DOI: 10.7860/JCDR/2024/68490.19531

Original Article

Respiratory Medicine Section

Normative Data of Maximal Respiratory Pressures in Adult Population of the Himalayan Region: A Cross-sectional Study

RAKHEE KHANDURI[1], AASHISH NEGI[2], KANCHAN BALA[3], VARUNA JETHANI[4], SUSHANT KHANDURI[5]

ABSTRACT

Introduction: Measurement of Maximal Static Respiratory Pressures (MSRP) is a non invasive tool to determine global respiratory muscle strength. The unique lifestyle factors in the Himalayan region, prompted the need for establishing normative values.

Aim: To establish the typical maximum respiratory pressures in the Himalayan region and, secondarily, to develop a predictive equation based on the normative data collected.

Materials and Methods: A cross-sectional observational study was conducted at the Department of Respiratory Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India. A total of 101 non smokers (78 males, 23 females) aged from 19-70 years were selected after initial screening by a questionnaire and spirometry from the attendants of patients attending Himalayan Hospital from July 2000 to May 2022. Sustained Nasal Inspiratory Pressure (SNIP), Maximal Expiratory Pressure (MEP), and Maximal Inspiratory Pressure (MIP) values were measured using Micro Respiratory Pressure Meter (RPM) following the American Thoracic Society Technical Statement (ATS) standard protocol. The prediction model for the Maximal Respiratory Pressure (MRP) was obtained using regression analysis. Height, age, weight, and Body Mass Index (BMI) were included as variables in the calculations. The statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) program for Windows (Version 22.0).

Results: There was a statistically significant difference observed in MIP among males 91.77±29.41 cmH_2O and females 65.26±19.55 cmH_2O and in MEP among males 86.37±26.96 cmH_2O and females 56.04±18.29 cmH_2O. Both MIP and MEP averages were more in males than in females. In the present study, there was no significant relationship between height, weight, BMI, and respiratory pressure in females. There was no significant relationship between MIP and MEP plus height, age, weight, or BMI. Weight (r-value=0.24), age (r-value=0.27), and BMI (r-value=0.27) all had a significant association in men.

Conclusion: Based on these findings, it can be concluded that there are gender-based disparities in MRP in the Himalayan population, with males exhibiting higher average values than females. Additionally, while there was no significant correlation between anthropometric factors and respiratory pressures in females, in males, weight, age, and BMI showed significant associations with these respiratory parameters.

Keywords: Body mass index, Maximal expiratory pressure, Maximal inspiratory pressure, Regression analysis, Spirometry, Sustained nasal inspiratory pressure

INTRODUCTION

Measuring the Maximum Static Respiratory Pressures (MSRP) during inspiration, known as Maximum Inspiratory Pressure (MIP), and during expiration, known as Maximum Expiratory Pressure (MEP), is a rapid, simple, and non invasive method for evaluating the strength of respiratory muscles [1]. These pressure levels are monitored against an airway obstruction to determine these values. MEP represents supra-atmospheric pressure produced by the intercostal and abdominal muscles during breathing, while MIP is a measure of the strength of inspiratory muscles created by sub-atmospheric pressure [2]. The significance of measuring these pressures lies in distinguishing between simple spirometry, which indicates restrictive lung disease, and identifying weakened respiratory muscle strength as the cause. These measurements provide insights into both healthy individuals and help assess respiratory diseases. Physicians can utilise this data to identify causes of dyspnoea causes and provide targeted treatments, considering that respiratory muscles form an individual's respiratory pump [3]. Another application is assessing the response to respiratory muscle training.

The present study addresses a critical gap in evaluating abnormal muscle strength within the Himalayan population, where normal reference values have been lacking. While studies on Caucasians and some Asian populations exist, comprehensive data for the Himalayan region is notably scarce [2,4-8]. Previous research in South Indian, northeastern, and North Indian populations offers isolated insights, but a comprehensive understanding remains elusive [8-11].

The unique lifestyle factors in the Himalayan region, including challenging living conditions, distinct dietary habits, smoking prevalence, and varying physical endurance, prompted the need for establishing normative values. Recognising the potential influence of environmental conditions, dietary habits, and physical demands specific to this region, the present study aimed to determine normative values for MIP and MEP. Additionally, the study aimed to formulate a predictive equation based on gathered normative data, crucial for optimising patient care in this unique demographic. The present research contributes to filling the void in normal reference values for the Himalayan population and underscores the necessity of understanding these values in the context of race, weight, height, BMI, age, and sex.

