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Original Article

# Determining the relationship among stress, xerostomia, salivary flow rate, and the quality of life of undergraduate dental students

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الملخص

أهداف البحث: قد يؤدي جفاف الفم إلى العديد من أمراض الفم، التي تؤثر في النهاية على جودة الحياة المتعلقة بصحة الفم. تهدف هذه الدراسة إلى تقييم العلاقة بين التوتر، وجفاف الفم، ومعدل تدفق اللعاب، وجودة الحياة المتعلقة بصحة الفم بين الشباب.

طرق البحث: قمنا بدعوة ٧٢ مشاركا لإكمال ثلاث استبانات معتمدة تتضمن مقياس التوتر الملحوظ، ونسخة مختصرة من مخزون جفاف الفم وملف مختصر عن تأثير صحة الفم. تم جمع اللعاب غير المحفز وتحديد معدل التدفق. بناء على النسخة المختصرة من مخزون جفاف الفم ونقص اللعاب، كما تم تصنيف المشاركين إلى أربع مجموعات: جفاف الفم الذاتي، وجفاف الفم الذاتي والمحسوس، وجفاف الفم المحسوس، وعدم جفاف الفم الصحيح. بناء على متوسط نتيجة مقياس التوتر الملحوظ، وتم تصنيف المشاركين إلى مجموعات التوتر العالي والتوتر المنخفض.

النتائج: تم ملاحظة اختلاف كبير في معدل تدفق اللعاب غير المحفز ونتيجة مقياس التوتر الملحوظ بين مجموعات جفاف الفم، بينما لم تكن نتيجة ملف صحة الفم مختلفة إحصائيا. وتم ملاحظة ارتباط كبير بين نتائج النسخة المختصرة من مخزون جفاف الفم والملف المختصر عن تأثير صحة الفم، ومعدل تدفق اللعاب غير المحفز ومقياس التوتر الملحوظ.

الاستنتاجات: أظهرت هذه الدراسة أن التوتر الملحوظ يمكن أن يؤثر على معدل تدفق اللعاب. بين مجموعات جفاف الفم، ودرجات التوتر ومعدلات تدفق اللعاب مختلفة بشكل كبير. إضافة لذلك، فإن جفاف الفم الذاتي له تأثير على جودة الحياة المتعلقة بصحة الفم.

الكلمات المفتاحية: طلاب طب الأسنان؛ جفاف الفم؛ معدل التدفق؛ الشخص السليم؛ جودة الحياة

## Abstract

**Objective:** Xerostomia may result in several oral conditions, which ultimately affect oral health-related quality of life (OHRQOL). This study aims to evaluate the relationship of stress, xerostomia, salivary flow rate, and OHRQOL among young adults.

**Method:** We invited 72 participants to complete three validated questionnaires including the Perceived Stress Scale-10 (PSS-10), a shortened version of the Xerostomia Inventory (SXI), and the shortened Oral Health Impact Profile (S—OHIP). Unstimulated saliva was collected, and flow rate was determined. Based on the SXI scores and hyposalivation, the participants were categorised into four groups: subjective xerostomia, subjective and objective xerostomia, objective xerostomia, and true nonxerostomia. Based on the median PSS score, participants were categorised into high stress and low stress groups. Data were analysed using the Mann—Whitney U test, Kruskal—Wallis H test, and Spearman's correlation coefficient. A *p* value of 0.05 was set for all tests.

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**Results:** A significant difference was observed in the unstimulated salivary flow rate ($\chi^2(3) = 26.677$, $p < 0.001$) and PSS scores ($X^2(3) = 8.552$, $p = 0.036$) between xerostomia groups, while OHIP scores were not statistically different ($X^2(3) = 5.488$, $p = 0.139$). A significant correlation was observed between SXI and S−OHIP scores ($r = 0.348$, $p = 0.003$) and unstimulated salivary flow rate and PSS ($r = -0.259$, $p = 0.028$).

