



Evaluation on Lung Functions after Examination Stress in Student Population

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Professional degrees are daunting to the learning group because of a modern curriculum that is dramatically different from high school curricula and other educational courses. It is more pronounced among first year students in educational institutions because of rivalry and demands from institution managers, academic staff and parents. Stress causes many detrimental effects in the body.

Aim: The present study planned to evaluate the effect of examination stress on the changes in lung functions among dental college students.

Materials and Methods: 20 normal students were selected and categorised into normal and stressed students. They were assessed for a lung function test using RMS helios 702 Spirometer. The parameters such as FVC, FEV1, FEV1/FVC, PEFR, FEF25-75 were assessed.

Results: It is observed that there was a decrease in the values of FVC, FEV1, FEV1/FVC, PEFR, FEF25-75 in exam stressed students when compared to normal students. The values of FEV1/FVC and FEF25-75 were statistically significant.

Conclusion: Thus, the study concluded an innovative finding that there was an inverse association with depressive symptoms in the pulmonary function test of exam stressed students which was

shown by a statistically significant decrease in FEV1/FVC and FEF25-75. Exam is really a stressful experience and affects both male and female students. Awareness should be conducted among students about ill effects of stress. Decreased stress, increased lung function results in increased academic performance.

Keywords: Exam stress; innovative finding; lung functions; FEV1/FVC ratio; FEF 25-75.

1. INTRODUCTION

Professional colleges are a learning group that is given more importance in their curriculum. The standard of education is comparatively higher for students compared to high school curricula and other educational courses [1]. So the students are liable to face a lot of issues and this is more pronounced among first year students in educational institutions because of rivalry and demands from institution managers, academic staff and parents. This Stress causes many detrimental effects in the body [2,3]. Apart from all of these stressors, evaluation stress is at the top of the list in professional classes. It is a feeling of anticipation, dread, and anxiety brought on by the idea of an upcoming deadline and apprehensive fear of exam results [4-6].

Dental students are no way different from students in other professional fields such as pharmacy, architecture, agriculture, and so on. Though a moderate amount of stress is important for students to sustain and enhance their day-to-day success and to meet exams with trust, elevated and cumulative stress may be detrimental to the body and mind. The term "stress" was first introduced by Hans Selye in 1936 and, according to him stress is "the body's non-specific response to any demand for change". Stress is known to be associated with autonomic neurobehavioral and cardiovascular changes [7-9]. In response to any kind of threat, our body is armed with a protective mechanism through neural and hormonal systems. Neural part is operated by the Autonomic Nervous System (ANS) and the hormonal part functions by the pituitary and adrenal axis. The two functions are coordinated as the Hypothalamic Pituitary Adrenal (HPA) axis. ANS provides a quick and short response in the form of "fight-or-flight" nature that makes the body withstand the stress whereas the HPA axis provides a slower and prolonged response with sufficient resources that are needed to withstand the stress [10-12]. A huge syllabus also may contribute to development of stress in undergraduate dental students [13,14]. There is a relationship between mental health and respiratory health which is well

recognized [10,15-17] however the exact nature and direction of these complex associations are not known. The stressful stimuli have a short-term and measurable influence especially on the airways [18,19]. The stress research has moved towards refinement and greater focus on the aspects perceived demand on the characteristic situation active, passive coping demands.

Learning capabilities vary among students and each student has their own method of learning [20,21] However, teaching style in a dental college cannot be modified according to individual students' preference. Examination is another factor which increases mental stress and examination related stress also increases sympathetic nervous system activity in students. [22-24] Our team has extensive knowledge and research experience that has translate into high quality publications [25-29]

Despondency, feeling nervous, having a non-interest in all the routine activities are some of the common symptoms of stress. Anxiety and stress are the leading causes of ill health and disability worldwide. More than 22 percent of the total population is suffering from depression worldwide, as per the World Health Organization (WHO) [30] This type of mental illness has been found to be more common among medical students without preponderance between males and females. It can be due to a variety of reasons, such as long and tough syllabuses, toughest exams, and long hours of classes, all of which need to be thoughtful [31-33]. One of the reasons that many medical and dental college teachers set up a toughest question paper to increase the standard of learning. So the students in this state feel difficult to clear such difficult tests. Inability to cope with a kind of expected situation, dental students sometimes succumb to poor sleep and depression, anxiety, and Stress. Previous studies reported that examination stress may lead to serious threat to the body disrupting the homeostasis and affects all the physiological systems. But the reports on the influence of examination stress on lung functions are scanty. So the present study planned to evaluate the lung functions between

normal and exam stressed undergraduate first year dental students.

