

Original Research Article

COMPARATIVE STUDY OF LUNG FUNCTION TEST AMONG BALLOONING AND PURSUING LIP EXERCISE

Running title: Lung function test analysis.

ABSTRACT

Introduction: Lung function tests have been routinely taken for diseased people such as COPD, asthma patients. Exercise and food habits play a vital role in improvement in lung function among these people. Hence, the current study is to assess the lung function parameters among the population performing lip and ballooning exercises.

Materials and Methods: The present study was carried out among the participants with the age of 18- 25 years from saveetha dental college. 45 healthy volunteers were divided into three groups. Each group consists of 15 individuals. Group 1: Control; Group 2: Ballooning exercise subjects; Group 3: Pursuing lip exercise individuals. RMS Helios spirometer was used to measure lung volumes and capacities like FVC, FEV1, PEF, PEF 25-75, FEV3. Statistical analysis was done using SPSS software, student 't' test. P value of less than or equal to 0.05 was considered to be as statistically significant.

Results: FEV1/FVC is statistically significant among lip exercises (88.61 ± 12.03) but insignificant among ballooning exercises than control individuals (97.61 ± 6.32). FEF25-75 is statistically more significant among pursuing lip exercise (2.65 ± 1.74) than ballooning and control individuals. FVC is statistically more significant among ballooning (1.99 ± 0.27) than pursuing lip exercise and control individuals.

Conclusion: It is evident that the subjects performing ballooning exercise have significant increase in lung capacity in comparison with the subjects pursuing lip exercise. Regular exercise produces a positive effect on the lung by increasing the pulmonary capacities. The present study revealed that regular breathing exercise has an important role in determining and improving lung volumes and capacities.

KEYWORDS: Pulmonary function test, lung volume, exercise, COPD, spirometer, Innovative technology

INTRODUCTION:

Spirometry assesses the integrated mechanical function of the lung, chest wall, respiratory muscles, and airways by measuring the total volume of air exhaled from a full lung (total lung capacity [TLC]) to maximal expiration (residual volume [RV]). The forced vital capacity (FVC) and the forced expiratory volume in the first second of the forceful exhalation (FEV1), should be repeatable to within 0.15 L. Reduction in FEV1 may reflect reduction in the maximum inflation of the lungs (TLC); obstruction of the airways; respiratory muscle weakness; or submaximal expiratory force due to poor coaching, poor understanding, or malingering. Airway obstruction is the most common cause of reduction in FEV1 (1). Vital capacity is determined by the lung dimensions, compliance and respiratory muscle power whereas PEFR is determined mainly by airway caliber, alveolar elastic recoil and respiratory muscle effort. The significance of FEF₂₅₋₇₅ is used for measuring the identified points at which 25% and 75% of the forced vital capacity has been exhaled and the calculated change in volume divided by the change in time. Using forced vital capacity as primary reference means that the measured FEF₂₅₋₇₅ is highly dependent on forced vital capacity volume (2). Cv for FEF₂₅₋₇₅ for 5-6yrs is 20% and its normal range is 40% to 160% (3). Mid expiratory flow rate of 25-75% is the average forced expiratory flow rate in the middle 50% of the forced vital capacity. It helps in diagnosis of obstructive ventilators pattern and is dependent on forced vital cocotte in turn FEF₂₅₋₇₅ which is highly variable. The significance of PEFR is a quick test to measure air flowing out the lungs and is mostly done for the people who have asthma (4).

That is, expiration is due to elastic forces of the lung just like balloons deflate faster at the start, so do lungs since flow depends on the elastic tension of the lungs. It measures the airflow through bronchi and also the degree of obstruction in the airways useful for asthma patients for the detection of narrow airways even before the symptoms appear. PEFR is mostly affected by height and weight. There is a good correlation between PEFR and FEV1 (5) it's normal range is 80% to 100%. FEV₃/FVC is 94% approx. It is used for early detection of airway obstruction and indicator of mild lung injury. (6)(7)

