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Original Article

Seasonal Differences in FEV_1 Response to Bronchodilation: A Comparison between Young and Elderly Patients

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S U M M A R Y

Background: The bronchodilation test is used to detect reversible airways obstruction, which is important for diagnosing asthma. Since asthma activity is influenced by seasons, with higher activity in the spring and fall, this study aimed to determine if the FEV_1 response to bronchodilation is season-dependent.
Methods: All enrolled asthmatic patients underwent pulmonary function testing. Bronchodilation was assessed by measuring FEV_1 change (ΔFEV_1) before and after inhalation of fenoterol 0.4 mg delivered by metered-dose inhaler with a spacer.
Results: There were 348 adult patients with positive bronchodilator test (ΔFEV_1 > 12% and 200 mL). In the younger population (n = 223 aged < 65 years), the ΔFEV_1 in winter (January–March) was +331.5 ± 119.0 mL (mean ± SD) and +337.6 ± 110.2 mL in summer (July–September). These were significantly less than the results in the other two seasons (April–June, + 398.9 ± 149.1 mL and October–December, + 397.4 ± 183.3 mL; $p = 0.015$). In the elderly (n = 125 aged ≥ 65 years), the ΔFEV_1 throughout the four seasons was similar ($p = 0.410$).
Conclusions: In younger adults, the bronchodilator variabilities are low in winter and summer, suggesting lower sensitivity of the test due to decreased asthma activity during these seasons. Bronchodilation in the elderly is not season dependent.

1. Introduction

Flow-volume spirometry is a reproducible and reliable method for assessing lung function. The bronchodilation test is used to detect reversible airways obstruction, which is important for diagnosing asthma.[1,2] In clinical practice, the recommended spirometric bronchodilation response in adults is an increase of 12% and 200 mL from baseline forced expiratory volume in 1 s (FEV_1).[3,4] The change in FEV_1 (ΔFEV_1) in response to bronchodilation is related to airway hyper-responsiveness and asthma severity, and can be influenced by many factors like age, sex,[5,6] and bronchodilating medication and its mode of delivery.[7,8] Morbidity varies with seasons and is relatively low during summer and winter.[9,10] The severity of clinical symptoms correlates with the degree of airway hyper-responsiveness. However, if the bronchodilation response is season-dependent remains unknown.

Asthma-related morbidity in children has been predominately linked to allergen exposure and seasonal sensitization. Atopy, however, is uncommon in the elderly with asthma. Whether this relationship of seasonal variation persists in the older population is unknown. Thus, this study aimed to evaluate the effects of seasonal differences on FEV_1 changes in response to bronchodilation in patients with positive bronchodilator test. The results were also compared between the younger and elderly populations.

2. Materials and methods

2.1. Subjects and study design

A total of 2781 patients underwent pulmonary function measurements with bronchodilator testing in an out-patient setting at a

Abbreviations: ΔFEV_1, difference between FEV_1; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; PEF, peak expiratory flow.

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tertiary care medical center in Tamsui, Taiwan, between January 2013 and December 2015. Patients were excluded if they were <20 years of age, had poor performance on pulmonary function testing, or had a peak expiratory flow (PEF) < 40% of predicted. All patients with positive bronchodilator test were included and categorized by month. This study was approved by the Institute Board of MacKay Memorial Hospital (16MMHIS032).

2.2. Pulmonary function tests and bronchodilator test

Pulmonary function measurements were performed according to the American Thoracic Society guidelines.[11,12] No bronchodilators, either β-adrenergic agonists or theophylline, were administered within 8 h before the start of the study. All of the patients also underwent spirometry and lung volume measurements using the nitrogen wash-out method (Vmax 22; SensorMedics; Yorba Linda, CA) in the hospital. The predicted and percent-predicted values were calculated for FEV_1, FVC, and the FEV_1/FVC ratio using the reference values recommended by Knudson et al.[13]

Bronchodilator reversibility tests were performed using the largest FEV_1 and FVC from the best of three spirograms recorded on a single-breath bellows spirometer.[11] The subjects then inhaled 0.4 mg of fenoterol (Berotec; Boehringer Ingelheim) using an MDI under the guidance of a well-trained technician. Spirometry was performed and repeated after a 15–20 min delay. A positive bronchodilator response was defined as improvement of the FEV_1 by > 12% and 200 mL compared to baseline during a single testing session.[11] Those with a positive bronchodilator response constituted the study population.

2.3. Statistical analysis

All data were expressed as mean ± SD. Changes in FEV_1 were expressed as absolute and percent changes from baseline. Different variables for the bronchodilator response (ΔFEV_1 in mL and as percentage) were assessed by multiple logistic regression analysis. Analysis of variance (ANOVA), followed by the Fisher's protected least significant difference post hoc test, was used to compare differences in continuous variables among the different age groups. Statistical significance was set at $p < 0.05$. Differences between groups were tabulated and analyzed using the SPSS software (version 16.0; Chicago, IL).

