## Original Article

# Functional impairment in bronchiectasis: Spirometry parameters versus St. George's Respiratory Questionnaire scores: Any co-relation?

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## ABSTRACT

**Objectives:** Bronchiectasis is a common respiratory disease which has significant morbidity and mortality. Health-related quality of life scores are not routinely used for the assessment of bronchiectasis. The present study was undertaken with an aim to assess the clinical profile and functional impairment using spirometry in patients with bronchiectasis and to co-relate functional impairment with their St. George's Respiratory Questionnaire (SGRQ) score. **Methodology:** This was a cross-sectional study carried out on 102 patients of bronchiectasis. All patients were assessed for clinical profile, spirometry, and SGRQ scores. Forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC) and FEV1/FVC were measured and compared with SGRQ scores. Data analysis was done using SPSS version 20.0 and MS-Excel. **Results:** Obstruction was found in 62.7% and significant bronchodilator reversibility was observed in 30.4%. All spirometry parameters individually and combined showed a negative co-relation which was stastically significant ($P < 0.001$). Best co-relation was with FEV1 $r = -0.809$; symptom score, $r = -0.821$; activity score, $r = -0.849$; impact score and $r = -0.873$ total score. FVC% versus symptoms score $r = -0.735$; activity score $r = -0.729$, impacts score $r = -0.778$; total score $r = -0.792$. FEV1/FVC versus symptoms score $r = -0.227$, activity score $r = -0.278$, impacts score $r = -0.263$, total score $r = -0.274$. **Conclusion:** SGRQ scores have shown good correlation with functional impairment. It can be used as a modality to evaluate health status of patient in resource constraint settings.

**KEY WORDS:** Bronchiectasis, Bronchospirometry, St. George's respiratory questionnaire

## INTRODUCTION

Bronchiectasis refers to the abnormal widening of the bronchi with airway suppuration. It is characterized by permanent dilatation of bronchi and bronchioles caused by the destruction of the muscle and elastic tissue. There is impaired mucociliary clearance, which leads to a vicious cycle of bacterial colonization and excessive bronchial inflammation.[1,2] The disease leads to recurrent lower respiratory tract infections, worsening pulmonary functions, pulmonary hypertension, and respiratory failure.[1] It is a heterogeneous condition with

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diverse etiologies which vary in different populations. Despite using advanced immunological and genetic diagnostic tests, in up to 40% of patient's etiology remains undetermined.[3] Patients commonly complain of cough with copious expectoration, hemoptysis, dyspnea, and chest pain.[4]

Bronchiectasis is conventionally described as an obstructive disease along with chronic obstructive pulmonary disease (COPD) and asthma. However, it is a distinct entity in itself. Pulmonary function tests (PFTs) are used as an objective measure for functional assessment in respiratory diseases. Obstructive impairment is seen most frequently in bronchiectasis.[5] Lower pulmonary functions are associated with more severe disease, higher risk of exacerbation requiring hospitalization, and mortality.[6,7] In addition, airway hyperresponsiveness in bronchiectasis has been associated with poorer quality of life, lower baseline spirometric values, and more frequent exacerbations.[8]

Health-related quality of life (HRQL) scores for asthma and COPD are in vogue since many years, unlike bronchiectasis. HRQL questionnaires are important, as they can help the clinicians to evaluate the impact of disease on a patient's daily life and act as a modality to monitor the clinical status of the patient and worsening of lung function. For health assessment in bronchiectasis, St. George's respiratory questionnaire (SGRQ) is a validated questionnaire. It is a self-administered HRQL measure which contains 50 items and 76 weighted responses. Responses are divided into three components: symptoms, activity, and Impact. Scores can range from 0 (best possible score) to 100 (worse possible score) for each component. A total score is calculated which summaries the responses. A meta-analysis by Spinou *et al*. on HRQL questionnaires in bronchiectasis showed that SGRQ was the most extensively studied questionnaire in bronchiectasis with good internal consistency, test-retest reliability, and convergent validity. However, there was conflicting data for discriminative ability on quality of life in bronchiectasis based on forced expiratory volume (FEV) 1%.[9]

### Objectives
#### *Primary objectives*
To assess the co-relation of spirometry parameters with SGRQ scores in bronchiectasis.

#### *Secondary objectives*
To study the clinical profile, pulmonary function impairment, and bronchodilator reversibility (BDR) on spirometry in patients of bronchiectasis.

