidation reduction and academic stress in undergraduate students of dental surgery during a period of 6 months.

METHODS

The study used a prospective case–control design linked to a fixed cohort. This research was conducted in the

© 2012 FDI World Dental Federation

Faculty of Dentistry of the Autonomous University of Mexico State (UAEMex), located in Toluca, Mexico.

Participants included 58 women and 15 men aged 18–22 years. This research was approved by the Bioethics Committee of the Centre of Research and Advanced Studies in Dentistry (CIEAO) and was conducted in full accordance with the World Medical Association Declaration of Helsinki. The participation of undergraduates was voluntary and informed consent was signed by each person. Cases and controls were obtained from the same student population. Controls were selected among students who had not had caries during the period from March to September 2010. Cases were selected from students who had demonstrated caries during that period. Inclusion criteria considered male or female students of regular academic status. Exclusion criteria were: the presence of any systemic disease such as diabetes, hypertension, thyroid disease and heart disease; chemotherapy or radiation treatment of the head and neck; the continuous use of medication including antihistamines, tricyclic antidepressants, anticholinergics, benzodiazepines, antihypertensives, diuretics, phenothiazines, clonidine hydrochloride and narcotic analgesics; the use of fixed dental appliances; married status, and pregnancy.

Study measurements were obtained at two time-points, in September 2010 (before academic achievement tests were held) and in March 2011 (after the semester started). At both time-points the incidence of caries, stimulated salivary flow rate and salivary capacity for oxidation reduction were recorded and the Sisco inventory for academic stress was implemented.

Oral examinations were performed by a dentist in a dental unit in a non-invasive manner with a no. 5 dental mirror and a probe (PCP11.5B; Hu-Friedy GmbH, Leimen, Germany), using biological barriers in line with criteria proposed by the WHO[14], in order to obtain standardised data on decayed, missing and filled teeth (DMFT). Participants with dental caries lesions were diagnosed using this DMFT index.

The collection of stimulated saliva was carried out in small groups of seven to 15 students at 10.30–11.00 hours. Students were asked to mechanically stimulate the production of saliva by chewing on a piece of sterile polyethylene (15.0 × 15.0 × 0.2 mm). The procedure first required participants to chew on the polyethylene for 1 min in order to remove food particles and epithelial debris in swallowed saliva. After this, participants were asked to chew for a further 5 min and to spit the saliva into a graduated glass. The amount of saliva secreted was divided by the length of time taken for the sample collection and expressed as ml/min. The ranges established were: low (< 1.0 ml/min) and normal (≥ 1.0 ml/min)[2].

Salivary capacity for oxidation reduction was established using the RD test Showa (Showa Yakuhin Kako Co. Ltd, Tokyo, Japan). A pipette was used to extract 1 ml of saliva from each of the samples deposited by the students in graduated vessels. The 1-ml samples were placed in reagent discs and put into an incubator (Yamato DS44; Yamato Scientific America, Inc., Santa Clara, CA, USA) at a temperature of 36 °C for 15 min in order to obtain readings from the discs. According to the manufacturer's specifications, salivary capacity for oxidation reduction was reported as high, medium or low.

Academic stress levels were obtained using the Sisco inventory for academic stress validated for the Mexican population by Barraza-Macías[15]. The test was applied by a trained and standardised psychologist.

This test consists of 41 items and generates a result in one of three categories of academic stress: low, moderate and high.

Analysis

In the data analysis, variables were recodified as categories in order to perform statistical analysis. Dental caries was categorised as a dichotomous variable as absent or present. Academic stress level was categorised as low or moderate/high. A descriptive analysis was obtained in order to determine the distribution of each variable. Multivariate logistic regression was used to determine associations between the dependent and explanatory variables.

Statistical analysis was performed using SPSS Version 19 (SPSS, Inc., Chicago, IL, USA). *P*-values of ≤ 0.05 were considered to indicate statistical significance.

