Stress recognition in dental students using smartphone sensor and a software: A pilot study

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INTRODUCTION

Stress!!
Stress is defined as “a state of psychological or physiological imbalance resulting from the disparity between situational demands and the individual’s ability and motivation to meet those needs.”[1]

According to Richard S Lazarus, stress is a feeling experienced when a person thinks that, “the demands exceed the personal and social resources the individual is able to mobilize.”[2]

It can be either positive or negative. Factors responsible are called – stressors. Dentistry is considered as a highly stressful occupation according to many studies. Stress among predoctoral dental students has been a subject of interest. Overwhelming burden of information leaves a minimal opportunity for the students to relax and recreate. An optimal level of stress enhances learning, while excess of stress is hazardous.[1]

Several technologies have been developed to recognize stress levels. Some methods are based on physiological signals as follows: blood pressure (BP), heart rate and
SpO$_2$ levels. The skin conductance has been considered as another biomarker for stress, where eccrine sweat activity that is controlled only by sympathetic nervous system activity is measured. Recently, sensor using skin conductance provided in a smartphone using software could be used to analyze the stress levels.[3]

This paper aims to use technology for recording and analyzing the heart rate, oxygen saturation and stress in dental students before and after their university practical examination viva, using the sensor and software provided in the smartphone that everyone can carry with them.

MATERIALS AND METHODS

The study was carried out on 70 3rd year Bachelor of Dental Surgery students, out of which 24 were male and 46 were female, who are appearing for their university practical examination. Their average age ranged between 22 and 25 years. Students are recruited for the study after written informed consent. Students with the history of neurological or psychiatric disorders, taking medicines affecting the emotional status and endocrinological profile, tendency of gingival bleeding or addicted to tobacco or alcohol were excluded from the study. The study protocol was approved by the Institutional Ethics Committee.

Heart rate, oxygen saturation and stress levels were measured using Samsung S-Health Software inbuilt in Android mobile of Samsung S 7 edge before and after their viva voce.

Heart rate was expressed in beats per minute, oxygen saturation in percentage and stress levels are measured into mild, moderate, neutral, severe and very severe based on the amount of stress.

Method

The index finger is placed for 1 min on the sensor present behind the smartphone – Samsung S7 edge. Android S-HEALTH software has three parameters: heart rate, oxygen saturation and stress level. Once the software measures, the values appear on the screen [Figures 1 and 2]. The data were compared and tabulated. Results obtained were statistically analyzed using paired “t”-test and Chi-square test. The following tables show the mean, standard deviation, standard error of probability and “P” values. $P < 0.05$ is considered statistically significant.

RESULTS

In this study, we found that individuals undergoing the natural stress of academic examinations exhibited distinct differences in levels of heart rate, oxygen saturation and stress.

Heart rate

The result of the study showed that the heart rate was found to be significantly higher ($P < 0.001$) in previva period than the postviva period. In previva, the mean heart rate was higher in females than males. However, in postviva, the mean heart rate was slightly higher in males than females [Table 1].

Oxygen saturation

The results of the study showed that the oxygen saturation was found higher in postviva period than the previva period. Comparison showed a statistically significant difference ($P < 0.01$). In previva, the mean oxygen saturation was slightly higher in females than males. However, in postviva, the oxygen saturation was slightly higher in males than females [Table 2].

Stress levels

The stress levels were found to be higher in previva period than the postviva period. Comparison showed a statistically significant difference ($P < 0.01$). The maximum number

![Figure 1: Android S-HEALTH software measuring heart rate and oxygen saturation, the values appearing on the screen](image)

| Table 1: Comparison of heart rate between previva and postviva of the entire study group |
|-------------------------------------|--------|--------|--------|-----|        |
|                                    | Mean   | SD     | SEP    | t    | $P$    | Result |
|-------------------------------------|--------|--------|--------|-----|--------|--------|
| Previva                             | 104.94 | 17.29  | 2.07   | 10.59| <0.001 | HS     |
| Postviva                            | 93.41  | 15.95  | 1.91   |     |        |        |

SD: Standard deviation, HS: Highly significant, SEP: Standard error of probability
of students showed moderate-to-severe stress in previva. However, in postviva, stress levels reached to neutral in most of the students. Gender differences in the aptitude to stress were identified. High aptitude of stress was recorded for females than males [Table 3].

