

Comparison of spirometric results obtained from the sitting and standing position in children participating in an epidemiological study

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Abstract

Introduction: It is recommended that spirometric testing in children be completed while sitting. Our experience indicates that children prefer standing during spirometry.

Aim: We sought to compare spirometric results obtained from the sitting (SIP) and standing (STP) positions.

Material and methods: Two testing sessions were performed in random order (SIP vs. STP: 30–45 min apart) in 118 children (7–13 years), attending one, randomly selected, primary school (response rate: 92%).

Results: Acceptable quality was found in 77.9% of STP and 77.1% of SIP maneuvers. Higher values of spirometric variables on STP, compared to SIP, were obtained for forced vital capacity (FVC) (2.12 ± 0.41 l vs. 2.11 ± 0.39 l) and forced expiratory volume in 1 s (FEV_1) (1.78 ± 0.36 l vs. 1.77 ± 0.35 l) but the differences were not statistically significant. Relative between-position differences (RBP) $\leq 5\%$ were found with the following frequencies: FVC: 56.4%, FEV_1 : 69.2%, PEF: 21.7%, and FEF_{25-75} : 24.3%. Similar patterns were found for FEF_{25} , FEF_{50} , and FEF_{75} . Relative between-position differences were related to age in the case of FEV_1 ($p = 0.005$), FEF_{25} ($p = 0.02$), and FEF_{25-75} ($p = 0.01$) where older children had smaller RBP. Forced vital capacity RBP was lower ($p = 0.01$) in subjects with current wheeze; PEF RBP were lower ($p = 0.02$) in children with asthma.

Conclusions: In epidemiological studies, the position of spirometric testing does not affect the results of lung function assessment.

Key words: spirometry, position, children, epidemiology.

Introduction

According to American Thoracic Society/European Respiratory Society (ATS/ERS) recommendations, it is preferable that spirometric testing in children be completed in the sitting position, for safety reasons [1]. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines indicate that the standing position involves a risk of syncope [2]. However, no specific data are used to support this view. Our experience with population-based studies indicates that children feel more comfortable standing during spirometry. There are few published reports which consider “standing results” [3, 4].

Aim

The current study was undertaken to compare spirometric results obtained from the sitting and standing

positions in children who were participants of an epidemiological study.

Material and methods

One randomly selected primary school in the city of Katowice, Poland acted as the sampling frame. All children aged 7–13 years attending the school were invited (response rate was 92%; study $n = 118$). Children performed spirometry (EasyOne) at two consecutive testing sessions in random order (sitting vs standing position) 30–45 min apart. Between sessions, children were at rest in the school. The tests were done according to ATS/ERS recommendations [1]. The quality of the spirometry tests was based on the A-F scale [5, 6]. Grades A, B, and C required a maximum difference between the two best forced expiratory volume in 1 s (FEV_1) and forced vital capac-

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ity (FVC) readings of < 100 ml, 101–150 ml, and 151–200 ml differences, respectively, and represent acceptable quality [5–7]. Analysis involved data from 78 (66.1%) children who had A-C readings in both positions. The following spirometric variables were used in the analysis: FVC, FEV₁, peak expiratory flow (PEF), forced expiratory flow at 25% of the pulmonary volume (FEF₂₅), forced expiratory flow at 50% of the pulmonary volume (FEF₅₀), forced expiratory flow at 75% of the pulmonary volume (FEF₇₅) and forced expiratory flow at 25–75% of the pulmonary volume (FEF_{25–75}).

Research was performed in accordance with the Declaration of Helsinki and the study protocol was reviewed and approved by the Ethical Review Board at the Medical University of Silesia, Poland (KNW/0022/KB1/5/1/13).

Statistical analysis

Statistical significance of absolute and relative (%) between-position differences was assessed using the paired *t*-test. The effect of sex, age, body mass index (BMI), and chronic respiratory symptoms on the relative between-position difference was assessed using the general linear model. The following symptoms were obtained from the questionnaire and included in the separate models: chronic cough (at least 3 months, most days), chest wheeze (last year), attacks of dyspnea (last year). Statistical inference was based on the criterion *p* < 0.05.

Results

The study group was composed of 29 girls and 49 boys. The mean age of subjects was 9.0 ±1.6 years. The frequency of chronic cough was 33.7%, of chest wheeze was 11.6%, and of attacks of dyspnea was 9.0%. No adverse events were observed (Table 1).