Sample size calculation with threshold probability of $\alpha$ =0.05 (level of significance) and with $\beta$ level of 0.20 (power of study 80%) and the previously observed co-relation coefficient in meta-analysis between bronchiectasis questionnaires and FEV1% being 0.30[9] the

minimal sample size calculated was, $n$ = 85. During the period of the study, a total of 102 patients were included.

## METHODOLOGY

### Subjects and methods
The study was a cross-sectional study carried out on bronchiectasis patients aged older than 18 years attending the respiratory outpatient department or admitted to a tertiary care chest hospital in western Maharashtra between May 2017 and May 2019. We excluded patients if they had any contraindication to spirometry, diagnosed cases of COPD, bronchial asthma, allergic bronchopulmonary aspergillosis (ABPA), and patients in exacerbations. Patients who were diagnosed to have bronchiectasis on high-resolution computed tomography (CT) chest and gave consent were included. Relevant history and examination findings were recorded. Patients had a baseline assessment in the form of SGRQ (available in English, Hindi and Marathi). Permission to use SGRQ score was taken from St Georges University, London. The number of exacerbations occurring in the preceding 6 months was determined from the history and clinical records. An exacerbation was defined as persistent (>24 h] deterioration in at least three respiratory symptoms (including cough, dyspnoea, hemoptysis, increased sputum purulence or volume, and chest pain), with or without fever (>37.5°C), radiographic deterioration, systemic disturbances, or deterioration in chest signs.

### Spirometry
All patients underwent spirometry for functional evaluation. Spirometry was performed using jaeger's computer based spirometer as per American Thoracic Society (ATS) guidelines on the subject.[10] The calibration was checked daily using a 3 L syringe discharged at least 3 times to give a range of flows verifying between 0.5 and 12 L/S. Spirometry was performed by a trained investigator with the patient in a sitting position. A nose clip was used to prevent air leakage. Three tests which were acceptable and repeatable as per ATS guidelines were obtained in each subject and were used to grade pulmonary function. FEV in 1 s (FEV1), forced vital capacity (FVC), and FEV1/FVC ratio were measured.

Pulmonary function impairments were classified according to the above-mentioned parameters in four groups (1) Normal-FVC >80% and FEV1 >80% of predicted, FEV1/FVC >70%. (2) Restriction-FEV1 and FVC <80% predicted and a preserved FEV/FVC ratio (>70%) (3) Obstruction-FEV1/FVC <70% with normal FVC (>80% of predicted). (4) Mixed defect-FEV1 and FVC <80% predicted and an FEV/FVC ratio of <70%.

BDR was performed as per guidelines of ATS. Short-acting b2-agonists (salbutamol) was given by four separate doses of 100 mcg by metered-dose inhaler. Spirometry was repeated after a 15-min delay. As per recommendations

the percent change from baseline and absolute changes in FEV1 and/or FVC in an individual subject was used to identify a positive bronchodilator response. FEV1 values of >12% and 200 mL compared with baseline during a single testing session were taken as "significant" bronchodilatation.

### Statistical analysis

Data analysis was done using SPSS version 20.0 (SPSS Inc, Chicago, IL, USA). Quantitative variables were presented as means (standard deviation) and qualitative variables as absolute values and percentage of the total. Pearson's coefficient was used to find the co-relation between SGRQ scores and spirometry parameters (FEV1%, FVC%, FEV1/FVC).

## RESULTS

Of our study population of 102 patients, 51% ($n$ = 52/102) were female and 49% ($n$ = 50/102) were male. The mean age was 50.12 years with a confidence interval of (46.94–53.30) and a standard error of 1.62. Only 10.7% ($n$ = 11/102) were smokers. Majority of patients were symptomatic, i.e., 93.13% ($n$ = 95/102), while seven patients were asymptomatic and were incidentally detected during evaluation of other diseases like malignancy or during preanesthesia check-ups. Commonest symptom seen was cough with expectoration in 83.3% ($n$ = 85/102), followed by dyspnoea in 67.6% ($n$ = 69/102) and 22.5% ($n$ = 23/102) suffered from hemoptysis. 12.7% ($n$ = 13/102) had chest pain. 5.8% ($n$ = 06/102) had other nonspecific complaints like weight loss, loss of appetite, fever, and fatigue. 21.6% ($n$ = 22/102) of patients had suffered from exacerbation in the preceding 6 months.