Physical activity decreases the risk of premature mortality and chronic diseases like cardiovascular diseases and diabetes mellitus (8). Advantages of performing exercises also involve people with chronic lung diseases COPD (5). Earlier researchers stated that regular exercising people have lower risk of hospital enters and all cause mortality in COPD patients(9). In recent studies, physical activity has shown association with slower age- related reductions of the forced expiratory volume in 1s in adults (10). Decrease in FEV1 means lung disease is getting worse (11). Furthermore, studies among sedentary and subjects performing exercises there is a significant increase in parameters and improved lung diffusion capacity among exercise performing subjects (12). It is known that pulmonary functions vary to the physical characteristics like age, height, weight, altitude. However, very less non-diseased population

Comment [H1]: Explain how this relates to the pursing lip exercise!. What are the reasons for choosing this intervention?

were involved in physical activities in elderly age (13). According to studies during exercising, the heart and the lungs come into action. When exercising, muscles work hard, the body requires more oxygen and more carbon dioxide is produced. When the lung is healthy, large breathing reserve volume is maintained (14)(15).

The period of exercise to bring improvement in PFT varied from 1 month to 8 months reported by various researchers in India. (16,17) The possible explanation is that regular forceful inspiration and expiration during exercise leads to strengthening of the respiratory muscles which in turn help the lungs to inflate and deflate maximally. This maximum inflation and deflation is an important physiological stimulus for the release of surfactant as stated by (16). The present study finding can also be explained on the basis of better functions of respiratory muscle strength, improved thoracic mobility and the balance between lung and chest elasticity which the athletes may have gained from regular exercise. Hence regular physical activity causes many desirable physiological, psychological and physical changes in the individual (6,18).

Our team has extensive knowledge and research experience that has translate into high quality publications(19–21)(22–27),(28)(29),(30),(31)(32)(33–37)

The main aim of the study is to measure the lung parameters between ballooning exercisers and pursuing lip exercisers

MATERIALS AND METHOD:

The present study was carried out among the participants with the age of 18- 25 years from saveetha dental college. 45 healthy volunteers were divided into three groups. Each group consists of 15 individuals. Group 1: Control; Group 2: Ballooning exercise subjects; Group 3: Pursuing lip exercise individuals. RMS Helios spirometer was used to measure lung volumes and capacities like FVC, FEV1, PEFR, PEF 25-75, FEV3. Statistical analysis was done using SPSS software, student 't' test. P value of less than or equal to 0.05 was considered to be as statistically significant. Ballooning exercise involves breathing in and out of air while the balloon deflates and inflates whereas pursuing lip exercise is breathe in through the nose for 2 seconds, purse the lips (pout shape) breathe out very slowly through pursed lips for 4 to 6 seconds and repeat

Comment [H2]: What is the sampling technique used for this study? What are the study's inclusion and exclusion criteria?

Comment [H3]:

RESULT AND DISCUSSION:

The purpose of this study is to compare the vital capacity of the subjects performing ballooning and lip exercises through lung function tests. From the figure 1 & 2, it was evident that the subjects performing ballooning exercise have significant increase in lung capacity in comparison with the subjects pursuing lip exercise.

After the performance, there was a significant increase in the lung capacity of the subjects performing ballooning exercises than pursuing lip exercises. Researchers stated that physical activity increases the performance of the lung as it is the vital organ responsible for the distribution of the oxygen and excretion of carbon dioxide. People who follow high intensity training have a risk of developing exercise induced asthma or a condition known as bronchial hyperresponsiveness in which the airways are blocked after exercise (4,38).

In this study it is evident that performing regular exercises has a vital role in increasing the lung capacities and volume. There are significant changes in all the parameters when it is compared to the control group but the difference between each parameter is less as the time considered for the exercises is very less FEV₃/FVC shows significance whereas rest other parameters show only differences (Table 1).

Ballooning exercising population has shown improvement in several ventilation related outcomes when compared to pursuing lip exercises population (39). But were not shown possible improvement in COPD patients compared to non-exercising group (3).