**Conclusion:** This study shows that perceived stress can influence salivary flow rate. Among the xerostomia groups, stress scores and salivary flow rates varied significantly. Additionally, subjective xerostomia has an impact on OHRQOL.

**Keywords:** Dental students; Dry mouth; Flow rate; Healthy individual; Quality of life

## Introduction

Stress is referred to as a positive or negative reaction of the body as a result of physical, emotional, or mental stimuli.[1] It may also be defined as the physiological response of the body to any demand for change.[2] Stress can be broadly classified as eustress and distress; hence, it can be positive, with health, performance, and behavioural benefits to the individual, or negative, with increased demands on the physical, emotional, and mental capabilities of the individual.[3] Stress has been reported in more than 50% of medical and dental students.[4] The perception of stress differs amongst individuals and depends on interpersonal, intrapersonal, academic, and environmental factors. It is higher in first-year undergraduate students compared to those in their senior years and more than two times higher in females compared to males.[2]

Stress and other psychological factors such as anxiety and depression are also associated with xerostomia. Xerostomia is a subjective sensation of oral dryness which may or may not be associated with a reduced salivary flow rate.[5] The overall prevalence of xerostomia is estimated to be 23% according to a systematic review and meta-analysis.[6] In a prospective study of adults aged 20−59 years, xerostomia prevalence was 11%.[7]

Many factors are associated with xerostomia such as medications, salivary gland and autoimmune diseases, psychological factors, and radiation therapy.[8] The stress-associated salivary biomarkers cortisol and calgranulin A have been reported to be associated with oral dryness and hyposalivation.[9] Stress and xerostomia are important factors which negatively affect the quality of life of an individual, and a significant correlation has been reported between perceived stress and xerostomia.[10−12] With dryness of the oral cavity, patients also report halitosis, swallowing and speech difficulties, and frequent oral ulcers.[11]

Saliva plays an important role in maintaining oral and dental health. The unstimulated salivary flow rate, representing the basal flow rate, is about 0.29 ml/min to 0.41 ml/min. A flow rate below 0.1 ml/min is considered hyposalivation and indicates salivary gland hypofunction.[13] Xerostomia due to prolonged hyposalivation may result in several oral conditions such as periodontal disease, caries, candida infections, burning mouth syndrome, tongue depapillation, tongue fissures, and mucosal ulceration[14] which ultimately affect oral health-related quality of life (OHRQOL).[12] Stress has been considered by some researchers owing to its probable role in causing xerostomia.[10,15] Most studies on xerostomia are either of geriatric patients who already suffer from co-morbidities or of patients who have underlying systemic or clinical oral diseases.[10,16] There is also insufficient evidence of the relationship between perceived stress and objective and subjective xerostomia in healthy young adults in Pakistan. Therefore, the aim of this study was to evaluate the relationship of stress, xerostomia, unstimulated salivary flow rate, and OHRQOL among young adults in stressful conditions due to end-of-year university examinations.

## Materials and Methods

### Study design and participants

For this cross-sectional study, 75 dental students in their first year of the Bachelor of Dental Surgery (BDS) at the Institute of Dentistry, CMH Lahore Medical College, in November 2019, were included through convenience sampling, after taking informed written consent. Data were collected on the day of the annual examination from the participants who appeared for the oral examination. The questionnaires and saliva sampling were conducted just before the student appeared for the Viva Voce Examination. Individuals below 18 years of age, with a systemic disease, and/or taking any medications in the last six months were excluded. The minimum required sample size was 70 participants, calculated on the basis of mean xerostomia scores using the formula $n = \left(\frac{Z*\sigma}{\Delta}\right)^2$, standard deviation ($\sigma$) of 2.03,[17] a 95% confidence interval, precision of 0.5, and a 10% non-responding rate.

