International Journal of Research in Medical Sciences
*Bhandare SA et al. Int J Res Med Sci. 2021 Jul;9(7):1960-1964*
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20212516

**Original Research Article**

# Correlation of peak expiratory flow rate and single breath count in normal adults

**Sushama A. Bhandare*, Sayali S. Rasal, Saraswati K. Iyer**

Department of Physiotherapy, P. T. School and Centre, Seth GS Medical College and KEM Hospital, Mumbai, Maharashtra, India

**Received:** 13 May 2021
**Revised:** 08 June 2021
**Accepted:** 09 June 2021

***Correspondence:**
Dr. Sushma A Bhandare,
E-mail: sushmab7@rediffmail.com



## ABSTRACT

**Background:** Spirometry mandates the requirement of equipments and skilled technicians which may be difficult to acquire in resource limited situations. Thus simple alternative tests like Peak Expiratory Flow Rate (PEFR) and Single Breath Count (SBC) can be used to assess the pulmonary functioning of an individual.
**Methods:** Hundred healthy participants of both genders between the age group of 18-50 years were recruited for this study. They were asked to perform PEFR using the Mini Wright Peak Flow Meter and SBC using a metronome. Three reading were noted and the best of three readings were used for analysis.
**Results:** The mean age and BMI of the participants were 31.54±10.42 years and 23.88±5.14 kg/m2 respectively. The Spearman's correlation coefficient of PEFR and SBC was 0.7048 with $p<0.001$ indicating a strong positive correlation.
**Conclusions:** SBC can be used as a simple, convenient and cost-effective alternative to PEFR to assess pulmonary function in adults.

**Keywords:** Peak expiratory flow rate, Single breath count, Spirometry

## INTRODUCTION

Spirometry is an invaluable gold standard assessment tool to assess the pulmonary functioning of an individual. It assesses the volume of air inhaled and exhaled by an individual in unit time.[1] It is useful in the detection of obstructive as well as restrictive airway diseases, to quantify the degree of impairment or severity, assess prognosis and operative risks, evaluate health status prior to enrollment in a rehabilitation program, monitor effects of various environmental exposures and to study the effect of drugs and treatment on pulmonary functioning.[2] There is an increased use of spirometric evaluation in recent times owning to the increased incidences of respiratory conditions, air pollution and cigarette smoking.[3]

However, the use of spirometry mandates the requirement of an expensive spirometric equipment and a skilled technician to operate the same which may not be available in an emergency department or during screenings for large population and mass casualties. Thus simple, cost effective alternatives to spirometry were devised to be used in such situations. These alternative bedside assessment tools are inexpensive, can be easily taught, learnt and administered and are reproducible.[4] They include the cough test, wheeze test, Debono's whistle test, Snider's match blow test, breath holding time test and single breath count amongst many others.[5-8]

Peak expiratory flow rate (PEFR) is the maximal expiratory flow that is performed after a maximal inhalation. It is sustained for at least 10 milliseconds of

exhalation and is measured using a simple, portable hand held flow gauge device called the peak flow meter in liter/minute (L/min).[9] It is reflective of airway caliber, respiratory muscle strength as well as voluntary effort. It is routinely used in the diagnosis and monitoring of asthma by identifying triggers and assessing treatment response.[10]

Single breath count (SBC) is an inexpensive and easily obtainable parameter to assess the pulmonary functioning in an emergency setting where spirometry is not available. It is easy to perform and requires a simple tuning device (metronome). The subject is asked to take a deep breath and count to the metronome beats in normal speaking voice without taking another breath. The metronome is set at a frequency of 2 counts per second.[11]

PEFR, in spite of being a popular bedside assessment tool is effort and co-ordination dependent, requiring the use of a peak flow meter. It mandates patient understanding of the maneuver which can be difficult to perform by children and flail individuals. Sharing a common peak flow meter device could also increase the chances of cross infection amongst individuals.[12] SBC on the other hand is a simple and feasible assessment tool requiring the use of a metronome.

Hence, in this study the authors have correlated PEFR and SBC in adults to assess the degree of applicability of SBC as an effective bedside assessment tool to assess pulmonary function.

## METHODS

This cross sectional co-relational study was conducted in PT School and Centre, Seth G.S. Medical College and KEM Hospital, Mumbai, India over a period of one month (January to February 2020). Hundred normal healthy participants were recruited using convenient sampling. Both genders and individuals of the age group of 18-50 years were included in this study. Individuals with a known history of any pulmonary condition, spinal deformities such as kyphosis and scoliosis and those suffering from an ongoing respiratory tract infection were excluded from this study. Participants were explained about the study purpose, procedure and written consent was taken. Participants were then asked to perform PEFR and SBC.