MATERIALS AND METHODS

A cross-sectional observational study was conducted at the Department of Respiratory Medicine, Himalayan Institute of Medical

Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India, from July 2000 to May 2022. The research and Ethical Committee of Swami Rama Himalayan University (SRHU/HIMS/RC/2019/47) approved the present research project. All subjects signed a written informed consent form before participating in the study.

Sample size: The sample size was calculated in accordance with the published study [8]. A target confidence interval of 95% and a relative precision of 5% were chosen. Initially estimated at 450, the sample size was subsequently limited to 101 subjects due to the nationwide lockdown imposed during the pandemic.

Inclusion criteria: All non smoker healthy subjects aged more than 18 years and less than 70 years who were permanent residents of the Himalayan region were included in the study.

Exclusion criteria:

- Subjects who were not able to understand and follow the commands to do this test (perhaps due to language issue or changes) or who were not residents of the Himalayan region were excluded from the study.
- Patients with pulmonary and cardiac disorders were also excluded.

Study Procedure

A total of 101 healthy subjects from Uttarakhand participated in the study at the study Institute. Aadhar card and ration card were used as proof of permanent residence. Written informed consent was obtained from all subjects.

To attract healthy individuals coming to hospital along with patients, a public information notice regarding participation in the study was displayed in waiting areas of the general Outpatient Department (OPD) and Pulmonary OPD.

Initially, subjects were asked questions from a pre-formed questionnaire, including demographic details, symptoms, smoking history, medical and surgical history, and symptoms related to cardiac and pulmonary diseases. Subjects meeting the inclusion criteria underwent baseline pulmonary function testing using the Medisoft Spiro air [Table/Fig-1]. Assessments were conducted by a trained physiotherapist and a dedicated spirometry technician at Himalayan Hospital.

[Table/Fig-1]: Medisoft Spiro air used for baseline pulmonary function testing.

Age, weight, height, and BMI were recorded. A metric stadiometer and a computerised weighing scale were used to measure standing height and body weight, respectively. BMI was calculated by dividing weight (in kilograms) by the square of height (in metres). The respiratory pressure meter (MicroRPM) by CareFusion, UK Ltd., United Kingdom, was used to measure MIP and MEP. Measurements were taken following the guidelines provided by the ATS/European Respiratory Society (ERS) Statement of Respiratory Muscle Testing from 2002. All participants were advised to wear a nasal clip and securely grip a round mouthpiece in order to avoid air leakage throughout all movements.

They were then positioned in a sitting posture with their backs supported. MEP was assessed starting from Total Lung Capacity (TLC) or maximal inhalation, while subjects were requested to exert their maximum inspiratory effort starting from Residual Volume (RV) or maximal exhalation to determine MIP. The largest amount of pressure value (in cmH_2O) measured during atleast three attempts (each lasting atleast 2 seconds and maintained for 1 second without any leaks) was considered good and noted down, as long as the values did not more than 10% higher than the previous attempt or the highest recorded value. Each movement was followed by a one-minute rest period, and there was a five-minute interval between MIP and MEP evaluations.

STATISTICAL ANALYSIS

The statistical analysis was conducted using the SPSS program for Windows (version 22.0). MRP was plotted against the anthropometric data (age, height, weight, BMI) of all subjects. Multiple regression analysis using stepwise linear regression was employed to develop prediction equations for maximum respiratory pressures. All groups included the four variables in the multiple regression analysis, adding a variable to the prediction equation only when more than one correlation coefficient was statistically significant ($p<0.05$).

RESULTS

The frequency and percentage of baseline variables including age, gender, height, and weight of the study sample are presented in [Table/Fig-2].

Variables	Frequency (f)	Percentage (%)
1. Age (in years)		
a) 19-38	38	37
b) 39-58	36	36
c) 59-79	27	27
2. Gender		
a) Male	78	77
b) Female	23	23
3. Height (in cm)		
a) 143-158	19	19
b) >158-173	67	66
c) >173-187	15	15
4. Weight (in kg)		
a) 40-57	22	22
b) >57-76	67	66
c) >76-95	12	12

[Table/Fig-2]: Frequency and percentage of baseline variables of patients with Maximal Respiratory Pressures (MRP).