3. Results

3.1. Population sample

A total of 2781 patients underwent pulmonary function measurements by bronchodilator testing during the study period. The response was positive in 348 individuals (223 between 20 and 65 years of age; 125 aged ≥ 65 years), who constituted the study population. According to the month each occurred during the calendar year, individual increases in ΔFEV_1 (bronchodilator response) were shown (Fig. 1).

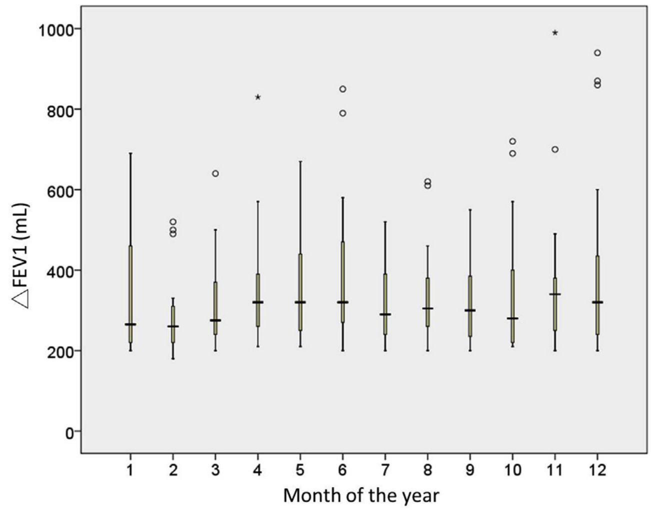

Fig. 1. Boxplots of bronchodilator responses (ΔFEV_1 in mL) of patients presented by month during the calendar year.

There was a trend of seasonal differences in bronchodilation response. The responses significantly increased in April and November. Among the four seasons, no differences were found in the FEV1 values (ml and % of predicted) and FEV1/FVC ratio at baseline spirometry (Table 1). However, the ΔFEV_1 significantly increased in spring (April–June, + 363.2 ± 138.3 mL) and fall (October–December, + 357.2 ± 163.9 mL) than in winter and summer ($p = 0.022$).

In the younger population (age <65 years), there was no significant difference in terms of demographic data or severity of baseline pulmonary function in the four seasons (Table 2). The ΔFEV_1 in winter (January–March) was +331.5 ± 119.0 mL and +337.6 ± 110.2 mL in summer (July–September). Both were significantly less than the results in spring and fall (April–June, + 398.9 ± 149.1 mL and October–December, + 397.4 ± 183.3 mL, respectively; $p = 0.015$) (Fig. 2).

In elderly population (age ≥65 years), there was no significant seasonal difference in baseline pulmonary function (Table 3) and there was only a trend of high ΔFEV_1 in spring, as well as low ΔFEV_1 in winter and summer, but without significant difference ($p = 0.410$) (Fig. 2).

Table 1
Characteristics, baseline values, and bronchodilator response of patients with positive bronchodilator test (n = 348).

Variables	January to March (n = 90)	April to June (n = 98)	July to September (n = 67)	October to December (n = 93)	p[a]
Age, yr	57.9 ± 15.5	58.3 ± 16.5	57.7 ± 16.8	56.6 ± 16.7	0.904
Height, cm	162.0 ± 8.1	162.8 ± 6.9	162.3 ± 8.7	162.2 ± 8.6	0.922
Weight, kg	69.1 ± 15.2	68.1 ± 16.2	69.7 ± 15.7	68.9 ± 13.5	0.933
Baseline spirometry					
FVC, %	87.9 ± 18.2	89.6 ± 19.5	86.4 ± 19.4	93.8 ± 18.6	0.068
FEV_1, %	66.0 ± 18.1	66.1 ± 17.3	68.9 ± 18.0	70.1 ± 17.0	0.306
FEV_1/FVC, %	61.2 ± 13.2	60.5 ± 13.9	65.3 ± 12.1	61.6 ± 13.1	0.116
PEF, %	75.2 ± 24.3	71.2 ± 22.9	74.9 ± 22.6	77.3 ± 23.1	0.329
FEV_1 increase after bronchodilator test					
ΔFEV_1, ml	312.6 ± 111.9	363.2 ± 138.3	320.8 ± 98.0	357.2 ± 163.9	0.022
ΔFEV_1, %	19.9 ± 7.4	23.2 ± 11.8	19.5 ± 7.3	20.7 ± 10.0	0.038

Abbreviations: ΔFEV_1, difference between FEV_1; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; PEF, peak expiratory flow.
Data are expressed as mean ± SD.
[a] Comparison of four groups by ANOVA for continuous variables.

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