### *PEFR*

Prior to performing PEFR, the indicator of the Mini Wright peak flow meter was set at zero. The participant was instructed to stand straight, take a deep breath, hold the mouthpiece in his/her mouth and seal the lips around it ensuring that the tongue was away from the mouthpiece and no air leak was present. The participant was then asked to blow as hard as he/she can into the mouthpiece. The peak flow meter was then removed, the reading was recorded and the participant was asked to breathe normally.[13] Three readings were recorded and the best of the three readings was considered for final analysis. A wash out period of 1-2 minutes was given between recording the readings to avoid fatigue.

### *SBC*

The participant was instructed to stand straight, take a deep breath and then commence counting of serial numbers in normal speaking voice without taking another breath. The counts were timed on a metronome set at a frequency of 2 counts per second using the Metronome Beats® Application, version 3.5.0 on a mobile based android operating system.[14] Three readings were recorded and the best of the three readings was considered for final analysis. A wash out period of 1-2 minutes was given between recording the readings to avoid fatigue.

Cross overs were maintained to avoid any biases in the results.

Institutional Ethics Committee approval was sought prior to the commencement to the study.

The data was statistically analysed using the GraphPad Prism 9 software. Since the data was not normally distributed, the Spearman's rank correlation test was used to study the correlation between PEFR and SBC.

## RESULTS

Table 1 shows the demographic data of the participants in the study comprising of the gender distribution and mean age (31.54±10.42 years) and BMI (23.88±5.14 kg/m2).

**Table 1: Demographic data.**

| Characteristic | Males | Females | Total |
|---|---|---|---|
| **n** | 29 | 71 | 100 |
| **Age (years) Mean ±SD** | 32.79±10.29 | 31.03±10.51 | 31.54± 10.42 |
| **BMI (kg/m$^2$) Mean ±SD** | 23.90±4.16 | 23.86 ±5.52 | 23.88±5.14 |

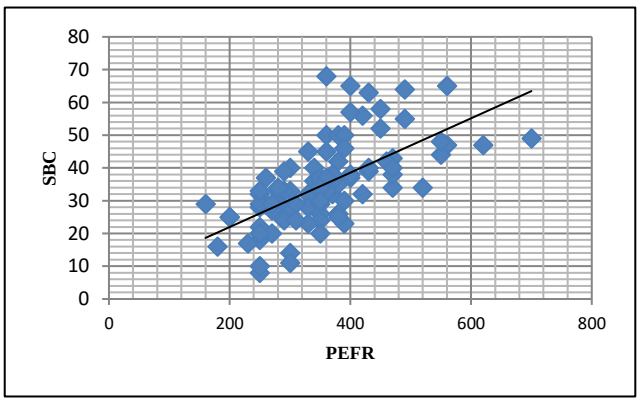


**Figure 1: Scatter plot for PEFR versus SBC (r=0.7048).**

**Table 2: PEFR and SBC values obtained in study population.**

| Parameter | Males | Females | Total |
|---|---|---|---|
| **PEFR (Liter/minute) Mean ±SD** | 450±93.66 | 313.38 ±62.84 | 353± 95.67 |
| **SBC Mean ±SD** | 43.17±10.53 | 31.17±11.45 | 33±12. 41 |
| **SBC Median** | 40 | 29 | 33 |

**Table 3: Spearman's rank correlation test for PEFR and SBC.**

| Spearman r | 0.7048 |
|---|---|
| **95% CI** | 0.5862 to 0.7938 |
| **p value** | <0.001 |

Table 2 shows the mean PEFR (353±95.67 liter/minute) and mean and median values of SBC (33±10.42, 33) respectively obtained from the study participants.

Table 3 shows the values obtained by the Spearman's correlation rank test. With $\alpha$=0.05, the $r^s$ value is 0.7048 with p<0.001 indicating a statistically significant strong positive correlation between PEFR and SBC. The 95% Confidence Interval lies between 0.5862 to 0.7938.