RESULTS

The sample consisted of 73 students divided into two groups of, respectively, cases (students who showed incidents of caries within 6 months of the baseline oral measurement) and controls (students who did not demonstrate this disease). The first oral assessments identified 50 controls (12 men and 38 women) and 23 cases (three men and 20 women). The mean ± standard deviation (SD) age of the total cohort was 19.84 ± 1.22 years. The mean ± SD stimulated salivary flow rate in the total cohort was 0.95 ± 0.52 ml/min. Overall, 56.2% of the students had a low salivary capacity for oxidation reduction and 69.9% of participants demonstrated a moderate/high level of academic stress.

Incidences of caries were 0.328 in the group of students with a moderate/high stress level and 0.222 in the group of students with a low stress level. Multivariate logistic regression analysis was performed to determine the associations between the study variables and caries risk in undergraduate dentistry students.

© 2012 FDI World Dental Federation

The results of multivariate logistic regression analysis are shown in *Table 1*. For the gender variable, a negative β-value indicates a decrease in risk for developing dental caries in male students compared with female students. This is corroborated by an exponential β-value [exp(β)] of < 1 (0.361). This parameter quantifies this correlation and indicates that caries risk was approximately 0.639 times lower in men than in women.

For the age variable, the exp(β) for students aged 18 years indicates their relative risk for developing dental caries was 1.976 times greater than that of students aged 22 years.

For the stimulated saliva variable, the value of exp(β) indicates that students with a stimulated salivary flow rate of < 1 ml/min had a 1.933-times greater risk for caries than students with a stimulated salivary flow of ≥ 1 ml/min.

In the analysis of the academic stress variable, a positive β-value indicates a correlation with dental caries. Moderate/high stress levels were found to increase the risk for caries over low stress levels, as confirmed by an exp(β) of > 1. When this correlation was quantified, the risk for tooth decay was found to be approximately 4.564 times higher in students with moderate/high stress levels. Thus the student population is at greater risk for caries when levels of academic stress increase from low to moderate or high. Predicted values for the student population with caries by level of academic stress are shown in *Figure 1*.

In the analysis of salivary capacity for oxidation reduction, the exp(β) value indicates that students with a medium–high capacity for oxidation reduction were less likely to develop caries than those with a low capacity; however, this variable was excluded from the model because the difference was not statistically significant.

The maximum power of discrimination for the model is 73.3%. The receiver operating characteristic (ROC) curve shows the multinomial logistic regression model is clearly statically significant (*Figure 2*). The area under the ROC curve shows the logistic regression model to have good sensitivity and specificity (*Table 2*).

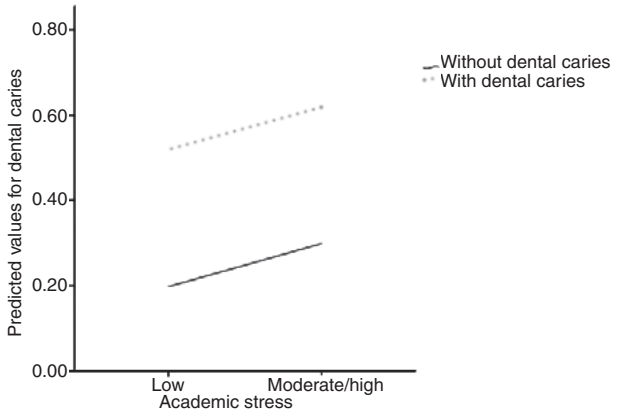

Figure 1. Predicted values for caries in the student population by level of academic stress.

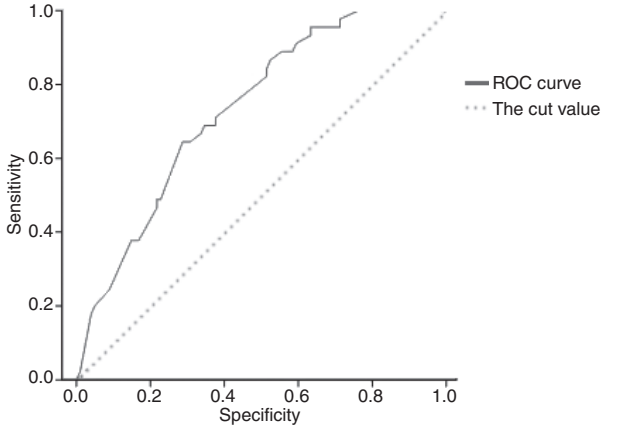

Figure 2. Curve showing the sensitivity and specificity of the logistic regression model.