From [Table/Fig-3], it is clear that the comparison between participants' heights and weights were segmented into specific ranges. The majority of participants fell into the height range of greater than 158 to 173 cm and the weight range of greater than 57 to 76 kg, indicating a concentration of individuals within these particular height and weight brackets among the study participants.

	Male	Female	
Variables	Mean±SD	Mean±SD	p-value
Age (in years)	47.78±16.45	41.52±16.18	0.11
Height (cm)	168.33±6.67	155.65±6.75	0.001
Weight (kg)	67.21±9.08	53.91±7.79	0.001
BMI (kg/m^2)	23.72±3.00	22.29±3.35	0.06

[Table/Fig-3]: Comparison of baseline variable among males and females.

The comparison of MIP and MEP between males and females is shown in [Table/Fig-4]. While age exhibited no significant difference (p=0.11), substantial disparities were evident in MIP and MEP. Males displayed significantly higher MIP and MEP values compared to females (p<0.001), indicating distinct respiratory muscle strength differences between genders. While BMI differences did not reach statistical significance (p=0.06), a trend towards divergence was observed, suggesting a potential difference in BMI between genders. The findings emphasise pronounced differences in respiratory muscle capabilities, indicating gender-based variations in respiratory strength.

Variables	Total	Males	Females	p-value
		Mean±SD	Mean±SD	
MIP	101	91.77±29.41	65.26±19.55	0.001*
MEP	101	86.37±26.96	56.04±18.29	0.001*

[Table/Fig-4]: Comparison of MIP and MEP (in cmH_2O) among males and females.
*p-value is significant

The significant differences in MIP and MEP between males and females is demonstrated in [Table/Fig-4]. Both MIP and MEP were markedly higher in males (MIP: 91.77±29.41 cmH_2O; MEP: 86.37±26.96 cmH_2O) compared to females (MIP: 65.26±19.55 cmH_2O; MEP: 56.04±18.29 cmH_2O), with p-values of 0.001 for both parameters.

These findings highlight distinct respiratory muscle strength disparities between genders, indicating that males tend to exhibit significantly greater MIP and MEP values compared to females. In [Table/Fig-5], the correlation analysis between MIP and MEP with baseline variables among males and females revealed distinct patterns. In males, MIP demonstrated modest positive correlations with weight (MIP: r=0.24, p=0.03; MEP: r=0.12, p=0.29) and BMI (MIP: r=0.27, p=0.02; MEP: r=0.17, p=0.15), indicating a weak association between these factors and respiratory pressures. However, in females, while similar trends were observed, correlations with weight (MIP: r=0.30, p=0.16; MEP: r=0.26, p=0.22) and BMI (MIP: r=0.25, p=0.25; MEP: r=0.24, p=0.27) appeared slightly stronger but still modest, hinting at a potential gender-specific relationship between weight, BMI, and respiratory pressures. Notably, age and height exhibited minimal to negligible correlations with both MIP and MEP across genders, suggesting a limited impact of these factors on respiratory pressures among the studied population.

Variables	Males		Females	
	Pearson's correlation	p-value	Pearson's correlation	p-value
1. Age	-0.27	0.02	-0.25	0.26
2. Height	-0.02	0.86	0.12	0.60
3. Weight	0.24	0.03	0.30	0.16
4. BMI	0.27	0.02	0.25	0.25
MEP with baseline variables among males and females				
1. Age	0.04	0.71	-0.05	0.83
2.Height	-0.08	0.46	0.06	0.79
3. Weight	0.12	0.29	0.26	0.22
4. BMI	0.17	0.15	0.24	0.27

[Table/Fig-5]: Correlation of MIP with baseline variables among males and females.

In [Table/Fig-6], the linear regression analysis revealed distinct patterns in the association between baseline variables and MIP and MEP among males. MIP demonstrated significant positive associations with age (r=0.27, p=0.02), weight (r=0.24, p=0.03), and BMI (r=0.27, p=0.02), indicating their potential contributions to the variance in MIP values. However, height exhibited a negligible correlation (r=0.02, p=0.86) with MIP, suggesting minimal influence. Conversely, among males, MEP did not show significant associations with any baseline variables- age, height, weight, or BMI. All variables displayed low r-values and non significant p-values, suggesting a lack of substantial linear relationships with MEP in this male cohort.

These results suggest that, in males, age, weight, and BMI might impact MIP, while baseline variables showed minimal to no impact on MEP.