2. MATERIALS AND METHODS

2.1 Study Setting

An analytical study was conducted in February 2021 among 1st year undergraduate dental students at Saveetha Dental College, Vellapanchavadi, Chennai.

2.2 Study Population

The study was conducted in 20 normal healthy male adults in the age group of 17-20 years with matching anthropometric measurements. They were screened for their medical history and physical conditions; the functional status of the respiratory system was assessed by pulmonary function test (PFT) using a spirometer (RMS Helios 702).

Exclusion criteria: Subjects with obesity, suffering from cardiorespiratory problems and subjects under steroidal medication for some reasons were excluded from the study.

2.3 Study Methods

The subjects were categorised into two groups

Group 1: Students involved in cultural activities and not stressed

Group 2: Students undergoing examination and stressed due to scoring of marks in university exams.

The ventilatory functions were assessed using RMS Helios 702 spirometer and the parameters studied were forced vital capacity (FVC), forced expiratory volume in 1st sec.(FEV1), FEV1/FVC ratio, FEV3/FVC ratio, peak expiratory flow rate (PEFR), Forced expiratory flow 25- 75(FEF 25-75)

2.4 Statistical Analysis

The values were expressed as mean \pm Stdev. The results were analysed using SPSS software (statistical packages of social sciences) version 23 and the statistical test used was independent T- Test. ($p < 0.05$)

3. RESULTS

It is observed that there is a significant decrease in the values of FVC, FEV1, FEV1/FVC, PEFR,

FEF25-75 in exam stressed students compared to normal students.

The values of FVC, FEV1 and PEFR are statistically non-significant ($p > 0.05$).

The values of FEV1/FVC and FEF25-75 are statistically significant ($p < 0.05$).

4. DISCUSSION

It is understood that the examination is a stressful experience, and its effect depends on the individual's ability to perceive and respond to it. Students are grouped under two categories. One group of students take the exam as a challenge and also have fun with less stress. Other group of students take the examination as a burden and pressure with more impact of stress. The biggest difference is that the first category understands how to handle it with proper strategy and technique, and the second category does not know or does not try to know how to manage the situation [34,35].

The knowledge of subjects evaluated by performing the examination is the normal practise that any student must face during his or her academic life. Present systems of evaluation are likely to cause discomfort both physically and mentally in the body. Hypothalamic-Pituitary-Adrenal (HPA) axis and sympathetic system are activated during stress [35]. When sympathetic system is activated that causes vasoconstriction, and tachycardia. Because of this, the cardiac output and peripheral resistance increase, which increases both systolic as well as diastolic blood pressure [36-38]. This research also revealed a rise in body temperature and respiratory rate at the time of the examination. Examination stress is a kind of psychological stress that causes mild fever [39-41]. The exact mechanism behind this is unknown. In exchange, the elevated body temperature raises the respiratory rate. Increase in temperature at rest increases the pulmonary ventilation and respiratory rate [42-44].

In the present study it is observed that there is considerable fall in PEFR value in exam stressed students when compared to normal students. Similarly in the previous research [45] that as there is an increase in stress level there is significant fall in the PEFR value. The psychosocial variables are strongly related to PEFR, thus suggesting that they play more important roles in bronchial constriction. Stress reduces PEFR through cognitive behaviour pathways or through its direct effect on the

parasympathetic system or combination of both [46,30,47]. Chronic stress induces the release of norepinephrine or related alterations in the alterations in the alpha-adrenergic receptor sensitization may facilitate an adaptation to chronic stress [48-50].

The students under stress could be advised to undertake yoga training as it helps to overcome stress. Similarly in the previous article it is stated that yoga training helps to reduce stress and increases functional vital capacity.

Table 1. Demographic characteristics of studied subjects

Sl.no.	Variable	Mean ± SD	
		Normal Students	Exam stressed Students
1	Age in years	18.3 ± 0.68	19 ± 0.82
2	Height in cms	170 ± 11.92	169 ± 11.53
3	Weight in kgs	62.1 ± 11.66	66 ± 12.59

Table 2. Mean spirometric values between normal and exam stressed students

Sl. No.	Parameters	Mean ± SD	
		Normal Subjects	Exam Stressed Subjects
1	FVC	3.209± 0.51	1.99 ± 0.417
2	FEV1	2.75 ± 0.604	1.78 ± 0.66
3	FEV1/FVC	98.47 ± 3.28	89.61 ± 6.243
4	PEFR	5.59 ± 0.948	5.07 ± 1.677
5	FEF25-75	3.57 ± 0.955	3.073 ± 0.438