### Data collection

Participants first completed the demographic form and questionnaires, after which saliva sampling was done. To determine perceived stress in the last month, the shortened version of the Perceived Stress Scale (PSS) was used. It is a widely used validated questionnaire for measuring the degree to which situations in one's life are appraised as stressful.[18] The questionnaire comprised 10 items on a five-point Likert scale. The cumulative score of the questionnaire ranges from 0 to 40. Higher scores indicate higher perceived stress. The relatively high stress and low stress groups were categorised based on the median score.[10] Those below the median value were considered the low stress group, and those equal to or above the median score were categorised in the high stress group. For xerostomia assessment, a shortened version of the Xerostomia Inventory (SXI) was

utilised. The inventory has five items referring to the experience of dry mouth in the last month. It is also valid in terms of satisfactory psychometric properties and focused questions related to the oral cavity.[19] A short version of the Oral Health Impact Profile (S−OHIP), a reliable and validated questionnaire[20] comprising 14 questions, was used for OHRQOL. The overall score ranges from 0 to 56. A higher score represents a greater oral impact and poor OHRQOL.

For the salivary flow rate assessment, participants were instructed the day before to refrain from eating, drinking, performing oral hygiene measures, and smoking for 60 min on the day of data collection. All saliva samples were collected between 8 and 10 am to minimize fluctuation in saliva secretion associated with circadian rhythm and to standardize the protocol.[21] For the saliva sample collection, each participant was asked to sit upright in a quiet room. Unstimulated saliva was collected by the draining method in a pre-weighed plastic container. The participant was asked to do an initial swallow to empty the oral cavity of any residual saliva and was instructed not to swallow the saliva afterwards until informed by the researcher. A stopwatch was used to record the initial swallow as the starting time, and the participant was informed that at the end of 5 min, they would hear a bell to signal that they should stop drooling into the container. The participant drooled into the container as soon as saliva accumulated by keeping the mouth partially open and head slightly tilted to aid the drooling. After the collection period, the container was weighed again. Subtracting the weight of the container before and after saliva collection determined the weight of the saliva in grams. As 1 g of saliva = 1 ml,[22] the unstimulated salivary flow was calculated by dividing the volume of saliva by the collection time.

Since xerostomia can be subjective, objective, or both, we categorised xerostomia on the basis of SXI scores and presence or absence of hyposalivation (whole unstimulated salivary flow rate < 0.1 ml/min[23]), based on the study by Gholami et al.[15] An SXI score equal to 5 indicated no subjective xerostomia, and scores above 5 indicated the participant had subjective xerostomia. Moreover, participants who had only hyposalivation without subjective xerostomia (SXI score 5) were considered to be objectively xerostomic. Participants with both SXI scores greater than 5 and the presence of hyposalivation were placed in the combined subjective and objective xerostomia group. True non-xerostomics were those participants who neither had SXI scores greater than 5 nor hyposalivation.

*Data analysis*

For the data analysis, categorical data were expressed as frequency and percentage. Continuous variables were presented as median, as the data were not normally distributed (Shapiro Wilk test: $p < 0.01$). The spread was presented as an interquartile range (IQR), noted as the 25th and 75th percentiles. The Mann Whitney U test was employed to compare the high stress group with the low stress group and gender-based differences between PSS, S−OHIP, and SXI. The Kruskal Wallis H test with Bonferroni adjustment was used to compare the four xerostomia status groups. Possible associations between perceived stress, salivary flow rate,

subjective xerostomia, and OHRQOL were explored with the Spearman rank correlation test. The data were analysed using SPSS, version 23.0 (IBM Corp, Armonk, NY, USA). A $p$ value of 0.05 was set for all tests.

## Results

A total of 75 students were included in this study, and the data of the participants who met the inclusion and exclusion criteria and completed the general demographic form and three validated questionnaires (72 in number, response rate 96%) were analysed. The characteristics of the study population are summarised in Table 1.