**DISCUSSION**

Medical or dental curriculum is stressful, and varied levels of stress have been reported among students as suggested by Siddiqui et al. [4] and Lacey et al. [5].

Several technologies have been developed to identify stress levels. Some methods are based on physiological signals: heart rate, heart rate variability, BP, cortisol, pupil diameter and skin conductance. Activity of sympathetic and parasympathetic nervous system can be monitored through increased BP, heart rate and decreased oxygen saturation. [6]

Today, we have many wearable devices, such as mobile phones and wearable sensors, to measure physiological or behavioral stress. This paper aims to use technology to recognize stress levels using data from the software present in smartphone through sensor using skin conductance. In 2013, Sano and Picard conducted a study on “Stress Recognition using Wearable Sensors and Mobile Phones.” [3]

In this study, the values were found to be significantly higher in previva than postviva. Stress, heart rate and oxygen saturation were measured using a sensor and S-HEALTH software present in smartphone (Samsung S7 edge). The index finger of the participant was asked to place for 1 min on the sensor present behind the smartphone – Samsung S7 edge. Once the software measures, the values appear on the screen.

This study is based on skin conducance. This has been considered as another biomarker for stress, where eccrine sweat activity that is controlled by only sympathetic nervous activity is measured. [3]

**Presence of constant stress can lead to**

- Negatively affect the state of progress and level of physical health of students
- Specific dysfunctions that may endanger their mental and social health
- There has been a steady decrease of general health status
- Causes fear, incompetence, guilt and anger
- Adversely affect the learning of the curriculum, prevent concentration, decision-making and mastering other skills necessary for studying. [7]

**Methods to reduce stress**

- Formation of skills for stress resistance by the implementation of health-saving technologies in student lifestyle is necessary
- To accelerate and improve the adaptation of 1st year students to university studies, it is necessary to be constructive
- Reducing adaptation to stress among medical students was done by doing meditation
- The students should be made aware of the negative consequences of stress faced
- An efficient relaxation program as well as counseling services should be provided to such stressed students to enhance their academic performance

**Table 2: Comparison of oxygen saturation between previva and postviva of the entire study group**

|        | Mean  | SD    | SEP  | t     | P  | Result |
|--------|-------|-------|------|-------|----|--------|
| Previva| 96.79 | 1.49  | 0.18 | 6.21  | <0.01 | S     |
| Postviva| 98.64 | 3.31  | 0.57 |       |     |        |

SD: Standard deviation, S: Significant, SEP: Standard error of probability

**Table 3: Comparison of stress levels between previva and postviva of the entire study group**

|        | Mild | Moderate | Neutral | Severe | Very severe | $\chi^2$ | P  |
|--------|------|----------|---------|--------|-------------|---------|----|
| Previva| 6    | 31       | 3       | 24     | 6           | 37.8    | <0.001 |
| Postviva| 9   | 20       | 31      | 10     | 0           | (HS)    |     |

HS: Highly significant

Figure 2: Android S-HEALTH software measuring stress levels, the values appearing on the screen
• The education system needs to develop better evaluation techniques which cause less distress among students
• Teachers need to develop and promote better support programs for struggling students for their well-being and for future generations to whom they are going to serve.[7,8]

CONCLUSION

Results obtained showed that examination is a situational stress resulting in anxiety, reflected as disturbed homeostasis of the body. Although these results are preliminary with limited number of participants and data, it revealed that mobile phone software and sensor can be used to detect stress levels at any point of time. Further larger sample size along with academic performances will be conducted.

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Conflicts of interest
There are no conflicts of interest.

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