The FEV1/FVC ratio when coupled with other parameters could be used as a predictor of obstructive and restrictive patterns of lung disorders (40)(41). In the present study, the mean of the percentage of predicted value of FEV1/FVC for Sedentary subjects was more or less the same whereas ballooning has less value compared to pursuing lip exercise. Some previous studies (42) have observed no significant differences in vital capacity in athletes when compared with non- athletes. The conflicting findings may be due to genetic and ethnic factors.

Population performing ballooning exercises showed significant increase in FVC, VC, PEFr, FEV₁, FEF₂₅₋₇₅, FEV₃ when compared to the pursuing lip exercises population (43,44). While the ballooning group's thoracic muscles interact for the activity and also basic respiratory muscles such as diaphragm, intercostal muscle and external intercostal muscles and accessory muscles involved in the lifting of rib cage action thereby increasing the vital capacity and lung function on performing regularly (45).

The reference articles were collected electronically and only articles published in english were referred for manuscript writing. The research took place for 10 days where each individual performed their respective exercise thrice a day. And very little population count of 15 was only considered for the exercise aspect as the outcome will have visible differences in a short time period. This experiment can be conducted on various racial populations and also as a comparison on swimmers and sprinters as each environment and exercise requires different amounts of breathing capacity.

PARAMETERS	BALLOONING			PURSING LIP		
	PRE	POST	Paired 't' test	PRE	POST	Paired 't' test
FVC	1.50±0.47	1.99±0.27	0.07	2.16±0.85	2.28±0.65	0.37
FEV ₁	1.82±0.83	1.93±0.23	0.77	2.13±0.85	2.03±0.72	0.33
FEV ₁ /FVC	97.76±5.01	97.13±6.32	0.34	98.63±2.83	88.61±12.03	0.06
PEFR	4.40±0.98	3.92±0.44	0.28	4.42±0.88	3.34±2.21	0.13
FEF 25-75	3.26±1.10	3.04±0.69	0.54	3.93±1.03	2.65±1.70	0.07
FEV ₃	1.73±0.60	1.99±0.27	0.24	2.16±0.85	2.28±0.65	0.37

Table 1: Mean, standard deviation of ballooning and pursuing lip exercise, its significance

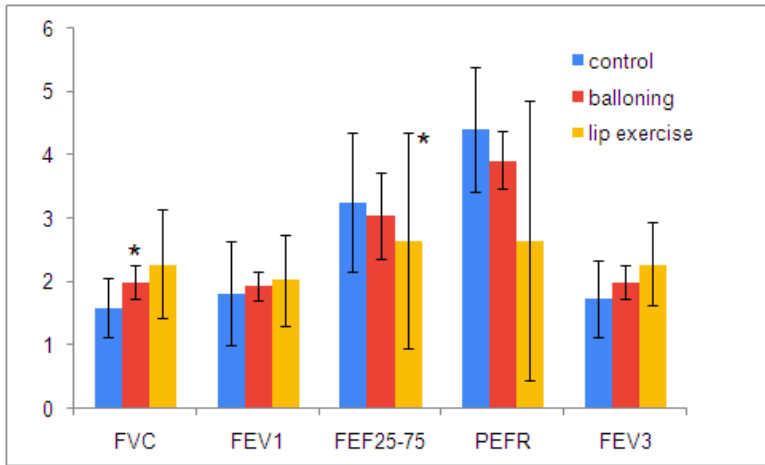


Figure 1: This bar graph represents Post parameters of lung volumes and capacities, where the X axis represents FVC, FEV₁, FEF₂₅₋₇₅, PEFR and FEV₃ and the Y axis represents mean value of individuals. Blue colour denotes control test individuals, red colour indicates ballooning test individuals and yellow colour indicates lip exercise test individuals. * represent statistically significant.