## DISCUSSION

PEFR is a routinely assessed parameter to predict disease severity and the need for hospitalization and has essentially replaced spirometry in the emergency department. It is a quick, simple, quantitative measure to gauge the degree of airway obstruction performed using a portable hand-held peak flow meter.[15]

The correlation of FEV1 and PEFR has been extensively studied in adult and paediatric populations. Bollinger et al studied the relationship between the severity of the asthmatic attack at the time of hospital admission and the eventual outcome of fifty-two patients presented in the asthma emergency room. Pulmonary function assessment was performed using a pneumotachograph and they found PEFR to be a better predictor for the need for hospitalization.[16] Nowak et al studied PEFR and FEV1 admission criteria in one hundred and nine acute episodes of ninety bronchial asthma patients and stated that PEFR correlated well with FEV1 at all stages of treatment with a correlation coefficient of 0.74 to 0.86.[17]

However, performing PEFR is a skill and effort dependent maneuver. It is known to primarily measure the flow of larger airways. PEFR is affected by the inhalation status, strength of the respiratory and abdominal muscles and the effort generated by the patient.[18] A study done by Eid et al also questions the reproducibility of PEFR in asthmatic children stating that with air trapping, a considerable amount of flow in the form of a quick burst of air can be generated at the start of a forceful exhalation. This would lead to a false higher value of PEFR causing false reassurance.[19]

Unlike PEFR, SBC does not require any tool with a mouthpiece which could be of concern due to contamination of equipment and be a possible source of spread of infection amongst individuals. However, it does require a fair degree of patient cooperation.

Escossio et al analyzed five hundred and sixteen hospitalized patients having various medical and surgical conditions and found that in the curve analysis (receiver operating characteristic/slow vital capacity=20 ml/kg) the single breath count value of 21 had a sensitivity of 94.44% and specificity of 76.62%. Also the intra class correlation coefficient for repeatability by the same examiner was 0.976 with p>0.005.[20]

SBC has also been studied for the purpose of triaging respiratory complications and failure in neuromuscular conditions such as botulism, myasthenia gravis and Guillian-Barre syndrome.

Kalita et al studied SBC and arterial blood gas (ABG) parameters in ninety-four GBS patients to derive the cut off point for intubation and mechanical ventilation. They found that desired ABG values without any respiratory distress were obtained with a SBC value of 7. For SBC of 5, the sensitivity and specificity for the need of mechanical ventilation were 90.6% and 95.2% respectively. They concluded that SBC was a useful non-invasive measure to guide the need for ABG analysis and respiratory function monitoring.[21] Another study done by Elsheikh et al with thirty-one acetylcholine receptor antibody positive myasthenia gravis patients also found SBC to be a reliable bedside assessment tool for monitoring respiratory function. They studied the correlation between SBC and Forced Vital Capacity (r = 0.554, p<0.01), negative inspiratory force (r = 0.519, p <0.01) and neck flexor strength (r=0.519, p<0.01).[22]

Bartfield et al performed a pilot study on twenty-two patients who required a pulmonary function test by also recording PEFR and SBC. The correlation found between SBC and FEV1 (r = 0.68) was slightly better than PEFR and FEV1 (r = 0.63). The correlation of SBC and PEFR was 0.68 and hence was a reasonable alternative to PEFR.[23]

Ali et al studied the correlation of spirometric indices with SBC in sixty-seven asthmatic children (5-18 years). The correlation coefficients of SBC to PEFR (r=0.55), FEV1 (r=0.66) and FVC (r=0.71), forced expiratory flow 25% to 75% (r=0.44) and FEV1/FVC (r= -0.29) showed that SBC may be sensitive to both obstructive and restrictive diseases and was also easily performed by children.[24]

In our study, the correlation coefficient between PEFR and SBC is 0.7048 with p<0.001 indicating a strong positive correlation thus, indicating that SBC can be applicable as a bedside assessment test to assess pulmonary functioning of adults.

However, in this study the correlation of PEFR and SBC to gold standard spiromtery was not performed and there could be extensive scope to study this correlation in various conditions affecting the pulmonary system.

## CONCLUSION

In this study, SBC showed a strong positive correlation to PEFR. SBC is a simple, alternative bedside assessment test to measure airway function when compared to PEFR. It is inexpensive and an easy to perform test which can be timely repeated as needed. Thus, SBC can be conveniently used as a substitute for device-oriented measures, as it requires the use of no common device which could be a source of risk of spread of infection amongst individuals.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

