



Letter

Effect of sitting vs standing posture on spirometry in children

Asthma is a common medical condition that affects adults and children. National asthma guidelines (National Institutes of Health) recommend spirometry, a pulmonary function test, as an essential part of the initial diagnosis and follow-up care of asthma. Per the American Thoracic Society, traditionally spirometry is performed with the patient in the sitting posture, but usually it is not documented on the spirometry report. During the past 25 years, the rates of overweight and obesity have increased by 30% to 400% among 2- to 19-year-old. Currently, the prevalence of overweight is 14.9%, and the prevalence of obesity is 16.9%.¹ Furthermore, the effect of obesity on asthma is well known. Given this significant shift in physical characteristics of the pediatric population, we sought to investigate the effect of posture on spirometry in children with a history of asthma.

In our clinic, children with asthma who agree to undergo spirometry are offered the opportunity to perform the study in the sitting and standing posture on a voluntary basis. In this retrospective study, we evaluated all patients who performed spirometry in both postures from January 1, 2013, through December 31, 2014. Medical records were reviewed for patients' demographics, anthropometric measurements, and spirometry. Patients with comorbid physical conditions that might affect the posture/spirometry (eg, scoliosis or muscular dystrophy) were excluded. The study was approved by the institution review board at Metro Health Medical Center. Overweight was defined as a body mass index (BMI; calculated as weight in kilograms divided by the square of height in meters) between the 85th and 94th percentile, and obesity as a BMI at or greater than the 95th percentile for age.

During the study period, 147 patients met our inclusion criteria. Overall, their mean (SD) age was 10.9 (3.3) years, and their mean (SD) BMI was 21.8 (6.7), of whom 83 of 147 (56.5%) were male. In our study population of 147 patients, 53 (36.1%) were African American, 42 (28.6%) were white, 29 (19.7%) were Hispanic, and 23 (15.6%) were of other ethnicities. The effect of sitting vs standing posture on spirometry differed between the sexes. There was a significant difference in forced expiratory flow between 25% and 75% (FEF_{25%–75%}) between sitting and standing posture in female patients but not in male patients. Among female patients, the mean (SD) FEF_{25%–75%} was higher in sitting vs standing posture (2.10 [0.90] vs 2.01 [0.82] L/s, respectively; $P = .02$). However, there were no differences in forced vital capacity (FVC), forced expiratory volume in 1 second (FEV₁), and FEV₁/FVC ratio in male or female patients in the sitting or standing posture. In addition, significant differences were found in FEV₁/FVC, FEF_{25%–75%}, and peak flow rate (PFR)

between sitting and standing posture in female patients with a BMI in the 85th percentile or greater. The FEV₁/FVC ratio and FEF_{25%–75%} were higher in the sitting than standing posture and the PFR was lower in the sitting than standing posture in overweight and obese female patients. However, no differences were found in spirometry in male patients with BMIs in the 85th percentile or higher (Table 1).

Several subjective and objective factors are considered in the assessment of asthma severity and control to guide appropriate pharmacotherapy. Often the patient's perception of dyspnea and the physician's ability to assess the degree of airflow obstruction by the history and physical examination alone are inadequate.² Among the available objective measures, spirometry is the most commonly used test because of its ease of administration, noninvasive nature, and reproducibility per National Institutes of Health guidelines. According to the American Thoracic Society guidelines, spirometry can be performed in either the sitting or the standing posture as long as it is documented. Most of the studies on the effect of posture on spirometry have been performed primarily in adults. Gudmundsson et al³ found a small but insignificant effect of posture on spirometry in 50 obese patients. However, Townsend et al⁴ and Melam et al⁵ found that both FVC and FEV₁ were larger in the standing vs sitting posture in 90 and 30 adult patients, respectively. The larger study of 235 pulmonary patients by Pierson et al⁶ had mixed results. Sitting values for the FVC and FEV₁ were higher among those with FVC of 2.14 L, FEV₁ of 1.68 L, FEF_{25%–75%} of 2.16 L/s, and FEV₁/FVC ratio of 75.7%. Patients with less than these values performed slightly better in the standing position. In our study, we did not have enough patients in each category of severity of asthma to study the effect of posture on spirometry at different severity of illness. The study by Berntsen et al,⁷ involving 115 obese, nonasthmatic children (23 overweight and 92 obese), found that FEV₁ and FVC were significantly higher in the sitting vs standing posture. In our study, only posture had an effect on FEF_{25%–75%} in female patients and on FEV₁/FVC ratio, FEF_{25%–75%}, and PFR in obese females in particular. We can only speculate that in our study the female adolescents' weight gain (associated with growth spurt and puberty) might have affected their body fat distribution differently than the male adolescents and therefore affected spirometry readings between sitting and standing postures. The respiratory system adherence is decreased by obesity because of excess soft-tissue compression of the thoracic cage, fatty infiltration of the chest wall, and increased pulmonary blood volume.⁸ The current literature suggests a general symmetrical reduction in both FVC and FEV₁ among all obese male and female individuals.⁹ However, men with more central obesity are known to have much

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Table 1
Effect of Posture on Spirometry in Overweight and Obese Patients According to Sex^a

Outcome measure	BMI ≥85 for male patients sitting (n = 36)	BMI ≥85 for male patients standing (n = 36)	P value	BMI ≥85 for females patients sitting (n = 27)	BMI ≥85 for female patients standing (n = 27)	P value
FVC	3.01 (1.8)	3.01 (1.19)	.92	2.74 (0.70)	2.77 (0.68)	.33
FEV ₁	2.44 (1.02)	2.44 (1.00)	.89	2.26 (0.53)	2.21 (0.51)	.62
FEV ₁ /FVC	0.80 (0.08)	0.81 (0.08)	.62	0.81 (0.07)	0.80 (0.07)	.05
FEF _{25%–75%}	2.45 (1.27)	2.45 (1.25)	.97	2.29 (0.68)	2.16 (0.62)	.03
PFR	4.88 (2.22)	4.99 (2.13)	.28	4.19 (1.10)	4.42 (1.17)	.04

Abbreviations: FEF_{25%–75%}, forced expiratory flow between 25% and 75%; FEV₁, forced expiratory volume in 1 second; FVC, forced vital capacity; PFR, peak flow rate.^aData are presented as mean (SD).

lower FVC and FEV₁ for a given BMI.⁹ In adults with asthma, McLachlan et al¹⁰ have found an association between airflow obstruction and percentage of body fat in women but not in men. Our findings could have been the results of a type I error because we have a small number of patients and the differences in spirometry are small. Even if these differences in spirometry are statistically significant, they might not have a clinical significance because these differences are small. In addition, we could have had a lower FEV₁/FVC and a lower FEF_{25%–75%} in the standing position secondary to an increase in FVC while standing. Future prospective studies are needed to determine whether sex plays a significant role in spirometry at different postures.

In conclusion, because there is an intrapostural variability in spirometry reading, especially among female patients, we recommend documentation of postures on spirometry records to ensure proper tracking and comparison on serial test results.

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