Indigenous Regression Equations for Forced Oscillation Technique – A Much Needed Affair

Samriti Gupta¹ • Sushil K. Kabra²

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Measurement of lung function is an essential component for making decision in patients with obstructive lung diseases. Spirometry is considered as the gold standard for assessment of lung function, both for diagnosis and monitoring in patients with asthma. However, it is difficult to be performed by smaller children due to its effort dependent nature and need for cooperation. Forced Oscillation technique (FOT) is a novel and effort independent pulmonary function test for diagnosis of airway obstruction requiring only tidal breathing maneuver. FOT measures the mechanical properties of respiratory system by imposing multiple sinusoidal pressure waves of different frequencies on tidal breaths and determines various parameters which include impedance (Zrs), resistance (Rrs), reactance (Xrs), resonant frequency (RF) and area under reactance (AX) [1]. The problem with the use of FOT is the non-availability of standard reference values or equations which preclude their utility on global basis. Also, the normal values of Rrs and Xrs depend on ethnicity, gender, standing height, age, body weight, and measuring techniques which tend to differ among different populations. Hence, it is important to have local reference values for their interpretation.

Reference equations determine the lung function values of a single patient by comparing his/her data to the data distributed in the reference population while regression equations determine the expected values of lung function as a function of age, weight and height [2]. Several studies have been done in various populations to generate the reference values for FOT both in adults and children using reference or regression equations determined by multiple linear regression models [3–6]. It has been observed that the resistance and reactance

values vary significantly with age and height in children with height being the strongest covariate in all previous studies in children [3, 4, 7]. Studies in Caucasian and Italian population have shown more or less similar predicted values while variable values were observed in Mexican population indicating non-applicability of predicted values of one place on global basis [8].

The study by De et al. [9] published in this issue has determined FOT prediction equations for within breath and whole breath respiratory impedance by multiple linear regression model in healthy Indian school children aged 5–17 years. The resistance and reactance were measured at frequencies of 5, 11 and 19 Hz. Standing height was found to have significant correlation with Zrs as well as for R5 and X5 which is similar to other studies. Gender based differences were also found in the present study with lower R5 and X5 in boys than girls after 14 y of age. The study has determined regression equations for within breath impedance unlike previous studies. The limitations of the study include involvement of single center and non inclusion of preschool children (3–5 years) where FOT may be considered more useful. Z scores were not determined for the predictive values to determine the normal range.

The within breath analysis *i.e.* determining separate inspiratory and expiratory resistance and reactance values may have the potential role in determining expiratory airflow limitation and has been evaluated in adult population [5, 10]. Due to differences in ethnicity and other anthropometric variables among different populations, reference values and equations of one place can't be applied for other populations. Hence, local data should be generated to address the issue of applicability and better clinical interpretation. To generalize the prediction equations of one ethnicity, multicentric study should be done to determine the reference population along with Z values in future for Indian population.

✉ Sushil K. Kabra
skkabra@hotmail.com

¹ Department of Pediatrics, Dr. Rajendra Prasad Government Medical College, Tanda, Kangra, Himachal Pradesh 176001, India

² Department of Pediatrics, All India Institute of Medical Sciences, New Delhi 110029, India

Compliance with Ethical Standards

Conflict of Interest None.

References

1. Oostveen E, MacLeod D, Lorino H, et al. The forced oscillation technique in clinical practice: methodology, recommendations and future developments. *Eur Respir J*. 2003;22:1026–41.
2. American Thoracic Society. Lung function testing: selection of reference values and interpretative strategies. *Am Rev Respir Dis*. 1991;144:1202–18.
3. Hall GL, Sly PD, Fukushima T, et al. Respiratory function in healthy young children using forced oscillations. *Thorax*. 2007;62:521–6.
4. Shackleton C, Barraza-Villarreal A, Chen L, Gangell CL, Romieu I, Sly PD. Reference ranges for Mexican preschool-aged children using the forced oscillation technique. *Arch Bronconeumol*. 2013;49:326–9.
5. De S, Banerjee N, Kushwah GS, Dharwey D. Regression equations of respiratory impedance of Indian adults measured by forced oscillation technique. *Lung India*. 2020;37:30.
6. Kalchiem-Dekel O, Hines SE. Forty years of reference values for respiratory system impedance in adults: 1977–2017. *Respir Med*. 2018;136:37–47.
7. AlBlooshi A, AlKalbani A, Narchi H, et al. Respiratory function in healthy Emirati children using forced oscillations. *Pediatr Pulmonol*. 2018;53:936–41.
8. Shackleton C, Barraza-Villarreal A, Romieu I, Calogero C, Hall G, Sly P. Forced oscillation technique (FOT) reference values: Does one size fit all? *Eur Respir J* [Internet]. 2012 Sep 1;40. Available at: https://erj.ersjournals.com/content/40/Suppl_56/P3205. Accessed 5th Jan 2020.
9. De S, Banerjee N, Tiwari RR. Regression equations of respiratory impedance measured by forced oscillation technique for Indian children. *Indian J Pediatr*. 2019:1–8. <https://doi.org/10.1007/s12098-019-03116-x>.
10. Aarli BB, Eagan TML, Ellingsen I, Bakke PS, Hardie JA. Reference values for within-breath pulmonary impedance parameters in asymptomatic elderly. *Clin Respir J*. 2013;7:245–52.

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