Values are expressed as mean ± STEV

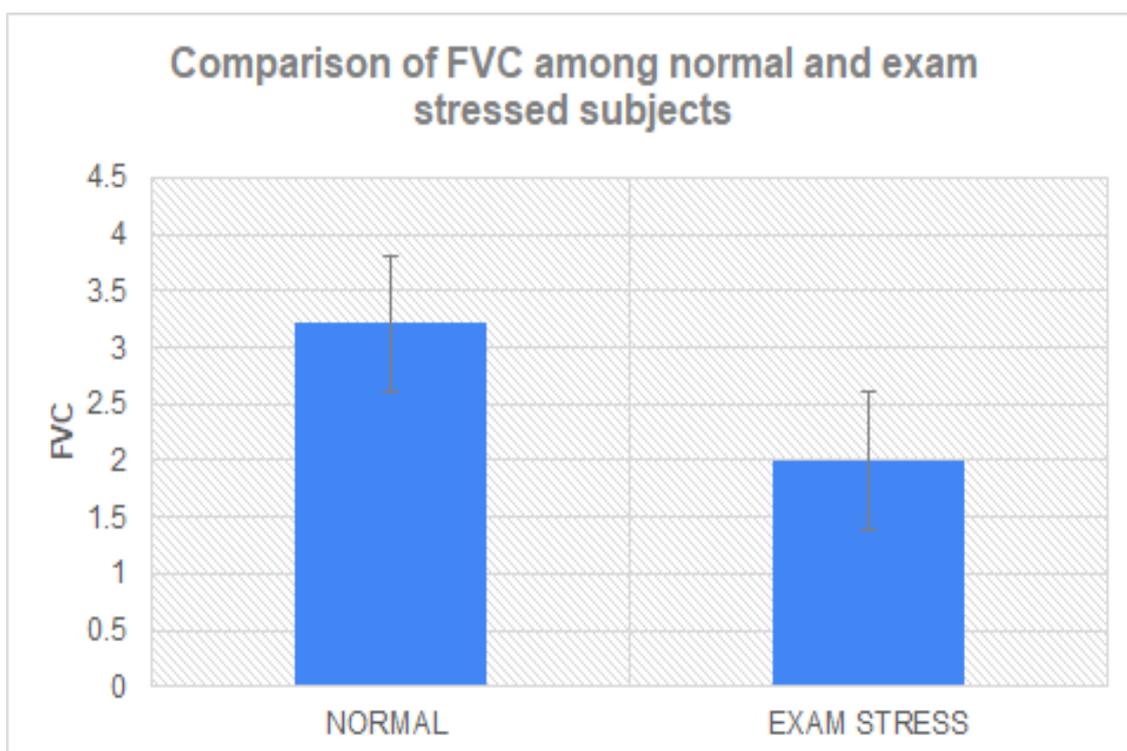


Fig. 1. Depicts the bar graph showing the comparison of FVC (l/min) between normal and exam stressed 1st year dental students. The X- axis represents the normal and stressed students and the Y axis represents FVC. It is observed that there is a decrease in FVC in exam stressed students compared to normal students. The value is statistically non-significant. (P=0.475)

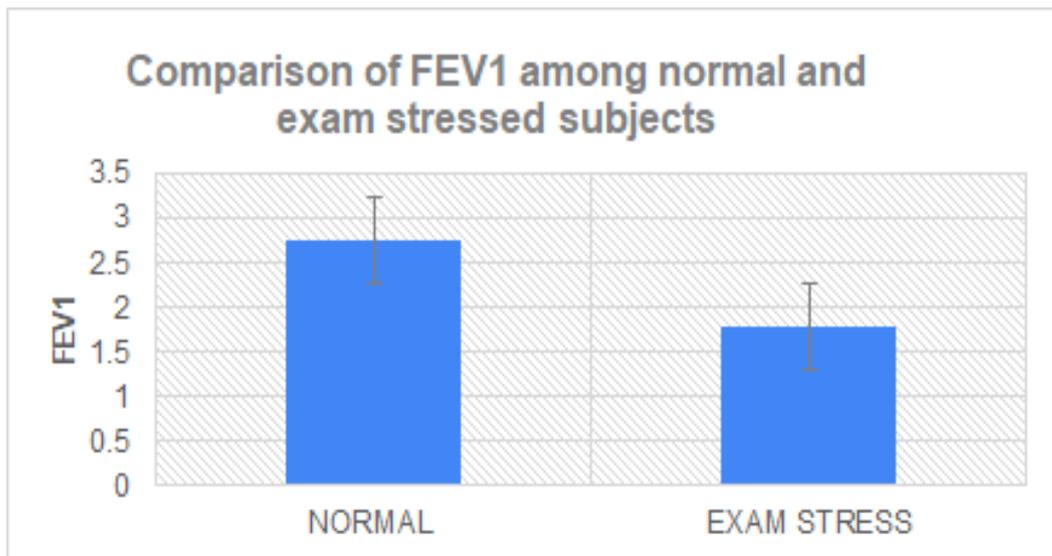


Fig. 2. Depicts the bar graph showing the comparison of FEV1 (l/min) between normal and exam stressed 1st year dental students. X axis represents the normal and exam stressed students and Y axis represents FEV1. It is observed that there is a decrease in FEV1 value in exam stressed students compared to normal students. The value is statistically non-significant (P=0.606)