Table 2 Area under the curve for sensitivity and specificity of the logistic regression model

Area	SE	Asymptotic significance	95% CI
0.733	0.042	0.000	0.651–0.815

SE, standard error; 95% CI, 95% confidence interval.

Table 1 Logistic regression results

Dental caries	Parameter	β-value	*P*-value	Standard error	Exp(β)	95% CI	
						Lower	Upper
Present	(Intersection)	−2.119	0.002	−0.822	0.120	−3.742	−0.495
	Gender	−1.020	0.053	0.584	0.361	−2.174	0.135
	Age	0.681	0.048	0.737	1.976	−0.775	2.137
	Stimulated saliva flow (≥ 1 ml/min)	0.659	0.051	0.478	1.933	−0.286	1.605
	Academic stress	1.518	0.014	0.929	4.564	−0.317	3.353
	Oxidation reduction capacity of saliva	−0.633	0.360	0.690	0.591	−1.997	0.731

SE, standard error; 95% CI, 95% confidence interval.

© 2012 FDI World Dental Federation

DISCUSSION

The results of this study in healthy students aged 18–22 years show that female gender is a risk factor for developing dental caries, that a reduction in salivary flow increases the risk for dental caries and, finally, that a statistically significant ($P = 0.014$) association between moderate or high levels of academic stress and dental caries exists.

The finding that risk for caries is greater in women than in men agrees with results reported in recent studies, such as that by Lukacs and Largaespada[16], who attributed a greater prevalence of dental caries in women to various factors, including: the greater susceptibility of girls than boys to earlier tooth eruption; the greater tendency of women to consume pieces of food while they are preparing food, and the natural consequence of hormonal changes, specifically changes of oestrogen levels during the female lifecycle at puberty, pregnancy and menopause, which influence factors such as salivary flow, thereby supporting the further development of dental caries.

Salivary flow has significant impact on the process of caries development; poor salivary flow has a direct negative consequence manifested in a greater tendency towards tooth decay. The present study confirmed that a reduction in saliva flow results in an incremental trend in the development of tooth decay. However, this finding is not consistent with research conducted by Llena-Puy *et al.*[17] or Kanasi *et al.*[18], in which no direct correlation between the presence of caries and stimulated salivary flow was identified. However, both of these studies were performed in children and the difference in the ages of the respective study populations may at least in part explain the difference in results.

As salivary flow decreases, salivary capacity for oxidation reduction also varies; if capacity is low, the risk for developing caries is higher. However, this statement is not supported by the present study because its results did not achieve statistical significance ($P = 0.360$).

In the sample in the current study, analysis of the age variable showed that subjects aged 18 years were at greater risk for tooth decay, which contradicts results reported by Protsenko and Makeeva[19], who found a high incidence of dental caries that increased with age. However, despite the incremental increase in caries in relation to age, the logistic regression model used in the latter study[19] did not show a significant difference between age groups. By contrast, the present research did show statistical differences between age groups, which may reflect the particular age ranges considered.

In the present study, academic stress levels were higher during the examination period. This is consistent with findings reported by Rajab[20], who stated: '…in periods immediately prior to examinations, students are more stressed.'

As there is no previous research correlating levels of academic stress with dental caries, the results of the present paper may be considered of great importance because they include statistically significant data showing that the risk for tooth decay increases at higher levels of stress.

Although university students are known to be affected by academic stress to varying levels, the topic has not received much research attention. It is important that the main factors that cause stress are identified and that strategies to minimise the risk for physical and mental health damage in students are implemented.

It is important to mention that dentistry students are exposed to academic stress as an inherent part of their academic training. The requirements of clinical practice, constant examinations, heavy workloads, lack of time to rest and other situations all combine to produce academic stress.

CONCLUSIONS

According to this study, age, salivary flow rate and academic stress level are each related to risk for the development of dental caries.

Acknowledgements

The authors thank Judith Serrano-Arjona, Department of Preventive Dentistry, Faculty of Dentistry, Autonomous University of the State of Mexico (UAEMex) and the students who participated in this study for their perseverance and enthusiasm.

