Study of diurnal variation in peak expiratory flow rates in healthy men in South India

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Background
Peak expiratory flow rate (PEFR) reflects the strength and condition of respiratory muscles and the degree of airflow limitation in large airways. PEFR shows hour-to-hour variation that follows a specific pattern in asthmatics and in healthy individuals. Adequate data are not available on the diurnal variation in normal individuals who are students in professional courses and living a sedentary lifestyle. Hence, this study was undertaken to study the diurnal variation in PEFRs in healthy men in South India.

Participants and methods
PEFR was recorded in 50 adult healthy male students who were nonsmokers, between 18 and 23 years of age and studying in professional courses (MBBS, BDS, Nursing and MSc). Mini Wright's peak flow meter was used to measure the PEFR. PEFRs were recorded at 7–8 a.m., 10–11 a.m., 1–2 p.m., 4–5 p.m. and 7–8 p.m. for 2 consecutive days.

Results
On analysis of PEFR records of each individual, it was seen that there was an overall dip in the morning at 7–8 h PEFR, which increased during the daytime, peaking in the afternoon at 4–5 p.m. and eventually decreased in the night. Participants did not show the peak PEFR values at the same time point: 16% of participants had a rise in PEFR in the early morning hours; afternoon (1–2 p.m.) peak was observed in 22% of participants; and evening (4–5 p.m.) peak was observed in 36% of participants. Only 2% of participants showed a peak in the night time (7–8 p.m.) PEFR values.

Conclusion
This study provided the preliminary reference data of diurnal variation of PEFR in healthy adults. As there is a variation in the PEFR recorded during different time points of the day, it is advisable to record the PEFR at the same time point to compare the PEFR between individuals.

Keywords:
diurnal variation, peak expiratory flow rate, South Indian male

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Introduction

Peak expiratory flow rate (PEFR) reflects the strength and condition of respiratory muscles and the degree of airflow limitation in large airways. PEFR shows hour-to-hour variation that follows a specific pattern in asthmatics and in healthy individuals. Adequate data are not available for the diurnal variation in normal individuals who are students in professional courses and living a sedentary lifestyle. Hence, this study was undertaken to study the diurnal variation in PEFRs in healthy men in South India.

Diurnal variation relates to the variation/fluctuation in PEFR, which occurs during the course of each day (24 h).

PEFR is one of the pulmonary function tests that provide a quantifiable measure of lung function. It is relatively a simple and easy procedure to evaluate respiratory function compared with pulmonary function testing. Peak expiratory flow is a measurement of the movement of air into and out of the lungs during various breathing manoeuvres [1].

Lowest PFT values were seen at noon, and highest values were seen in the afternoon. Circadian changes occur in close temporal relation with body temperature, oxygen consumption and carbon dioxide production. None of these variables could fully explain the diurnal pattern of ventilation [2]. Breathing is closely regulated by metabolic rate, which is influenced by multiple factors, including activity and state of arousal, as well as hormonal and autonomic nervous system inputs. Circadian oscillations in the sympathetic activity may have an impact on the airway smooth muscles. They also suggested that scheduling elective surgical procedures or extubating patients with very limited

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lung function can be performed in accordance with the diurnal pulmonary clock.

Aims and objectives

This study was undertaken to study the diurnal variation in PEFRs in healthy men in South India.

Participants and methods

The present study was conducted in the pulmonary function laboratory of Chettinad Medical College at Chennai, India. A total of 50 apparently healthy, sedentary men, who were nonsmokers, between 18 and 23 years of age, and studying in professional courses (MBBS, BDS, Nursing, and MSc) were included in the study. Mini Wright's peak flow meter was used to measure the PEFR. PEFR were recorded at 7–8 a.m., 10–11 a.m., 1–2 p.m., 4–5 p.m. and 7–8 p.m. for 2 consecutive days. Ethical clearance was obtained from institution ethical committee.

Before starting the actual study, the participants were briefed about the protocol, and informed consent was obtained. Thorough history taking was carried out as regards suitability as per the above inclusion and exclusion criteria. Basic clinical examination was carried out to rule out any cardiopulmonary or other illness.