Variables	r-value	F value	Regression equation	p-value
Age	0.27	6.07	115.01-0.486X	0.02*
Height	0.02	0.03	107.10-0.091X	0.86
Weight	0.24	4.58	38.40+0.794X	0.03*
BMI	0.27	6.17	28.12+2.683X	0.02*
Linear regression of MEP with baseline variable in males				
Age	0.04	0.14	82.97+0.071X	0.71
Height	0.08	0.54	143.56+0.340X	0.46
Weight	0.12	1.13	62.17+0.360X	0.29
BMI	0.17	2.14	51.14+1.485X	0.15

[Table/Fig-6]: Linear regression of MIP with baseline variable in males.
*p-value is significant

In [Table/Fig-7], the linear regression analysis in females highlighted varying associations between baseline variables and MIP and MEP. MIP showed modest correlations with weight (r=0.30, p=0.16) and BMI (r=0.25, p=0.25), indicating potential influences on MIP variability. However, age and height exhibited weaker correlations with MIP and lacked statistical significance, suggesting minimal impact. Similarly, MEP in females displayed modest correlations with weight (r=0.26, p=0.23) and BMI (r=0.24, p=0.27), hinting at potential but weak relationships. Age and height showcased negligible correlations with MEP, implying minimal influence on expiratory pressure in females. In summary, weight and BMI hinted at associations with both MIP and MEP among females, while age and height appeared to have limited impact on respiratory pressures in this group. Weight, height, and age were employed as predictive factors to formulate regression models for MIP and MEP.

Variables	r-value	F value	Regression equation	p-value
Age	0.25	1.36	77.62-0.298X	0.26
Height	0.12	0.28	13.32+0.334X	0.60
Weight	0.30	2.12	24.32+0.759X	0.16
BMI	0.25	1.39	32.85+1.453X	0.25
Linear regression of MEP with baseline variable in females				
Age	0.05	0.05	58.25-0.053X	0.83
Height	0.06	0.07	31.43+0.158X	0.79
Weight	0.26	1.55	22.87+0.615X	0.23
BMI	0.24	1.31	26.53+1.324X	0.27

[Table/Fig-7]: Linear regression of MIP with baseline variable in females.

Age was specifically integrated into a simple regression analysis model to derive mathematical equations for MIP and MEP, providing suggested formulas tailored to the Uttarakhand Indian Population due to its substantial predictive influence on MRPs:

Males:

- MIP: All ages=115.01-0.486×age
- MEP: All ages=82.97+0.071×age

Females:

- MIP: All ages=77.62-0.298×age
- MEP: All ages=58.25-0.053×age

DISCUSSION

The present research aimed to establish normative values for MRPs in males and females aged 18-70 years. Significant variations were observed compared to prior studies conducted on Caucasian [4,5,11], Brazilian [2,12,13], Colombian [14], and various Asian populations [8-10,15]. The reported mean MIP values for males (91.77±29.41) and females (65.26±19.55), along with mean MEP values for males (86.37±26.96) and females (56.04±18.29), notably differed from values documented in studies by Wilson et al., among Caucasian populations [11], and Nambiar VK and Ravindra S among the South Indian population [9]. These variations underscore potential distinct respiratory pressure norms within the Uttarakhand Indian Population compared to these diverse ethnic groups.

The differences observed in MRPs among varied populations emphasise the potential influence of demographic and ethnic factors on these measures. These disparities hold crucial implications for clinical practice, suggesting the necessity for region-specific reference values in diagnostic and therapeutic contexts. Tailoring assessments and treatment protocols based on population-specific normative data can significantly enhance the accuracy and effectiveness of respiratory care among individuals in the Uttarakhand Indian Population.

Variations in maximum respiratory pressures, influenced by weight, height, and diverse factors, stem from methodological nuances [5,12]. Measurement techniques, equipment, air leaks, and individual motivation significantly impact the accurate assessment of MIP and MEP. Excessive buccinators muscular activity during measurement can overestimate results, misrepresenting true respiratory muscle strength [15,16].

In comparison to prior studies, these findings underscore the importance of standardised methodologies and equipment in ensuring accurate respiratory pressure assessments. Clinically, meticulous attention to measurement protocols is crucial. Tailoring assessments to minimise confounding factors ensures precise evaluations, enhancing diagnostic accuracy and treatment efficacy in respiratory care.