Based on SXI scores and flow rate, there were 53 (73.6%) participants who had subjective xerostomia alone, whereas nine (12.5%) participants were true non-xerostomics. The criteria for the xerostomia status, along with the unstimulated salivary flow rates, are given in Table 2. The objective assessment of xerostomia was based on the unstimulated salivary flow rate. The median unstimulated salivary flow rate of the participants was 0.26 ml/min (IQR 0.13−0.43). Ten participants (13.8%) had an unstimulated salivary flow rate below 0.1 ml/min: eight of these participants reported associated subjective xerostomia, while the remaining two did not. Of the total 72 participants, eight (11.1%) had both hyposalivation and subjective xerostomia. A Kruskal Wallis H test showed that there was a statistically significant difference in the unstimulated salivary flow rate between the different xerostomia status groups, $\chi^2(3) = 26.677$, $p < 0.001$. Additionally, the Dunn's pairwise test was carried out for the six pairs. There was a significant difference between three pairs ($p < 0.05$, adjusted using the Bonferroni correction): The objective xerostomia-only group was significantly different from the true non-xerostomia ($p = 0.047$) group, and the objective and subjective xerostomia group was significantly different from the subjective xerostomia-only group ($p < 0.001$) and true non-xerostomia group ($p < 0.000$). No gender-based difference was seen in the SXI scores ($p = 0.432$) or salivary flow rate ($p = 0.740$).

The PSS ranged between 0 (no stress) and 40 (severe stress), with a median of 23 (IQR 15−33) in the study sample. Gender-based differences were not seen in the PSS scores ($p = 0.755$). PSS scores according to xerostomia status are shown in Table 3. According to the Kruskal Wallis H test, there were statistically significant differences in PSS scores between the xerostomia status groups, $X^2(3) = 8.552$, $p = 0.036$. Dunn's pairwise test using Bonferroni adjustment showed that the PSS scores were more significantly different in the subjective and objective xerostomia group than in the objective xerostomia-only group ($p = 0.027$).

| Table 1: Study population characteristics. | |
|---|---|
| Variable | $n = 72$ |
| Mean age in years (range) | 19.4 (18−21) |
| Male, $n$ (%) | 17 (23.6) |
| Female, $n$ (%) | 55 (76.4) |

**Table 2: Participants' xerostomia status based on SXI scores and unstimulated salivary flow rate (n = 72).**

| Xerostomia status group | Criterion | n (%) | Unstimulated salivary flow rate ml/min (IQR) | p value |
|---|---|---|---|---|
| Subjective xerostomia only | SXI > 5 and unstimulated salivary flow rate > 0.1 ml/min | 53 (73.6) | 0.29 (0.18−0.44) | < 0.001 |
| Objective xerostomia only | SXI = 5 and unstimulated salivary flow rate < 0.1 ml/min | 2 (2.8) | 0.04 | |
| Subjective and objective xerostomia | SXI > 5 and unstimulated salivary flow rate < 0.1 ml/min | 8 (11.1) | 0.05 (0.03−0.07) | |
| True non-xerostomia | SXI = 5 and unstimulated salivary flow rate > 0.1 ml/min | 9 (12.5) | 0.44 (0.21−0.75) | |

**Table 3: Xerostomia status and its relationship with PSS and S−OHIP scores (n = 72).**

| Xerostomia status group | n (%) | PSS score (IQR) | $X^2$ (p value) | S−OHIP score (IQR) | $X^2$ (p value) |
|---|---|---|---|---|---|
| Subjective xerostomia only | 53 (73.6) | 23 (15−32.5) | 8.522 (0.036)* | 10 (4−17) | 5.488 (0.139) |
| Objective xerostomia only | 2 (2.8) | 6.5 | | 1.5 | |
| Subjective and objective xerostomia | 8 (11.1) | 34 (21−35.75) | | 10 (3.5−14) | |
| True non-xerostomia | 9 (12.5) | 22 (18.5−27) | | 6 (1.5−14.5) | |

$X^2$, Kruskal Wallis H test.
*Significant at the 0.05 level.