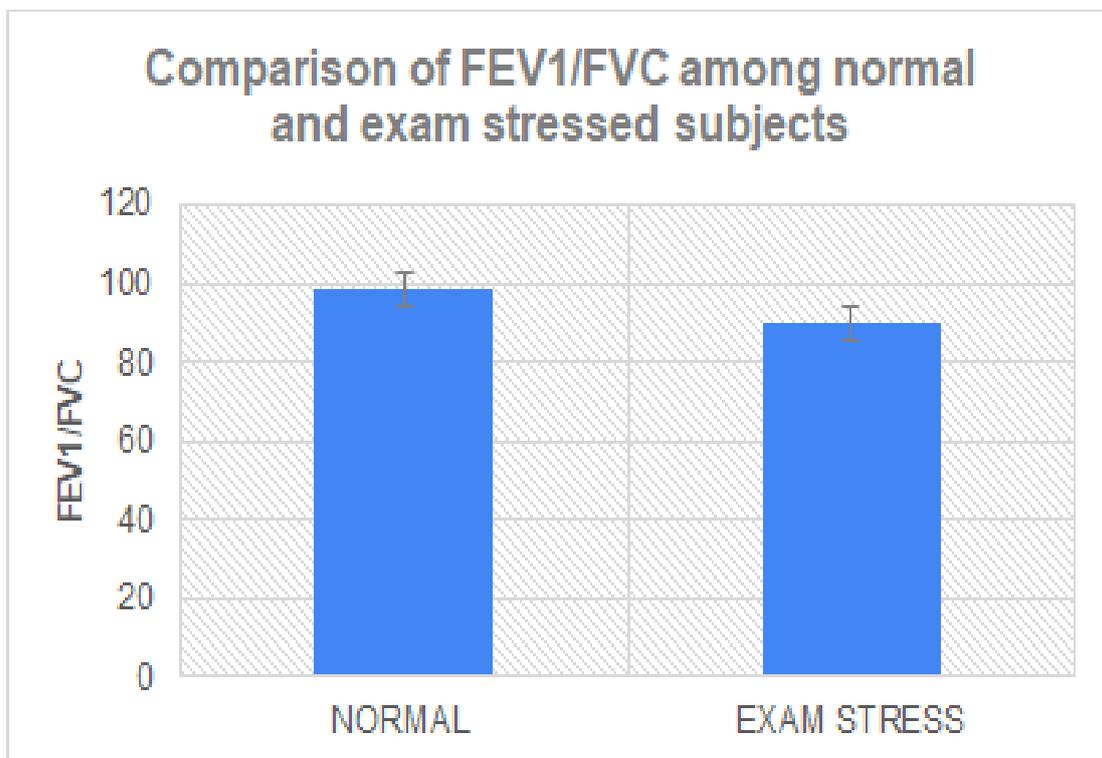


Fig. 3. Depicts the bar graph showing the comparison of the ratio Forced Expiratory Volume (FEV1) by Functional Vital Capacity (FVC) between normal and exam stressed 1st year dental students. X axis represents the normal and exam stressed students and Y axis represents the FEV1/FVC ratio. It is observed that there is a decrease in FEV1/FVC ratio value in exam stressed students compared to normal students. The value is statistically significant (P = 0.000)