The sizeable number of the patients 74.5% (76/102) had bronchiectasis secondary to pulmonary tuberculosis (TB) including 03 cases of multidrug resistance TB. Seven patients had a history of pneumonia in the past while two patients each were diagnosed with cases of Rheumatoid Arthritis and Kartagener Syndrome. The etiological profile is shown in Figure 1. In 11 patients etiology could not be ascertained historically or on investigations.

Pre- and postspirometry values are shown in Table 1. Obstruction was found in majority i.e., 62.

7% ($n$ = 64/102), 21.6% ($n$ = 22/102) patients had a mixed defect (obstruction + restriction) and restriction was seen in 9.8% ($n$ = 10/102) patients. 5.9% ($n$ = 6/102) patients had normal spirometry. Significant BDR was observed in 30. Four percent ($n$ = 31/102).

All patients filled up the SGRQ questionnaire. Values of SGRQ score of the patients for symptoms, activity, Impact is shown in Table 2. The mean total score was 40.30 with values ranging from 0% to 95.47%.

SGRQ scores were compared to spirometry parameters FEV1%, FVC %, and FEV1/FVC. All parameters individually and combined showed a negative co-relation which was statistically significant with $P$ < 0.001, shown in Table 3 and graphically represented in Figures 2-4. Best co-relation of SGRQ scores individually and combined was seen with FEV1.

## DISCUSSION

Bronchiectasis continues to be a clinically challenging disease with significant morbidity and mortality. Chronic infection and recurrent damage to the airways sets in a vicious cycle leading to persistent symptoms, physiological impairment causing ventilatory defects, abnormal gas exchange, and hemodynamic consequences which lead to pulmonary hypertension and cor-pulmonale.[4] It is
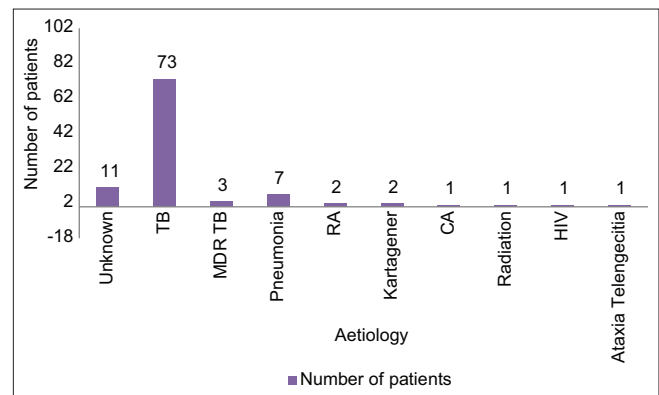


**Figure 1:** Etiological profile of patients. TB: Tuberculosis, MDR: Multidrug resistance, RA: Rheumatoid arthritis, CA: Cancer, HIV: Human immunodeficiency virus-acquired immunodeficiency virus syndrome)

### Table 1: Spirometry parameters

| Value | Pre BD | | | | | Post BD | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FEV1 (L) | FEV1 (%) | FVC (L) | FVC (%) | FEV1/FVC | FEV1 (L) | FEV1 (%) | FVC (L) | FVC (%) | FEV1/FVC |
| Minimum | 0.45 | 21.7 | 0.66 | 22.7 | 35.02 | 0.1 | 24.4 | 0.63 | 29.4 | 47.43 |
| Maximum | 3.5 | 117.1 | 4.37 | 119.2 | 97.08 | 3.6 | 120.8 | 4.58 | 118 | 97.17 |
| Mean | 1.45 | 57.05 | 2.23 | 72.88 | 64.85 | 1.58 | 63.21 | 2.32 | 75.71 | 68.72 |
| SD | 0.68 | 17.90 | 0.92 | 20.23 | 10.08 | 0.70 | 18.53 | 0.91 | 19.18 | 9.35 |
| Median | 1.345 | 60.915 | 2.025 | 80.925 | 65.125 | 1.515 | 68.3 | 2.08 | 82.85 | 69.1 |
| SE | 0.07 | 1.77 | 0.09 | 2.00 | 1 | 0.07 | 1.83 | 0.09 | 1.90 | 0.93 |
| Lower CI | 1.32 | 53.58 | 2.06 | 68.96 | 62.89 | 1.45 | 59.61 | 2.14 | 71.99 | 66.90 |
| Upper CI | 1.58 | 60.53 | 2.41 | 76.80 | 66.80 | 1.72 | 66.80 | 2.49 | 79.43 | 70.53 |