**Table 4: Comparison of different variables of high and low stress groups.**

| Variable | Low stress group PSS < 23 n = 34 | | High stress group PSS ≥ 23 n = 38 | | p value |
|---|---|---|---|---|---|
| | Median | IQR | Median | IQR | |
| SXI | 7.5 | 6−9 | 7.5 | 6−8.25 | 0.685 |
| S−OHIP | 10 | 2.75−14.5 | 10 | 4−17.25 | 0.627 |
| Unstimulated salivary flow rate | 0.3 | 0.16−0.49 | 0.23 | 0.12−0.34 | 0.133 |

Mann Whitney U test employed.

Participants who reported comparatively low stress (PSS < 23) were compared to those with relatively high stress (PSS ≥ 23), as shown in Table 4. Participants who had relatively high stress had a lower unstimulated salivary flow rate compared to those with low stress. However, the difference was not statistically significant.

The S−OHIP scores of the four xerostomia status groups are given in Table 3. The S−OHIP scores were not statistically different across the groups ($X^2(3) = 5.488$, $p = 0.139$). Similarly, the S−OHIP scores of the low stress and high stress groups were also not significant, $p = 0.627$ (Table 4). No gender difference was seen in the S−OHIP scores ($p = 0.167$).

The correlation between the SXI and S−OHIP scores was moderately positive with a statistically significant difference ($r = 0.348$, $p = 0.003$), as shown in Table 5. It shows that higher subjective xerostomia score has a greater impact on OHRQOL.

There was no correlation between SXI and PSS ($r = -0.028$, $p = 0.813$) or SXI and unstimulated salivary flow rate, as shown in Table 5. There is a moderately negative correlation between the unstimulated salivary flow rate and PSS, with a statistically significant difference ($r = -0.259$, $p = 0.028$), as shown in Table 6. The results show that students with high perceived stress had a significantly lower unstimulated salivary flow rate. No correlation was found between PSS and S−OHIP ($r = 0.159$, $p = 0.183$).

**Table 5: Correlation of the SXI with other variables.**

| Variable | r | p value |
|---|---|---|
| PSS | −0.028 | 0.813 |
| S−OHIP | 0.348 | 0.003* |
| Unstimulated salivary flow rate | 0.045 | 0.710 |

r Spearman's Rho correlation coefficient.
*Correlation is significant at the 0.05 level (2-tailed).

**Table 6: Correlation of unstimulated salivary flow rate with other variables.**

| Variable | r | p value |
|---|---|---|
| PSS | −0.259 | 0.028* |
| S−OHIP | 0.037 | 0.757 |

r Spearman's Rho correlation coefficient.
*Correlation is significant at the 0.05 level (2-tailed).

## Discussion

There were eight (11%) participants who had both subjective and objective xerostomia, which is similar to studies reported by others in more or less similar age groups.[7,24,25] Amongst our study sample, the prevalence of subjective xerostomia was 73.6%. Bergdahl and Bergdahl reported that 63% of patients who experienced taste disturbance also had subjective xerostomia.[26] Setia et al. reported that in undergraduate dental students, 21% of males and 14% of females had self-perceived dryness of the mouth.[27] However, they did not use any validated xerostomia inventory. Prevalence of xerostomia is difficult to compare with other studies owing to differences in geographical location, age group, health conditions, psychological factors, and inclusion and exclusion criteria.[6,28] We have included undergraduate dental students, in which subjective and objective xerostomia prevalence has not been previously reported in stressful situations. Some have considered subjective or objective assessment of xerostomia as a criterion for labelling a participant as xerostomic or non-xerostomic, some have used both subjective and objective tools, and still others have used a cut off SXI score of $\geq$ 10 to label a person as xerostomic.[29] We included only those participants who were in stressful situations that might have affected the results. Moreover, we categorised xerostomia status on the basis of objective and/or subjective xerostomia, as xerostomia assessment tools such as SXI only allow for an estimation of the degree of xerostomia.