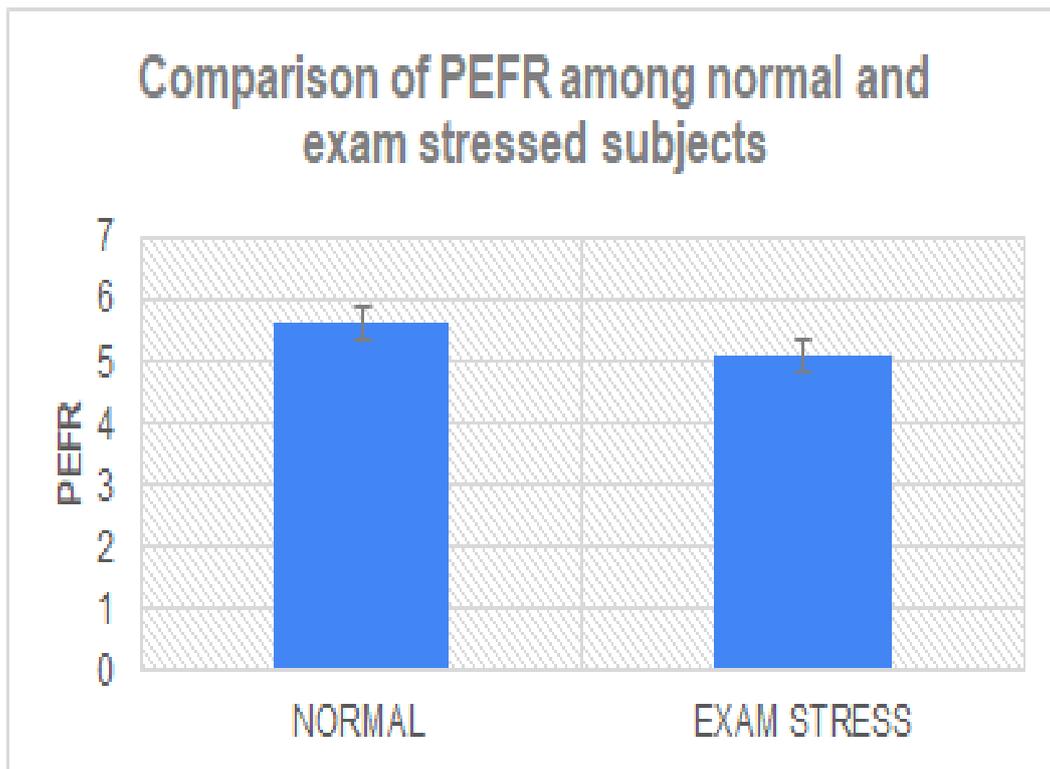


Fig. 4. Depicts the bar graph showing the comparison of Peak Expiratory Flow Rate (PEFR - l/min) between normal and exam stressed 1st year dental students. X axis represents the normal and exam stressed students and Y axis represents the PEFR. It is observed that there is a decrease in PEFR value in exam stressed students compared to normal students. The value is statistically non-significant. (P=0.428)

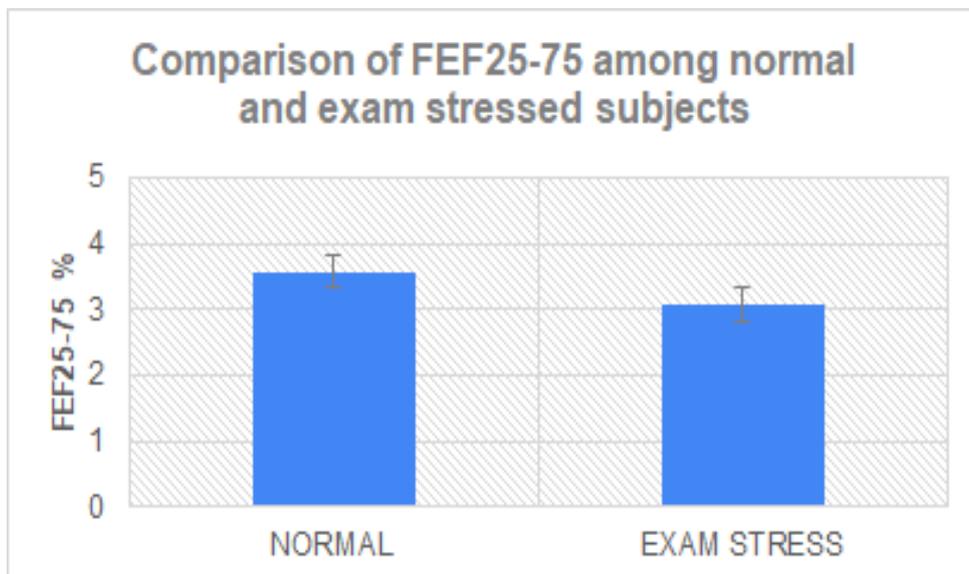


Fig. 5. Depicts the bar graph showing the comparison of Forced Expiratory Flow (FEF25-75 (l/min)) between normal and exam stressed 1st year dental students. X axis represents normal and exam stressed students and the Y axis represents FEF25-75. It is observed that there is a decrease in FEF25-75 value in exam stressed students compared to normal students. The value is statistically significant (P value 0.05)

The study creates awareness and knowledge among students about the decrease in lung function due to increased exam stress. Limitations of the study is that the number of individuals involved for the study is less in number which may be the reason for non significant values. These may be rectified in the future study in the same line with more number of subjects into consideration.