In previous studies like Black and Hyatt's research, age emerged as a crucial factor, mirroring the findings in the current study. They highlighted a significant negative association between age and both MIP and MEP across genders [10]. Aging tends to correspond with a decline in respiratory muscle strength, consistent with numerous other studies [14,15]. Both males and females showcased reduced MRPs, likely attributed to age-related changes such as increased RV and decreased inspiratory capacity, resulting in lower MIP [5-10]. Additionally, factors like reduced elastic recoil in the chest, stiffened joints, and increased thoracic kyphosis might contribute to MEP decline, especially since it relies on TLC [16].

Comparisons between male and female MIP and MEP revealed significant differences ($p<0.05$), likely linked to anatomical, structural, and hormonal distinctions [16]. These consistent findings across studies emphasise the impact of aging on respiratory muscle strength and function. Understanding these age-related changes holds crucial clinical implications. Tailoring interventions to counteract age-associated declines in respiratory muscle strength can be pivotal in enhancing respiratory function and overall quality of life in aging populations. Additionally, recognising gender-specific variations can guide more precise diagnostic and therapeutic approaches in respiratory care. Regression analysis was employed to establish a predictive model for MRP, considering age, height, weight, and BMI as determining factors. However, in females, no significant relationships were found between height, weight, BMI, and respiratory pressure. Additionally, there were no significant associations observed between MIP and MEP with height, age, weight, or BMI in females. In contrast, among males, age, weight, and BMI exhibited statistically significant interrelationships, with respective correlation coefficients (r-values) of 0.27, 0.24, and 0.27. This may explain the fact that in males from the Himalayan population, there were no significant associations found between height, weight, BMI, and respiratory pressures. Conversely, females exhibited significant relationships with height, weight, age, and BMI influencing respiratory pressures. The gender-specific variations suggest that factors beyond anthropometric measures play a more dominant role in males, while in females, the multifactorial nature of respiratory pressures is evident. Gopalkrishna A et al., study showed significantly contrasting results from the current study regarding the lack of significant relationships in females [3]. The measured values for both MIP and MEP were notably lower in both males (by 30%) and females (by 20%) compared to values reported in earlier studies. Age emerged as the most influential factor for predicting PI max and PE max in both genders according to our findings. Contrary results in non Himalayan populations emphasise the importance of region-specific studies, highlighting the impact of diverse environmental and lifestyle factors on respiratory physiology. The present study underscores the need for a refined understanding of the unique determinants of respiratory pressures within the Himalayan demographic.

Limitation(s)

Subjects from hilly areas were included in the present study. The potential impact of altitude on MRP between populations could have been compared. Due to the limited sample size, a detailed assessment of MRPs within specific age groups could not be accurately conducted.

CONCLUSION(S)

A need exists for multicentre studies involving larger participant groups to precisely predict MRPs using regression equations within the Indian population. The present expanded research scope would enable a more comprehensive understanding of the various factors influencing respiratory pressures across different demographic and geographic settings in India. Additionally, a broader study with increased sample sizes could refine and validate predictive models, ensuring their accuracy and applicability in clinical practice for more precise respiratory assessments and tailored interventions among diverse Indian populations. The present study establishes normative values for MRP in the UP West and Uttarakhand population aged 20-70. Gender differences were significant, with males exhibiting higher MRP values. Age negatively correlated with MRP in both genders. In males, weight, BMI, and age correlated with MRP, while no significant correlations were found in females for height, weight, or BMI. The findings underscore gender-specific variations and highlight the impact of age, weight, and BMI on respiratory pressures. This research offers essential insights for clinicians conducting respiratory assessments in the Himalayan population, enhancing diagnostic accuracy and treatment efficacy.

Acknowledgement

The authors are thankful to Dr. Anjana Williams for her critical inputs. They are thankful to all their subjects who consented to the present study.