BD: Bronchodilator, SD: Standard deviation, SE: Standard error, CI: Confidence interval, FEV1: Forced expiratory volume in 1 s, FVC: Forced vital capacity
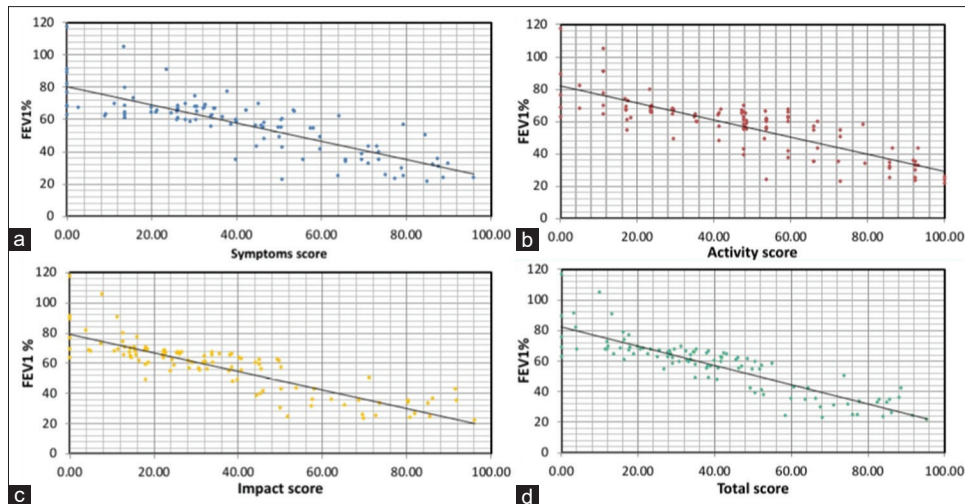
**Figure 2:** Correlation between forced expiratory volume 1% with St. George's respiratory questionnaire (a) Symptoms score, (b) Activity score, (c) Impact score, (d) Total score
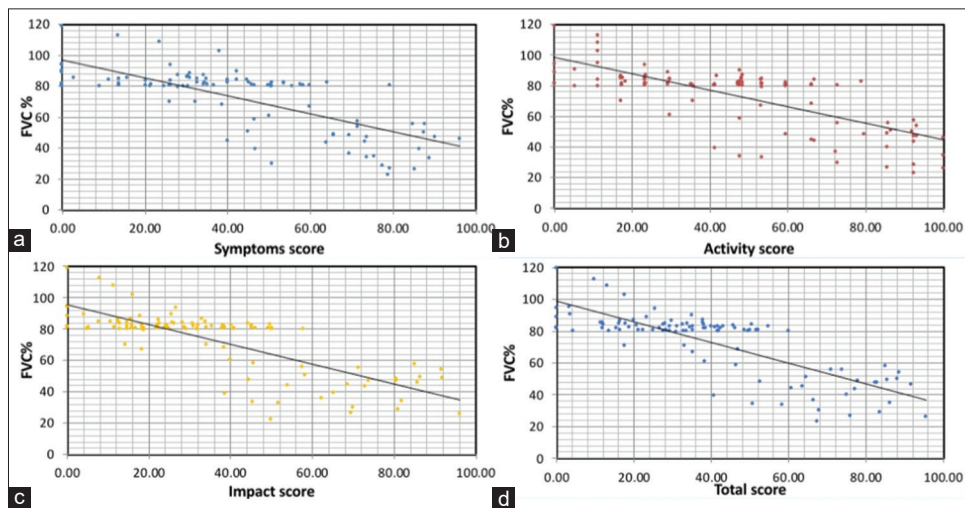


**Figure 3:** Correlation between forced vital capacity% with St. George's respiratory questionnaire (a) Symptoms score, (b) Activity score, (c) Impact score, (d) Total score

