

# Seasonal Patterns of Peak Expiratory Flow Rate in Young Healthy Individuals

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## ABSTRACT

**Background:** The seasonal changes are associated with changes in pulmonary functions including Peak Expiratory Flow Rate (PEFR). These changes are different among different population and location. This study thus aims to evaluate the seasonal variations in PEFR among healthy young individuals in Kathmandu.

**Methods:** A comparative study was carried out among 60 undergraduate medical students of Maharajgunj Medical Campus in the department of Clinical Physiology. The students were selected by convenient sampling technique and after obtaining the informed consent, the PEFR was recorded with the help of Wright's peak flow meter with proper training. The PEFR was recorded two times i.e. morning and daytime hours in winter season (January-February) 2023 and also in same daily hours of summer season (May-June) 2023 in the same participants. The data were analyzed using SPSS-16 version and the paired T test was used to compare the mean changes in PEFR in winter and in summer seasons.

**Results:** The PEFR in summer morning (499.50±89.50 L/min) was recorded higher than in winter morning (487.50±86.09 L/min) among total participants and also in male participants (567.33±69.34; 550.83±69.58) which was statistically significant with P value <0.05. Similarly, the PEFR in summer daytime (505.08±88.85 L/min) was comparatively more than in winter daytime (491.27±92.07 L/min) which was statistically significant among all participants with P value <0.05. The PEFR in the winter and summer seasons of male participants and in the summer of total participants showed the existence of diurnal variation which was statistically significant.

**Conclusions:** There is seasonal variation as well as diurnal variations of PEFR. So, the clinicians should be aware that the PEFR recorded in winter season and in the morning time might be less than that recorded in the summer and at the daytime respectively.

**Keywords:** Peak Exploratory Flow Rate; Pulmonary function; Seasonal change.

## INTRODUCTION

The Peak Expiratory Flow Rate is the maximum rate of flow with which air is expelled with maximum force after a deep inspiration.<sup>1</sup> It has been widely used in clinical practice and research as it is a sensitive marker for bronchial hyper-reactivity.<sup>2,3</sup> The National Heart Lung and Blood Institute has recommended, a diurnal variation of 20% or more, as a diagnostic benchmark for asthma.<sup>4,5</sup>

PEFR is affected by factors like seasons and altitudes.<sup>6-9</sup> The effects of extremes of temperature on lung function including PEFR has not been clearly defined though it is robustly linked with adverse cardiopulmonary events.<sup>10,11</sup> The higher ambient temperature is associated with decrease in PEFR among diseased condition like asthma.<sup>12</sup> In contrast, the higher temperature is also associated with better lung functions among healthy individuals in few other studies.<sup>13</sup> Since the air at higher altitude is less dense,

airway resistance is reduced. But the humid air also causes narrowing of the airways.<sup>10,12</sup> The difference in the study population and study location which includes different altitudes and humidity are also important determinants for differences in these observations along with seasonal and temperature variations.<sup>10</sup> Thus, the study regarding seasonal influences on PEFR among healthy individuals is important to know in our settings i.e. in Kathmandu as there's lack of much data regarding it and the result can bring new insight among the clinicians and researchers.

## METHODS

A comparative study was conducted in clinical physiology laboratory of Maharajgunj Medical Campus from January 2023 to June 2023. Ethical approval was obtained from the institutional review committee of Institute of Medicine, Kathmandu Ref: 07(6-11) E2;080/081 and informed written consent was obtained from the participants

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before performing the PEFR test. The sample size (n) was calculated based on the mean and standard deviation of PEFR among Nepalese adults in morning ( $503.13 \pm 50.95$  L/min) and in mid-day ( $531.88 \pm 43.95$  L/min) with the formula

$$n = (Z\alpha + Z\beta)^2 (\sigma/\delta)^2 = 29 \text{ [with 10\% additional]}$$

[ $\sigma$ : standard deviation of differences of paired observation;  $\delta$ : mean difference]