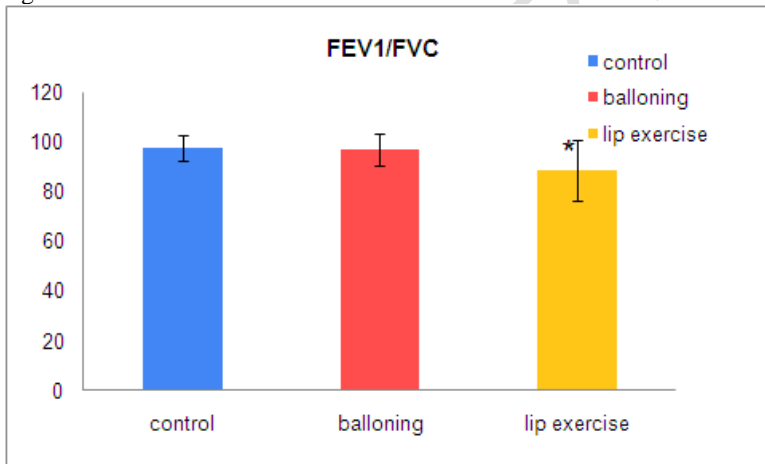


Figure 2: This bar graph represents Pre and Post FEV₁/FVC of lung volumes and capacities, where X axis denotes FEV₁/FVC and Y axis denotes count in number, red colour indicates ballooning test individuals and yellow colour indicates lip exercise test individuals. * represent statistically significant.

CONCLUSION:

There is a slight increase in lung capacity in both the subjects but only ballooning subjects show significance in FEV₁/FVC. Regular exercise produces a positive effect on the lung by increasing

the pulmonary capacities. The present study revealed that regular breathing exercise has an important role in determining and improving lung volumes and capacities.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors

REFERENCES:

1. Ubolnuar N, Tantisuwat A, Thaveeratitham P, Lertmaharit S, Kruapanich C, Mathiyakom W. Effects of Breathing Exercises in Patients With Chronic Obstructive Pulmonary Disease: Systematic Review and Meta-Analysis. *Ann Rehabil Med*. 2019 Aug;43(4):509–23.
2. Drewek R, Garber E, Stanclik S, Simpson P, Nugent M, Gershan W. The FEF25-75 and its decline as a predictor of methacholine responsiveness in children. *J Asthma*. 2009 May;46(4):375–81.
3. Landolfo F, Conforti A, Columbo C, Savignoni F, Bagolan P, Dotta A. Functional residual capacity and lung clearance index in infants treated for esophageal atresia and tracheoesophageal fistula. *J Pediatr Surg*. 2016 Apr;51(4):559–62.
4. Sheffer AL, Silverman M, Woolcock AJ, Díaz PV, Lindberg B, Lindmark B. Long-term safety of once-daily budesonide in patients with early-onset mild persistent asthma: results of the Inhaled Steroid Treatment as Regular Therapy in Early Asthma (START) study. *Ann Allergy Asthma Immunol*. 2005 Jan;94(1):48–54.
5. Carson KV, Chandratilleke MG, Picot J, Brinn MP, Esterman AJ, Smith BJ. Physical training for asthma. *Cochrane Database Syst Rev*. 2013 Sep 30;(9):CD001116.
6. Chen L, Liu X, Wang Q, Jia L, Song K, Nie S, et al. Better pulmonary function is associated with greater handgrip strength in a healthy Chinese Han population. *BMC Pulm Med*. 2020 Apr 29;20(1):114.
7. 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 [Internet]. Vol. 8, *PeerJ*. 2020. p. e10164. Available from: <http://dx.doi.org/10.7717/peerj.10164>