5. CONCLUSION

Thus, the study concluded an innovative finding that there was an inverse association with depressive symptoms in the pulmonary function test of exam stressed students which was shown by a statistically significant decrease in FEV1/FVC and FEF25-75. Stress has many detrimental effects on our bodily functions, especially lung functions. Stress has severe effects on asthmatic patients. This study flashes light on examination stress of the student population prone to go for unhealthy coping strategies. Much awareness should be created about the ill effects of stress. Counseling should be done for students who are under high exam stress, to decrease their stress level and thereby increase their academic performance. There should be a change in exam pattern that decreases the stress level of the students.

CONSENT

Informed consent was obtained from all the subjects after explaining the experimental procedure

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. A study on stressors of academic stress among students pursuing entrepreneurship professional courses. *Journal of Contemporary Issues in Business and Government* 2021;26. <https://doi.org/10.47750/cibg.2020.26.02.099>.
2. Nikkhou MR. The prevalence of stress feeling and physical complaints due to educational factors in Iranian high school students. *PsycEXTRA Dataset* 2005. <https://doi.org/10.1037/e538922013-183>.
3. RH, Hannah R, Ramani P, Ramanathan A, Jancy MR, Gheena S, et al. CYP2 C9 polymorphism among patients with oral squamous cell carcinoma and its role in altering the metabolism of benzo[a]pyrene. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology* 2020;130:306–12. <https://doi.org/10.1016/j.oooo.2020.06.021>.
4. Istianah, Istianah I, Hayati SN, Rustandi B. STRESS LEVELS AND EXAM RESULT AT GASTROINTESTINAL LESSON IN SCHOOL OF NURSING. *INDONESIAN NURSING JOURNAL OF EDUCATION AND CLINIC (INJEC)* 2018;1:206. <https://doi.org/10.24990/injec.v1i2.78>.
5. Barabadi H, Mojab F, Vahidi H, Marashi B, Talank N, Hosseini O, et al. Green synthesis, characterization, antibacterial and biofilm inhibitory activity of silver nanoparticles compared to commercial silver nanoparticles. *Inorg Chem Commun* 2021;129:108647.
6. Santhakumar P, Roy A, Mohanraj KG, Jayaraman S, Durairaj R. Ethanolic Extract of Capparis decidua Fruit Ameliorates Methotrexate-Induced Hepatotoxicity by Activating Nrf2/HO-1 and PPAR γ Mediated Pathways. *Indian Journal of Pharmaceutical Education and Research* 2021;55:s265–74. <https://doi.org/10.5530/ijper.55.1s.59>.
7. Mishra SP, Professor A, Department of Physiology, M. K. C. G. Medical College, Ganjam, Odisha. Assessment of Mental Stress among First Year Medical Students and Change in Level of Stress before Examination. *Journal of Medical Science And Clinical Research* 2017;05:18280–4. Available:<https://doi.org/10.18535/jmscr/v5i3.03>