A total of 30 male students and 30 female students were taken by convenient sampling. Participants of both sexes aged between 18 to 25 years were enrolled to the study. The participants who were smokers or had known cardiovascular and lungs diseases, chest or abdominal surgeries in preceding three months, current ear infections or known status of tympanic membrane perforation, detached retina, recent eye surgery and chest wall deformities like kyphosis, scoliosis, lordosis were excluded from the study. Participants were instructed about proper positioning and on how to blow into the mouth piece of Wright's Peak Flow Meter (Downs Surgical Canada Ltd.) after a maximum inspiration with nose blocked by a nose clip. It was recorded in standing posture and two minutes' rest was given to each participant after each test. Three recordings were obtained from each participant and the best value was taken for the analysis. The PEFR was recorded in two different seasons: winter and summer. It was recorded in morning (7-8 am) and daytime (1-2 pm) of the winter seasons and the same participants were followed up in summer seasons in the same hours in the morning and the day time. The data were managed and calculated using SPSS-16 version. All the data were expressed in mean and standard deviation. Paired t- test was used to determine the statistical significance and comparison was done in same group in winter and in summer seasons. P value equal to or less than 0.05 was considered statistically significant.

## RESULTS

The total number of participants was 60 with equal distribution among male and female. The mean weight of participants was  $57.51 \pm 10.11$  kg and mean height  $162.25 \pm 9.91$  cm. The baseline systolic and diastolic blood pressure were higher among males ( $118.87 \pm 8.93$  mm Hg;  $74.86 \pm 10.51$  mm Hg) in comparison to females ( $102.67 \pm 10.14$ ;  $66.66 \pm 9.94$  mm Hg). The resting pulse rate was higher among females ( $87.86 \pm 14.7$  beats per minute) compared to male participants ( $75.73 \pm 8.36$  beats per minute). (Table 1)

The PEFR in summer morning ( $499.50 \pm 89.50$  L/min) was recorded higher than in winter morning ( $487.50 \pm 86.09$  L/min) among total participants and also in male participants ( $567.33 \pm 69.34$  L/min;  $550.83 \pm 69.58$  L/min) which was statistically significant with P value  $< 0.05$ . (Table 2)

Similarly, the PEFR in the summer daytime ( $505.08 \pm 88.85$  L/min) was comparatively more than in winter daytime ( $491.27 \pm 92.07$  L/min) which was statistically significant among all participants with P value  $< 0.05$ . (Table 3)

The PEFR when compared between morning and daytime in winter and summer seasons separately showed the variable had statistically significant diurnal variations in both seasons among male participants. The statistically

**Table 1:** General Characteristics of the participants

Variables	Male (n=30)	Female (n=30)	Total (n=60)
Age (years)	20.70±0.95	20.20±0.80	20.45±0.90
Weight (kg)	63.08±9.97	51.94±6.66	57.51±10.11
Height (cm)	170.08±5.87	154.42±6.21	162.25±9.91
Systolic Blood Pressure (mm Hg)	118.87±8.93	102.67±10.14	110.77±12.51
Diastolic Blood Pressure (mm Hg)	74.86±10.51	66.66±9.94	70.76±10.95
Pulse Rate (beats per minute)	75.73±8.36	87.86±14.79	81.80±13.39

**Table 2:** Seasonal comparison of PEFR among the participants during morning time

Variables	Winter Morning PEFR (L/min)	Summer Morning PEFR (L/min)	t statistics/p value*
Male	550.83±69.58	567.33±69.34	t(29) = 2.55, p = 0.015
Female	424.17±44.04	431.67±44.39	t(29) = 1.72, p = 0.102
Total participants	487.50±86.09	499.50±89.50	t(59) = 3.09, p = 0.003

\*Paired T test

**Table 3:** Seasonal comparison of PEFR among the participants during daytime

Variables	Winter Day-time PEFR (L/min)	Summer Daytime PEFR (L/min)	t statistics/p value*
Male	561.03±73.08	574.33±62.76	t(29) = 2.01, p = 0.043
Female	421.50±42.85	435.83±46.92	t(29) = 2.07, p = 0.011
Total participants	491.27±92.07	505.08±88.85	t(59) = 3.20, p = 0.001