8. Warburton DER, Bredin SSD. Health Benefits of Physical Activity: A Strengths-Based Approach. *J Clin Med Res* [Internet]. 2019 Nov 21;8(12). Available from: <http://dx.doi.org/10.3390/jcm8122044>
9. Diaz AA. Paraseptal Emphysema: From the Periphery of the Lobule to the Center of the Stage. *Am J Respir Crit Care Med*. 2020 Sep 15;202(6):783–4.
10. Mikalsen IB, Halvorsen T, Juliusson PB, Magnus M, Nystad W, Stensrud T, et al. Early life growth and associations with lung function and bronchial hyperresponsiveness at 11-years of age. *Respir Med*. 2021 Jan 8;177:106305.
11. Luzak A, Karrasch S, Wacker M, Thorand B, Nowak D, Peters A, et al. Association of generic health-related quality of life (EQ-5D dimensions) and inactivity with lung function in lung-healthy German adults: results from the KORA studies F4L and Age. *Qual Life Res*. 2018 Mar;27(3):735–45.
12. Lazovic B, Mazic S, Suzic-Lazic J, Djelic M, Djordjevic-Saranovic S, Durmic T, et al. Respiratory adaptations in different types of sport. *Eur Rev Med Pharmacol Sci*. 2015 Jun;19(12):2269–74.
13. Ghosh AK, Ahuja A, Khanna GL. Pulmonary capacities of different groups of sportsmen in India. *Br J Sports Med*. 1985 Dec;19(4):232–4.
14. Willis T, Macfarlane M, Willis D. Response to: the adult multidisciplinary respiratory neuromuscular clinic. *Breathe (Sheff)*. 2020 Dec;16(4):200277.
15. 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 [Internet]. Vol. 129, *Inorganic Chemistry Communications*. 2021. p. 108647. Available from: <http://dx.doi.org/10.1016/j.inoche.2021.108647>
16. Hildebran JN, Goerke J, Clements JA. Surfactant release in excised rat lung is stimulated by air inflation. *J Appl Physiol*. 1981 Oct;51(4):905–10.
17. Robertson B, van Golde LMG, Batenburg JJ. *Pulmonary Surfactant: From Molecular Biology to Clinical Practice*. Elsevier Science Limited; 1992. 753 p.
18. Pratt HS, Peter Beck E, Wirthlin LS, Graybiel A. *Studies on the Response to Acute Altitude Exposure with Special Reference to the Possibility of Early Detection of High Altitude Pulmonary Edema*. 1966. 26 p.
19. Saraswathi I, Saikarthik J, Senthil Kumar K, Madhan Srinivasan K, 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. *PeerJ*. 2020 Oct 16;8:e10164.
20. Santhakumar P, Roy A, Mohanraj KG, Jayaraman S, Durairaj R. Ethanollic Extract of

Capparis decidua Fruit Ameliorates Methotrexate-Induced Hepatotoxicity by Activating Nrf2/HO-1 and PPAR γ Mediated Pathways. *Ind J Pharm Educ*. 2021 Mar 19;55(1s):s265–74.

21. 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 Dec;54(6):880–9.
22. 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 Aug;46(8):1219–29.
23. Clarizia G, Bernardo P. Diverse Applications of Organic-Inorganic Nanocomposites: Emerging Research and Opportunities: Emerging Research and Opportunities. IGI Global; 2019. 237 p.
24. Prakash AKS, Devaraj E. Cytotoxic potentials of *S. cumini* methanolic seed kernel extract in human hepatoma HepG2 cells [Internet]. Vol. 34, *Environmental Toxicology*. 2019. p. 1313–9. Available from: <http://dx.doi.org/10.1002/tox.22832>
25. 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 Biol Int*. 2021 Jul;45(7):1498–509.
26. 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 Jan;45(1):e13572.
27. Vivekanandhan K, Shanmugam P, Barabadi H, Arumugam V, Raj DDRD, Sivasubramanian M, et al. Emerging Therapeutic Approaches to Combat COVID-19: Present Status and Future Perspectives [Internet]. Vol. 8, *Frontiers in Molecular Biosciences*. 2021. Available from: <http://dx.doi.org/10.3389/fmolb.2021.604447>
28. Ezhilarasan D. Critical role of estrogen in the progression of chronic liver diseases. *Hepatobiliary Pancreat Dis Int*. 2020 Oct;19(5):429–34.
29. Egbuna C, Mishra AP, Goyal MR. Preparation of Phytopharmaceuticals for the Management of Disorders: The Development of Nutraceuticals and Traditional Medicine. Academic Press; 2020. 574 p.
30. Kamath SM, Manjunath Kamath S, Jaison D, Rao SK, Sridhar K, Kasthuri N, et al. In vitro augmentation of chondrogenesis by Epigallocatechin gallate in primary Human chondrocytes - Sustained release model for cartilage regeneration [Internet]. Vol. 60, *Journal of Drug Delivery Science and Technology*. 2020. p. 101992. Available from: <http://dx.doi.org/10.1016/j.jddst.2020.101992>
31. 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 [Internet]. Vol. 1235, Journal of Molecular Structure. 2021. p. 130229. Available from: <http://dx.doi.org/10.1016/j.molstruc.2021.130229>