8. Bharath B, Perinbam K, Devanesan S, AlSalhi MS, Saravanan M. Evaluation of the anticancer potential of Hexadecanoic acid from brown algae *Turbinaria ornata* on HT-29 colon cancer cells. *J Mol Struct* 2021;1235:130229.
9. Saraswathi I, Saikarthik J, Senthil Kumar K, Srinivasan KM, Ardhanaari M, Gunapriya R. Impact of COVID-19 outbreak on the mental health status of undergraduate medical students in a COVID-19 treating medical college: a prospective longitudinal study. *Peer J* 2020;8:e10164.
<https://doi.org/10.7717/peerj.10164>.
10. Brewis AA. Hormones, Health, and Behavior: A Socio-Ecological and Lifespan Perspective. C. Panter-Brick, C. M. Worthman. *The Quarterly Review of Biology* 2001;76:273-4.
<https://doi.org/10.1086/393981>.
11. Clarizia G, Bernardo P. Diverse Applications of Organic-Inorganic Nanocomposites: Emerging Research and Opportunities: Emerging Research and Opportunities. IGI Global; 2019.
12. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. *J Oral Pathol Med* 2019;48:299-306.
13. Mani AP, Professor A, Department of Physiology, Al- Azhar Medical College and Super Specialty Hospital, Thodupuzha, Kerala, et al. A Study of Perceived Stress Levels in First Year Medical Students in South India. *International Physiology* 2018;6:90-3.
<https://doi.org/10.21088/ip.2347.1506.6218.8>.
14. Egbuna C, Mishra AP, Goyal MR. Preparation of Phytopharmaceuticals for the Management of Disorders: The Development of Nutraceuticals and Traditional Medicine. Academic Press; 2020.
15. Rimington LD, Davies DH, Lowe D, Pearson MG. Relationship between anxiety, depression, and morbidity in adult asthma patients. *Thorax* 2001;56:266-71.
16. Bisschop MI, Isabella Bisschop M, Kriegsman DMW, Deeg DJH, Beekman ATF, van Tilburg W. The longitudinal relation between chronic diseases and depression in older persons in the community: the Longitudinal Aging Study Amsterdam. *Journal of Clinical Epidemiology* 2004;57:187-94.
<https://doi.org/10.1016/j.jclinepi.2003.01.001>.
17. Ritz T, Kullowatz A. Effects of Emotion and Stress on Lung Function in Health and Asthma. *Current Respiratory Medicine Reviews* 2005;1:209-18.
<https://doi.org/10.2174/1573398054022993>.
18. Ritz T. Airway responsiveness to psychological processes in asthma and health. *Front Physiol* 2012;3:343.
19. Miller BD, Wood BL, Lim J, Ballow M, Hsu C. Depressed children with asthma evidence increased airway resistance: "Vagal bias" as a mechanism? *Journal of Allergy and Clinical Immunology* 2009;124:66-73.e10.
<https://doi.org/10.1016/j.jaci.2009.04.038>.
20. Mondal H, Mondal S, Das D. Learning style preference for basic medical science: A key to instructional design. *International Journal of Clinical and Experimental Physiology* 2016;3:122.
<https://doi.org/10.4103/2348-8832.191581>.
21. Ezhilarasan D. Critical role of estrogen in the progression of chronic liver diseases. *Hepatobiliary Pancreat Dis Int* 2020;19:429-34.
22. Kar M. Evaluation of Examination Stress and Its Effect on Cognitive Function among First Year Medical Students. *Journal Of Clinical And Diagnostic Research* 2014.
<https://doi.org/10.7860/jcdr/2014/9014.4680>.
23. Gowhari Shabgah A, Ezzatifar F, Aravindhan S, Olegovna Zekiy A, Ahmadi M, Gheibihayat SM, et al. Shedding more light on the role of Midkine in hepatocellular carcinoma: New perspectives on diagnosis and therapy. *IUBMB Life* 2021;73:659-69.
24. Martire S. Interferon-beta and regulatory cells: evaluation of treatment-induced modulation of Treg, Breg and CD56bright NK cell levels in multiple sclerosis patients n.d.
<https://doi.org/10.26226/morressier.59a3edabd462b8028d89536c>.
25. Rajendran R, Kunjusankaran RN, Sandhya R, Anilkumar A, Santhosh R, Patil SR. Comparative Evaluation of Remineralizing Potential of a Paste Containing Bioactive Glass and a Topical Cream Containing Casein Phosphopeptide-Amorphous Calcium Phosphate: An in Vitro Study.