\*Paired T test

significant diurnal variation was seen in summer season only for total participants and the difference was not statistically significant among female participants. (Table 4)

## DISCUSSIONS

This study has compared the PEFR among the participants in summer and winter seasons during morning (7-8 am) and daytime (1-2 pm). The PEFR in summer morning ( $499.50 \pm 89.50$  L/min) was comparatively more than in winter morning ( $487.50 \pm 86.70$  L/min) and also the PEFR in summer daytime ( $505.08 \pm 88.85$  L/min) was comparatively

**Table 4:** Comparison of PEFR between morning and daytime of same seasons

Variables	Morning PEFR (L/min)	Daytime PEFR (L/min)	t statistics/p value*
<b>Males</b>			
Winter	550.83±69.58	561.03±73.08	t(29) = 2.98, p = 0.006
Summer	567.33±69.34	574.33±62.76	t(29) = 2.35, p = 0.022
<b>Females</b>			
Winter	424.17±44.04	421.50±42.85	t(29) = 0.56, p = 0.624
Summer	431.67±44.39	435.83±46.92	t(29) = 1.05, p = 0.293
<b>Total participants</b>			
Winter	487.50±86.09	491.27±92.07	t(59) = 3.09, p = 0.256
Summer	499.50±89.50	505.08±88.85	t(59) = 2.29, p = 0.024

\*Paired t test

more than in winter daytime (491.27±92.07 L). These mean comparisons in total participants were also statistically significant. The results were similar among both male and female with increase PEFR during summer than in winter although the difference between winter morning and summer morning PEFR was not statistically significant in females.

Similar study done among healthy adult inhabitants of West Siberia had found that the minute ventilation along with number of functioning acini decreased as a reaction of respiratory tissues to the cold in winter season.<sup>13</sup> Similarly, the cold temperature is associated with peripheral vasoconstriction and shunting of blood centrally and inhalation of cold air is also associated with increase airway resistance.<sup>11,15,16</sup> These mechanisms could be associated with decreased PEFR among the participants in winter in this study as well.

However, the researchers have even found the contrast in the results. A study done by Bhusan B et al. shows that the PEFR decreased during summer among rural and urban school attending children.<sup>17</sup> Another study conducted in Brazil shows that summer was the season with lower PEF in elderly and best values are found in the spring.<sup>18</sup> Higher temperature has been linked with higher allergen exposure among asthmatic children with decreased PEFR in a recent panel study of 270 asthmatic children in Australia.<sup>12</sup> The airway drying resulting in bronchoconstriction and decrement of lung function can even occur in summer.<sup>19</sup> This study conducted in Kathmandu is of different altitude and humidity level than in other studies. Thus along with the seasonal fluctuations, study population and study location could also be responsible for these adverse outcomes.

This study has even found that the PEFR was lesser in morning and increased during daytime among the total participants mostly in summer season. This result is consistent with several other studies which reports lowest

PEFR in morning followed by progressive rise towards day.<sup>14,20,21</sup> The finding is supportive of the fact about circadian variation of airway caliber in human body which may be due to temperature fluctuations. The results of this study again emphasize the existence of variations of PEFR in different seasons and different times of day which the clinicians and the researchers should be aware of. These fluctuations can be seen in other respiratory parameters also. This study has particularly focused on PEFR which is an entirely effort dependent parameter leading to high intra-subject variability which depends upon the motivation as well as body built of the individual. These along with smaller group of participants could have led to statistically insignificant variations in PEFR among female participants. Thus, the whole respiratory dynamics and its variations as per changes in seasons can further be explored with larger sample size in different altitude of Nepal because temperature and humidity along with seasons might affect different lung parameters including PEFR.

## CONCLUSIONS

This research study concludes that the PEFR might be affected by the seasons and also by the time of the day. So, the clinicians and researchers should be aware that the PEFR recorded in winter or cold season and in the morning time might be less than the normalcy. Little bronchoconstriction due to exposure of cold might lead to this condition.

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