Conflicts of interest

None declared.

REFERENCES

1. World Health Organization. Oral Health Information Systems: Oral Health Surveillance. 2010. http://www.who.int/oral_health/action/information/surveillance/en/ (Accessed 5 September 2011).
2. Petersen PE. Sociobehavioural risk factors in dental caries – international perspectives. *Community Dent Oral Epidemiol* 2005 33: 271–279.
3. Segerstrom SC, Miller GE. Psychological stress and the human immune system: a meta-analytic study of 30 years of inquiry. *Psychol Bull* 2004 130: 601–630.
4. Dhabhar FS. Enhancing versus suppressive effects of stress on immune function: implications for immunoprotection and immunopathology. *Neuroimmunomodulation* 2009 16: 300–317.
5. McEwen BS, Gianaros PJ. Central role of brain in stress and adaptation: links to socioeconomic status, health, and disease. *Ann N Y Acad Sci* 2010 1186: 190–222.

© 2012 FDI World Dental Federation

6. Baker TB, McFall RM, Shoham V. Current status and future prospects of clinical psychology toward a scientifically principled approach to mental and behavioural health care. *Psychol Sci Public Interest* 2009 9: 67–103.
7. Knoll AT, Carlezon WA. Dynorphin, stress, and depression. *Brain Res* 2010 1314: 56–73.
8. Glover DA, Steele AC, Stuber ML. Preliminary evidence for lymphocyte distribution differences at rest and after acute psychological stress in PTSD-symptomatic women. *Brain Behav Immun* 2005 19: 243–251.
9. Glaser R, Kiecolt-Glaser JK. Stress-induced immune dysfunction: implications for health. *Rev Immunol Nat* 2005 5: 243–251.
10. Litinsky M, Scheer FA, Shea SA. Influence of the circadian system on disease severity. *Sleep Med Clin* 2009 4: 143–163.
11. Chen Y, Fenoglio KA, Dubé CM *et al.* Cellular and molecular mechanisms of hippocampal activation by acute stress are age-dependent. *Mol Psychiatry* 2006 11: 992–1002.
12. Shah M, Hasan S, Malik S *et al.* Perceived stress, sources and severity of stress among medical undergraduates in a Pakistani medical school. *BMC Med Educ* 2010 10: 2.
13. Birks Y, McKendree J, Watt I. Emotional intelligence and perceived stress in health care students: a multi-institutional, multiprofessional survey. *BMC Med Educ* 2009 9: 61.
14. Official Mexican Standard NOM-013-SSA2-1994 for the prevention and control of oral diseases. 1999. http://www.salud.gob.mx/unidades/cdi/nom/013ssa24.html (Accessed 3 January 2012).
15. Barraza-Macías A. Psychometric properties of academic stress in SISCO inventory. 2007. http://www.psicologiacientifica.com/bv/psicologia-248-1-propiedades-psicometricas-del-inventario-sisco-del-estres-ac.html (Accessed 3 January 2012).
16. Lukacs JR, Largaespada L. Explaining sex differences in dental caries prevalence: saliva, hormones and life history aetiologies. *Am J Hum Biol* 2006 18: 540–555.
17. Llena-Puy MC, Montañana-Llorens C, Forner-Navarro L. Cariogenic oral flora and its relation to dental caries. *ASDC J Dent Child* 2000 67: 42–69.
18. Kanasi E, Johansson I, Lu SC *et al.* Microbial risk markers for childhood caries in paediatricians' offices. *J Dent Res* 2010 89: 378–383.
19. Protsenko AS, Makeeva IM. Factors influencing major stomatological diseases prevalence in student youth of Moscow city. *Stomatologiia (Mosk)* 2010 89: 4–6.
20. Rajab E. Effects of stress in dentist students. *J Dent Res* 2001 46: 489–499.

Correspondence to:
Cynthia Mejía-Rubalcava,
DDS, Centre of Research and Advanced Studies in Dentistry (CIEAO),
Autonomous University of the State of Mexico (UAEMex),
Paseo Tollocan esq, Jesús Carranza,
Col. Universidad, Toluca 50130, Mexico.
Email: merucy_02@hotmail.com

© 2012 FDI World Dental Federation