- Pesquisa Brasileira Em Odontopediatria E Clínica Integrada 2019;19:1–10.
<https://doi.org/10.4034/pboci.2019.191.61>.
26. Ashok BS, Ajith TA, Sivanesan S. Hypoxia-inducible factors as neuroprotective agent in Alzheimer's disease. *Clin Exp Pharmacol Physiol* 2017;44:327–34.
 27. Sureshbabu NM, Selvarasu K, Jayanth KV, Nandakumar M, Selvam D. Concentrated Growth Factors as an Ingenious Biomaterial in Regeneration of Bony Defects after Periapical Surgery: A Report of Two Cases. *Case Reports in Dentistry* 2019;2019:1–6.
<https://doi.org/10.1155/2019/7046203>.
 28. Mohan M, Jagannathan N. Oral field cancerization: an update on current concepts. *Oncol Rev* 2014;8:244.
 29. Menon S, Ks SD, R S, S R, S VK. Selenium nanoparticles: A potent chemotherapeutic agent and an elucidation of its mechanism. *Colloids Surf B Biointerfaces* 2018;170:280–92.
 30. Mudigonda SK, Murugan S, Velavan K, Thulasiraman S, Krishna Kumar Raja VB. Non-suturing microvascular anastomosis in maxillofacial reconstruction- a comparative study. *J Craniomaxillofac Surg* 2020;48:599–606.
 31. Jiang CX, Li ZZ, Chen P, Chen LZ. Prevalence of Depression Among College-Goers in Mainland China: A Methodical Evaluation and Meta-Analysis. *Medicine* 2015;94:e2071.
 32. Sarokhani D, Delpisheh A, Veisani Y, Sarokhani MT, Manesh RE, Sayehmiri K. Prevalence of Depression among University Students: A Systematic Review and Meta-Analysis Study. *Depression Research and Treatment* 2013;2013:1–7.
<https://doi.org/10.1155/2013/373857>.
 33. Vivekanandhan K, Shanmugam P, Barabadi H, Arumugam V, Daniel Raj Daniel Paul Raj D, Sivasubramanian M, et al. Emerging Therapeutic Approaches to Combat COVID-19: Present Status and Future Perspectives. *Front Mol Biosci* 2021;8:604447.
 34. Abraham SG, Sridevi G, Sembulingam P. Gender Difference in the Impact of Examination Stress on Psychological and Physiological Profiles of Dental Students. *IOSR Journal of Dental and Medical Sciences* 2016;15:101–8.
<https://doi.org/10.9790/0853-150904101108>.
 35. J PC, Marimuthu T, C K, Devadoss P, Kumar SM. Prevalence and measurement of anterior loop of the mandibular canal using CBCT: A cross sectional study. *Clin Implant Dent Relat Res* 2018;20:531–4.
 36. Hausberg M, Barenbrock M, Hohage H, Müller S, Heidenreich S, Rahn K-H. ACE Inhibitor Versus β -Blocker for the Treatment of Hypertension in Renal Allograft Recipients. *Hypertension* 1999;33:862–8.
<https://doi.org/10.1161/01.hyp.33.3.862>.
 37. Wahab PUA, Madhulaxmi M, Senthilnathan P, Muthusekhar MR, Vohra Y, Abhinav RP. Scalpel Versus Diathermy in Wound Healing After Mucosal Incisions: A Split-Mouth Study. *J Oral Maxillofac Surg* 2018;76:1160–4.
 38. Oparil S, Amin Zaman M, Calhoun DA. Pathogenesis of Hypertension. *Annals of Internal Medicine* 2003;139:761.
<https://doi.org/10.7326/0003-4819-139-9-200311040-00011>.
 39. Oka T, Kanemitsu Y, Sudo N, Hayashi H, Oka K. Psychological stress contributed to the development of low-grade fever in a patient with chronic fatigue syndrome: a case report. *BioPsychoSocial Medicine* 2013;7:7.
<https://doi.org/10.1186/1751-0759-7-7>.
 40. Manjunath Kamath S, Jaison D, Rao SK, Sridhar K, Kasthuri N, Gopinath V, et al. In vitro augmentation of chondrogenesis by Epigallocatechin gallate in primary Human chondrocytes - Sustained release model for cartilage regeneration. *J Drug Deliv Sci Technol* 2020;60:101992.
 41. Tahmasebi S, Qasim MT, Krivenkova MV, Zekiy AO, Thangavelu L, Aravindhan S, et al. The effects of oxygen–ozone therapy on regulatory T- cell responses in multiple sclerosis patients. *Cell Biology International* 2021;45:1498–509.
<https://doi.org/10.1002/cbin.11589>.
 42. Haldane JS. The Influence of High Air Temperatures: No. 1. *J Hyg* 1905;5:494–513.
 43. Bazett HC, Thurlow S, Crowell C, Stewart W. STUDIES ON THE EFFECTS OF BATHS ON MAN. *American Journal of Physiology-Legacy Content* 1924;70:430–52.
<https://doi.org/10.1152/ajplegacy.1924.70.2.430>.
 44. Wadhwa R, Paudel KR, Chin LH, Hon CM, Madheswaran T, Gupta G, et al. Anti-

- inflammatory and anticancer activities of Naringenin-loaded liquid crystalline nanoparticles in vitro. *J Food Biochem* 2021;45:e13572.
45. Smyth JM, Soefer MH, Hurewitz A, Kliment A, Stone AA. Daily psychosocial factors predict levels and diurnal cycles of asthma symptomatology and peak flow. *J Behav Med* 1999;22:179–93.
46. Oei TPS, Bullbeck K, Campbell JM. Cognitive change process during group cognitive behaviour therapy for depression. *Journal of Affective Disorders* 2006;92: 231–41.
<https://doi.org/10.1016/j.jad.2006.02.004>.
47. Rajakumari R, Volova T, Oluwafemi OS, Rajesh Kumar S, Thomas S, Kalarikkal N. Grape seed extract-soluplus dispersion and its antioxidant activity. *Drug Dev Ind Pharm* 2020;46:1219–29.
48. Monnier L, Mas E, Ginet C, Michel F, Villon L, Cristol J-P, et al. Activation of oxidative stress by acute glucose fluctuations compared with sustained chronic hyperglycemia in patients with type 2 diabetes. *JAMA* 2006;295:1681–7.
49. Nambi G, Kamal W, Es S, Joshi S, Trivedi P. Spinal manipulation plus laser therapy versus laser therapy alone in the treatment of chronic non-specific low back pain: a randomized controlled study. *Eur J Phys Rehabil Med* 2018;54:880–9.
50. Solai Prakash AK, Devaraj E. Cytotoxic potentials of *S. cumini* methanolic seed kernel extract in human hepatoma HepG2 cells. *Environ Toxicol* 2019;34:1313–9.

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