Precautions observed during the manoeuvre

(1) It was ensured that the participant was comfortable and relaxed.
(2) The apparatus was sterilized and cleaned properly.
(3) The participant was trained adequately to perform different manoeuvres.
(4) The participant was instructed to hold the instrument in such a way that the hand did not obstruct the movement of the pointer.
(5) The pointer was kept at the lower most level. Both nostrils were clipped while blowing into the equipment.

BMI

The BMI was calculated from the height and weight of the participant using the following formula:

$$\mathrm{BMI} = \frac{\mathrm{weight}\,(\mathrm{kg})}{\mathrm{height}\,(\mathrm{m})^2}.$$

Body surface area

Body surface area (BSA) was calculated using Dubois' formula:

$$\mathrm{BSA}\ (\mathrm{m}^2) = \mathrm{weight}\,(\mathrm{kg})^{0.425} \times \mathrm{height}\,(\mathrm{cm})^{0.725} \times 0.007184$$

(Dubois 1916).

Calculation of diurnal variation

Amplitude percent mean (A%M) and SD percent mean (SD% M) were calculated using the following formulae:

$$\mathrm{A\%M} = \frac{\text{Highest PEFR of the day} - \text{lowest PEFR of the day} \times 100}{\text{Mean PEFR value of the day}}.$$

$$\mathrm{SD\%M} = \frac{\text{Standard deviation of PEFR value of the day} \times 100}{\text{Mean PEFR value of the day}}.$$

Statistical analysis

To analyse the diurnal variation of PEFR, the maximum out of the three recordings was taken as the final value.

The values at different time points were analysed using one-way analysis of variance. Diurnal variation was considered statistically significant with a *P* value of less than 0.05 (Tukey's test).

Results

The anthropometric values of the participants are presented in Table 1: age, 18–23 years; height, 166–182 cm; weight, 50–82 kg, BMI, 18–27, and BSA, 1.5–2.0 m^2. The actual measured values of PEFR are presented in Table 2. On analysis of PEFR records of each individual, it was seen

Table 1 Basic participant information

	Number	Age (years)	Height (cm)	Weight (kg)	BMI	BSA (m^2)
Male	50	18.14 ± 2.05	172.2 ± 8.48	66.79 ± 16.54	22.77 ± 4.52	1.79 ± 0.22

BSA, body surface area.

Table 2 Mean peak expiratory flow rate values for male participants

	7–8 a.m.	10–11 a.m.	1–2 p.m.	4–5 p.m.	7–8 p.m.
PEFR (l/min)	481.8 ± 82.7	488.8 ± 81.3	490.5 ± 82.87	501.6 ± 85.9	455.2 ± 73

PEFR, peak expiratory flow rate.

that there was an overall dip in the morning at 7–8 h PEFR, which increased during the daytime, peaking in the afternoon at 4–5 p.m. and eventually decreased in the night. Participants did not show the peak PEFR values at the same time point: 16% of participants had a rise in PEFR in the early morning; afternoon (1–2 p.m.) peak was observed in 22% of participants; and evening (4–5 p.m.) peak was observed in 36% of participants. Only 2% of participants showed a peak in the night time (7–8 p.m.) PEFR values (Table 3).

Table 3 Percentage of participants showing peak PEFR at different time points

	7–8 am	10–11 am	1–2 pm	4–5 pm	7–8 pm
Male	16%	24%	22%	36%	2%

Discussion

In this study, diurnal variation and postural changes in healthy individuals were studied. Our results showed that PEFR values were low in the morning, followed by a progressive rise peaking in the afternoon and evening and a small fall at night time. Increase in BMI within physiological limits increases PEFR, but in obese or malnourished individuals, PEFR is likely to vary depending on possible comorbid conditions.

Highest PEFR is seen around the midpoint, as it has been suggested that the rhythm in the plasma cortisol may be the pulmonary clock, as the nadir of the cortisol rhythm would be compatible with delayed effects of corticosteroids on the airways.

There are also a few data to suggest that diurnal variation is correlated with age and is significantly higher in elderly individuals [3,4]. Therefore, our study sample was distributed over a relatively narrow age range, within which we wanted to study any changes pertaining to diurnal variation.

Conclusion

This study provided the preliminary reference data of diurnal variation of PEFR in healthy adults. As there is a variation in the PEFR recorded during different time points of the day, it is advisable to record the PEFR at the same time point to compare the PEFR between individuals.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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