We did not find any gender-based difference in objective and subjective xerostomia. Similar results to ours have been reported,[30,31] whereas others have reported that females are more likely to have xerostomia compared to males.[7,12,16] This difference could be due to a smaller sample size and comparatively younger age group in the current study.

In this study, the unstimulated salivary flow rate was significantly different between the four groups based on xerostomia status. Similar results were also reported by others,[15] though some studies have reported that xerostomia may or may not be related to hyposalivation; it can be objective and/or subjective.[32,33] The reason could be differences in the various assessment tools used for xerostomia and in the study population.

Stress is an important factor of xerostomia. In our study, perceived stress was particularly associated with xerostomia status, though PSS was not correlated with SXI. Moreover, an increase in the perceived stress score is related to a reduced unstimulated salivary flow rate. Bergdahl and Bergdahl reported that anxiety, stress, and depression play important roles in subjective oral dryness. They found medications to be responsible for causing objective xerostomia.[34] We included only participants who were not on any medications, and stress was still found to be associated with xerostomia status and reduced salivary flow rate. Similarly to our study, others have also reported that examination stress reduced the salivary flow rate.[35] Individuals with perceived stress have higher odds of having subjective xerostomia, and xerostomia has a significant impact on perceived stress.[16,36] Bulthuis et al. reported that perceived stress was particularly correlated with XI scores ($r = 0.312$, $p < 0.001$) but not with unstimulated salivary flow rate.[10] However, the difference in the sample characteristics such as the age range of participants (12–99 years, with a mean age of 51 years) could have affected their results, as there are issues with compliance and cognitive abilities at age extremes.

We found a moderately positive and statistically significant correlation between SXI scores and OHRQOL. Similar studies have reported that xerostomia significantly reduced OHRQOL.[12,29,37] Niklander et al. reported a significant difference between OHRQOL and the presence or absence of xerostomia, with a mean S–OHIP score of 20.1 $\pm$ 14.32 in the xerostomic group[12] compared to our study, in which comparatively lower median scores were reported on S–OHIP. This difference could be due to the inclusion of more healthy and younger participants in our study.

The limitations of this study are that we did not use a control group of non-stressed and age- and gender-matched individuals, which could have produced a better understanding of the association between stress and xerostomia. Moreover, the socio-economic status of the studied population was not considered, and convenience sampling was used, which may have affected the findings of our study.

## Conclusion

Within the limitations of this study, we can state that perceived stress is negatively correlated with salivary flow rate but not with subjective xerostomia, based on SXI scores. However, stress scores and salivary flow rate significantly differed in different xerostomia groups. Subjective xerostomia also has a greater impact on OHRQOL.

## Recommendations

Future studies should be conducted using a control group of non-stressed and age- and gender-matched participants involving a multi-centre sampling approach. The relationship between stress and xerostomia is in need of further evaluation. Moreover, a comparison of junior and senior dental students and their different stress-coping strategies would also produce useful insights.

## Source of funding

## Conflict of interest

The authors have no conflict of interest to declare.

## Ethical approval

This study was reviewed and assessed by the ethical review committee of the CMH Lahore Medical College and Institute of Dentistry, Lahore – Pakistan. Reference Number 74/ERC/CMHLMC Dated: 30th June 2020.

## Authors' contributions

SA conceived and designed the study, conducted research, provided research materials, collected data, and wrote the initial and final drafts of the manuscript. SA analysed and interpreted the data. URS collected and organised the data. SA participated in writing part of the manuscript and approved its final revision. All the authors have critically reviewed and approved the final draft and are responsible for the accuracy and integrity of the content and similarity index of the manuscript.

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