REFERENCES

[1] American Thoracic Society/European Respiratory Society. ATS/ERS Statement on respiratory muscle testing. Am J Respir Crit Care Med. 2002;166(4):518-24. Doi: 10.1164/rccm.166.4.518. PMID: 12186831.
[2] Souza RB. Pressões respiratórias estáticas máximas. J Pneumol. 2002;28(Suppl 3):S155-65. Available from: https://doi.org/10.1590/S1413-35552007000500006.
[3] Gopalkrishna A, Vaishali K, Prem V, Aaron P. Normative values for maximal respiratory pressure in an Indian Mangalore population: Cross sectional pilot study. Lung India. 2011;28(4):247-52. Doi: 10.4103/0970-2113.85684.
[4] Arora NS, Rochester DF. Respiratory muscle strength and maximal voluntary ventilation in undernourished patients. Am Rev Respir Dis. 1982;126(1):05-08. Doi: 10.1164/arrd.1982.126.1.5. PMID: 7091909.
[5] Black LF, Hyatt RE. Maximal respiratory pressures: Normal values and relationship to age and sex. Am Rev Respir Dis. 1969;99(5):696-702. Doi: 10.1164/arrd.1969.99.5.696.
[6] Maciel M, Silva C, Sanchez F, Marques J, Cortez P, Amaral C, et al. Respiratory muscle strength evaluation in healthy adult and elderly women-Respiratory muscle strength assessment in adult and elderly. Health. 2018;10(8):1031-36.
[7] Sriboonreung T, Leelarungrayub J, Yankai A, Puntumetakul R. Correlation and predicted equations of MIP/MEP from the pulmonary function, demographics and anthropometrics in healthy Thai participants aged 19 to 50 years. Clin Med Insights Circ Respir Pulm Med. 2021;15:11795484211004494. Available from: https://doi.org/10.1177/11795484211004494.

[8] Choudhuri D, Choudhuri S. The characteristics and determinants of maximal expiratory pressure in young adults from Tripura. Int J Med Res Health Sci. 2014;3(2):364-68. Doi: 10.5958/j.2319-5886.3.2.076.
[9] Nambiar VK, Ravindra S. Maximal respiratory pressures and their correlates in normal Indian adult population: A cross-sectional study. Int J Physiother Res. 2015;3(4):1188-96. Doi: 10.16965/ijpr.2015.169.
[10] Rodrigues F, Bárbara C. Pressões máximas respiratórias Proposta de um protocolo de procedimentos • Maximal respiratory pressures: Proposition for a protocol of assessment. Rev Port Pneumol. 2000;6(4):297-307. Available from: https://doi.org/10.1016/S0873-2159(15)30905-3.
[11] Lee SH, Yim SJ, Kim HC. Aging of the respiratory system. Kosin Medical Journal. 2016;31(1):11-18.
[12] Costa D, Gonçalves HA, Lima LP, Ike D, Cancelliero KM, Montebelo MI. New reference values for maximal respiratory pressures in the Brazilian population. J Bras Pneumol. 2010;36(3):306-12.
[13] Gil Obondo LM, Lopez AL, Avila CL. Normal values of the maximal respiratory pressures in healthy people older than 20 years old in the city of Manizales-Colombia. Colomb Med (Cali). 2012;43(2):119-25.
[14] Janssens JP, Pache JC, Nicod LP. Physiological changes in respiratory function associated with ageing. Eur Respir J. 1999;13(1):197-205. Doi: 10.1034/j.1399-3003.1999.13a36.x.
[15] Okazaki T, Suzukamo Y, Miyatake M, Komatsu R, Yaekashiwa M, Nihei M, et al. Respiratory muscle weakness as a risk factor for pneumonia in older people. Gerontology. 2021;67(5):581-90.
[16] LoMauro A, Aliverti A. Sex differences in respiratory function. Breathe (Sheff). 2018;14(2):131-40.

PARTICULARS OF CONTRIBUTORS:
1. Professor, Department of Respiratory Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India.
2. Assistant Lecturer, Department of Physiotherapy, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India.
3. Assistant Professor, Department of Nursing, Swami Rama Himalayan University, Dehradun, Uttarakhand, India.
4. Associate Professor, Department of Respiratory Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India.
5. Professor, Department of Respiratory Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Rakhee Khanduri,
Professor, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University,
Swami Ram Nagar, Jollygrant, Dehradun-248016, Uttarakhand, India.
E-mail: drrakhikhanduri@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Nov 16, 2023
- Manual Googling: Dec 28, 2023
- iThenticate Software: Apr 09, 2024 (10%)

ETYMOLOGY: Author Origin

EMENDATIONS: 8

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Nov 15, 2023**
Date of Peer Review: **Dec 22, 2023**
Date of Acceptance: **Apr 11, 2024**
Date of Publishing: **Jun 01, 2024**