1. Moore VC. Spirometry: step by step. Breathe. 2012;8(3):232-40.
2. Miller MR, Hankinson JA, Brusasco V, Burgos F, Casaburi R, Coates A et al. Standardisation of spirometry. European respiratory journal. 2005;26(2):319-38.
3. Morris JF, Koski A, Johnson LC. Spirometric standards for healthy nonsmoking adults. American Review of Respiratory Disease. 1971;103(1):57-67.
4. Rega PP, Bork CE, Burkholder-Allen K, Bisesi MS, Gold JP. Single-breath count test: an important adjunct in the triaging of patients in a mass-casualty incident due to botulism. Prehosp Disaster Med. 2010;25(3):219-22.
5. Sato M, Tohara H, Iida T, Wada S, Inoue M, Ueda K. Simplified cough test for screening silent aspiration. Archives of physical medicine and rehabilitation. 2012;93(11):1982-6.
6. Colley JR, Holland WW. Evaluation of the de Bono whistle as a screening test of lung function. The Lancet. 1965;286(7405):212-4.
7. Abramowitz S, Leiner GC, Lewis WA, Small MJ. The evaluation of pulmonary function by the Snider match test. American Review of Respiratory Disease. 1965;92(1):124-8.
8. Desai U. The Novel Measurements and Correlations for Pulmonary Function Tests (TNMC-PFT) in interstitial lung diseases (ILD)-Using technology to simplify patient care. Pneumon. 2019;32(4):132-6.
9. Mrindha MA, Amin MR, Kabir AL. Peak expiratory flow rate (PEFR)-A simple ventilatory lung function test. Journal of Shaheed Suhrawardy Medical College. 2011;3(2):44-7.
10. Malo JL, L'archeveque J, Trudeau C, d'Aquino C, Cartier A. Should we monitor peak expiratory flow rates or record symptoms with a simple diary in the management of asthma?. Journal of allergy and clinical immunology. 1993;91(3):702-9.
11. Ushkow BS, Bartfield JM, Reicho PR, Raccio-Robak N. Single-breath counting for the assessment of bronchospastic patients in the ED. The American journal of emergency medicine. 1998;16(1):100-1.
12. Gorelick MH, Stevens MW, Schultz T, Scribano PV. Difficulty in obtaining peak expiratory flow measurements in children with acute asthma. Pediatric emergency care. 2004;20(1):22-6.
13. Dobra R, Equi A. How to use peak expiratory flow rate. Archives of Disease in Childhood-Education and Practice. 2018;103(3):158-62.
14. Kumari A, Malik S, Narkeesh K, Samuel AJ. Single breath count: A simple pulmonary function test using a mobile app. Indian Journal of Thoracic and Cardiovascular Surgery. 2017;33(4):369-70.
15. Dikshit MB, Raje S, Agrawal MJ. Lung functions with spirometry: An Indian perspective-I. Peak expiratory flow rates. Indian J Physiol Pharmacol. 2005;49(1):8-18.
16. Bolliger CT, Fourie PR, Kotze D, Joubert JR. Relation of measures of asthma severity and response to treatment to outcome in acute severe asthma. Thorax. 1992;47(11):943-7.
17. Nowak RM, Pensler MI, Sarkar DD, Anderson JA, Kvale PA, Ortiz AE, Tomlanovich MC. Comparison of peak expiratory flow and FEV1 admission criteria for acute bronchial asthma. Annals of Emergency medicine. 1982;11(2):64-9.
18. Li JT. Home peak expiratory flow rate monitoring in patients with asthma. InMayo Clinic Proceedings 1995;70(7):649-56
19. Eid N, Yandell B, Howell L, Eddy M, Sheikh S. Can peak expiratory flow predict airflow obstruction in children with asthma?. Pediatrics. 2000;105(2):354-8.
20. Escóssio AL, Araújo RC, Oliver N, Costa EC, Rizzo JÂ, Sarinho ES et al. Accuracy of single-breath counting test to determine slow vital capacity in hospitalized patients. Revista CEFAC. 2019;21(2).
21. Kalita J, Kumar M, Misra UK. Serial single breath count is a reliable tool for monitoring respiratory functions in Guillain-Barré Syndrome. Journal of Clinical Neuroscience. 2020;72:50-6.
22. Elsheikh B, Arnold WD, Gharibshahi S, Reynolds J, Freimer M, Kissel JT. Correlation of single-breath count test and neck flexor muscle strength with spirometry in myasthenia gravis. Muscle & nerve. 2016;53(1):134-6.
23. Bartfield JM, Ushkow BS, Rosen JM, Dylong K. Single breath counting in the assessment of

pulmonary function. Annals of emergency medicine. 1994;24(2):256-9.
24. Ali SS, O'Connell C, Kass L, Graff G. Single-breath counting: a pilot study of a novel technique for measuring pulmonary function in children. The American journal of emergency medicine. 2011;29(1):33-6.

**Cite this article as:** Bhandare SA, Rasal SS, Iyer SK. Correlation of peak expiratory flow rate and single breath count in normal adults. Int J Res Med Sci 2021;9:1960-4.