On average, higher values of spirometric variables on standing, compared to the sitting position, were obtained for each spirometric variable considered, but the differences were not statistically significant (Table 1). For FVC and FEV₁, the majority of children had less than 5% relative difference between positions (Table 1). Multi-variable

analysis showed that the relative (%) between-position differences were statistically significantly related to age only in the case of FEV₁ (*p* = 0.005), FEF₂₅ (*p* = 0.02), FEF_{25–75} (*p* = 0.01), and marginally in the case of FEF₅₀ (*p* = 0.08) and FEF₇₅ (*p* = 0.05). The associations were negative (older children had smaller relative differences). The relative (%) between-test differences were not related (*p* > 0.05) to gender and BMI. Only in the case of FVC and PEF were the relative sitting-standing differences statistically significantly related to the symptoms of asthma and were lower (*p* = 0.01) in subjects with current wheeze (2.3%) compared with children without current wheeze (6.1%); differences in PEF were lower (*p* = 0.02) in children with asthma (3.4%) than in children without asthma (13.2%).

Discussion

Our study showed that the acceptability level of spirometry results was similar in maneuvers performed in the standing and sitting positions (77%). However, only 62.1% of children performed acceptable tests on both occasions. Our observations are comparable to results from large epidemiological studies where the percentage of good quality spirometry based on the same criterion varies from 50% to 80% [8–10]. While the quality of spirometry is not dependent on position, an interesting issue is why some children were able to perform good spirometry only in one position. Random order of the initial position as well as a similar percentage of good quality spirometry in either position seems to eliminate the influence of the so-called “learning” effect.

Published data are inconsistent and the effect of the position during spirometry on spirometric values was found to be different across the studies [11–19]. Some research has shown that FVC, FEV₁ and PEF are significantly higher when obtained in the sitting position [11, 12], while others show that those parameters are higher in the standing position [13–18].

Table 1. Absolute and relative differences in spirometric variables between the standing and sitting position

| Variable | Sitting Mean ± SD | Standing Mean ± SD | Absolute difference Mean ± SD | P-value* | Relative difference Mean % ± SD | Relative difference standing-sitting | | | |
|--------------------------|----------------------|-----------------------|-------------------------------------|----------|---------------------------------------|--------------------------------------|-------|-------|-------|
| | | | | | | < 5% | < 10% | < 15% | < 20% |
| FVC [l] | 2.11 ±0.39 | 2.12 ±0.41 | 0.009 ±0.04 | 0.5 | 5.57 ±4.62 | 56.4 | 84.6 | 94.8 | 98.7 |
| FEV ₁ [l] | 1.77 ±0.35 | 1.78 ±0.37 | 0.017 ±0.13 | 0.2 | 5.85 ±6.63 | 69.2 | 83.3 | 88.4 | 92.3 |
| PEF [l] | 3.52 ±0.85 | 3.58 ±0.85 | 0.04 ±0.53 | 0.4 | 12.46 ±9.51 | 21.9 | 52.5 | 66.6 | 78.2 |
| FEF ₇₅ [l] | 1.01 ±0.44 | 1.06 ±0.41 | 0.04 ±0.35 | 0.2 | 27.28 ±30.70 | 15.4 | 28.2 | 39.7 | 57.6 |
| FEF ₅₀ [l] | 2.27 ±0.68 | 2.28 ±0.71 | 0.01 ±0.51 | 0.8 | 19.43 ±24.94 | 23.1 | 43.5 | 57.6 | 70.5 |
| FEF ₂₅ [l] | 3.16 ±0.90 | 3.24 ±0.85 | 0.07 ±0.61 | 0.2 | 16.60 ±21.62 | 30.8 | 52.6 | 64.1 | 73.1 |
| FEF _{25–75} [l] | 1.92 ±0.60 | 1.95 ±0.59 | 0.02 ±0.36 | 0.5 | 15.98 ±16.83 | 24.4 | 47.4 | 57.6 | 70.5 |

*Results of paired *t*-test comparing absolute values.

In our study, maneuvers in the standing position yielded slightly but not statistically significantly larger values of spirometric variables, particularly for flow rates. It supports the idea that there is no difference of spirometry parameters according to the standing or sitting position [16–18]. In addition to this, the relative differences were mostly less than 5% for FEV₁ and FVC, which indicates a difference which is not clinically important. While the relative differences were higher for the other spirometric measures, these are to be expected given the increased variability in general of these measures. Also, in an applied epidemiological setting, the common, and more useful, measures considered are the FEV₁ and FVC.

We found that age was inversely related to the relative percent differences in lung function between positions. This suggests higher consistency in the older age groups and supports the idea that as children age, their developmental ability to perform lung function tests is stronger.

Conclusions

In epidemiological studies of the respiratory health of children, the position of spirometric testing does not seem to affect the result of lung function assessment, especially in older children, or the safety level of the measuring procedure.

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Conflict of interest

The authors declare no conflict of interest.

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