32. Gowhari Shabgah A, Ezzatifar F, Aravindhana 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 Apr;73(4):659–69.
33. 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 Apr;48(4):299–306.
34. R H, 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 [Internet]. Vol. 130, Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2020. p. 306–12. Available from: <http://dx.doi.org/10.1016/j.oooo.2020.06.021>
35. J PC, Pradeep CJ, Marimuthu T, Krithika C, Devadoss P, Kumar SM. Prevalence and measurement of anterior loop of the mandibular canal using CBCT: A cross sectional study [Internet]. Vol. 20, Clinical Implant Dentistry and Related Research. 2018. p. 531–4. Available from: <http://dx.doi.org/10.1111/cid.12609>
36. Wahab PUA, Abdul Wahab PU, Madhulaxmi M, Senthilnathan P, Muthusekhar MR, Vohra Y, et al. Scalpel Versus Diathermy in Wound Healing After Mucosal Incisions: A Split-Mouth Study [Internet]. Vol. 76, Journal of Oral and Maxillofacial Surgery. 2018. p. 1160–4. Available from: <http://dx.doi.org/10.1016/j.joms.2017.12.020>
37. Mudigonda SK, Murugan S, Velavan K, Thulasiraman S, Krishna Kumar Raja VB. Non-suturing microvascular anastomosis in maxillofacial reconstruction- a comparative study. *Journal of Cranio-Maxillofacial Surgery*. 2020 Jun 1;48(6):599–606.
38. Nandhini T, Devi G. A comparative study of peak Expiratory Flow Rate in acute and chronic periodontitis. *J evol med dent sci*. 2020 Nov 2;9(44):3294–9.
39. Kanniappan V, Manivannan V. Efficacy of Balloon Blowing Exercise on Peak Expiratory Flow Rate in Young Adult Smokers. *J Lifestyle Med*. 2020 Jul 31;10(2):116–20.
40. R G, Gayatri R, Sethu G. Establishing norms for nasal spirometry [Internet]. Vol. 8, National Journal of Physiology, Pharmacy and Pharmacology. 2018. p. 1188. Available from: <http://dx.doi.org/10.5455/njppp.2018.8.0414226042018>
41. Tahmasebi S, Qasim MT, Krivenkova MV, Zekiy AO, Thangavelu L, Aravindhana S, et al. The effects of oxygen–ozone therapy on regulatory T-cell responses in multiple sclerosis patients [Internet]. Vol. 45, Cell Biology International. 2021. p. 1498–509. Available from: <http://dx.doi.org/10.1002/cbin.11589>
42. American Physiological Society (1887-). Exercise: Regulation and Integration of Multiple

Systems. Amer Physiological Society; 1996. 1210 p.

43. Frownfelter DL, Dean E, Dean EW. Cardiovascular and Pulmonary Physical Therapy: Evidence and Practice. Mosby; 2006. 848 p.
44. R GD, Gayatri DR, Sethu G. EVALUATION OF ADENOIDS BY ORONASAL AND NASAL SPIROMETRY [Internet]. Vol. 11, Asian Journal of Pharmaceutical and Clinical Research. 2018. p. 272. Available from: <http://dx.doi.org/10.22159/ajpcr.2018.v11i10.27365>
45. Wiedenroth Md CB, Rieth Md AJ, Kriechbaum Md S, Ghofrani Md H-A, Breithecker Md A, Haas Md M, et al. Exercise right heart catheterization before and after balloon pulmonary angioplasty in inoperable patients with chronic thromboembolic pulmonary hypertension. *Pulm Circ.* 2020 Jul;10(3):2045894020917884.

UNDER PEER REVIEW