## Table 2: St. George's respiratory questionnaire scores

| Data | Symptoms | Activity | Impact | Total score |
|---|---|---|---|---|
| Minimum | 0 | 0 | 0 | 0 |
| Maximum | 96.02 | 100 | 96.14 | 95.47 |
| Mean | 41.01 | 47.45 | 36.01 | 40.30 |
| SD | 25.70 | 27.56 | 24.75 | 24.60 |
| Median | 38.20 | 47.69 | 31.94 | 37.84 |
| SE | 2.55 | 2.73 | 2.45 | 2.44 |
| Lower CI | 36.02 | 42.10 | 31.20 | 35.53 |
| Upper CI | 46 | 52.79 | 40.81 | 45.08 |

SD: Standard deviation, SE: Standard error, CI: Confidence interval

a common disease in developing countries and four phenotypes have been described-rapidly progressive, slowly progressive, indolent, and hemoptysis predominant.[11] Bronchiectasis is described as one of the obstructive airway diseases like asthma and COPD. Though the clinical profile of all the diseases may be similar it is prudent to differentiate bronchiectasis from asthma and COPD as it has therapeutic and prognostic implications.

A study by Morrissey[12] reported that bronchiectasis is more common in women and more virulent. In our study, also the women marginally outnumbered men and ages ranged from 18 to 90 years. Recurrent infections in bronchiectasis result in cough with expectoration. In our study, cough with expectoration and dyspnoea were the most common symptoms. O'Donnell[13] in their review states that, "any patient when presenting with cough and mucopurulent sputum, bronchiectasis should be suspected as one of the commonest differential diagnosis."

In bronchiectasis, cough has been reported in more than 90% of patients,[14] dyspnea in 72%[4] and chest pain in 31%–50%.[14] Pappalettera *et al.* have reported chest pain in 20%–30% of patients which may be pleuritic.[15] Hemoptysis is another common presenting symptom which varies from blood staining to massive. Singh and Tiwari[16] studied etiology of hemoptysis in 214 patients and among them 3.5% had bronchiectasis. Magu *et al.*[17]
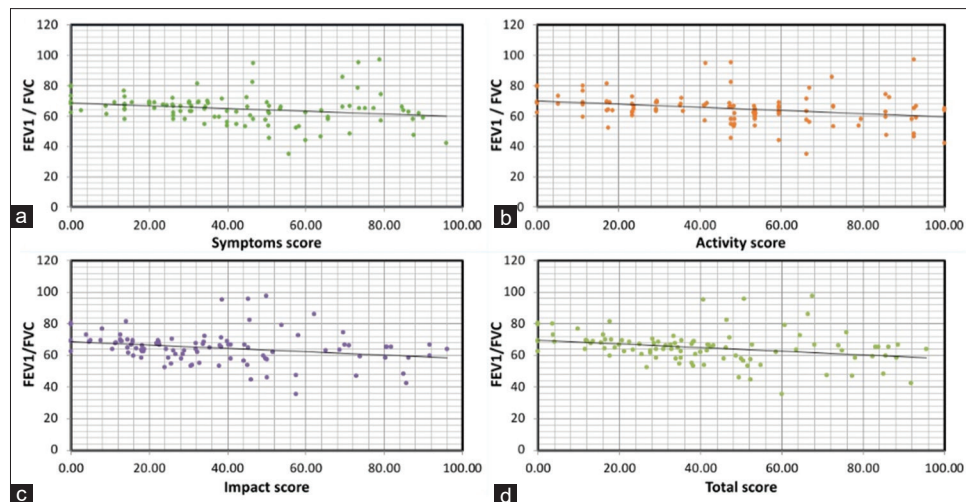
**Figure 4:** Correlation between forced expiratory volume 1/forced vital capacity% with St. George's respiratory questionnaire (a) Symptoms score, (b) Activity score, (c) Impact score, (d) Total score

**Table 3: St. George's respiratory questionnaire scores versus spirometry parameters**

| Correlation | Symptom | Activity | Impact | Total |
|---|---|---|---|---|
| FEV1 (%) | | | | |
| Pearson correlation | −0.809 | −0.821 | −0.849 | −0.873 |
| *P* | <0.001 | <0.001 | <0.001 | <0.001 |
| *n* | 102 | 102 | 102 | 102 |
| FVC (%) | | | | |
| Pearson correlation | −0.735 | −0.729 | −0.778 | −0.792 |
| *P* | <0.001 | <0.001 | <0.001 | <0.001 |
| *n* | 102 | 102 | 102 | 102 |
| FVE1/FVC | | | | |
| Pearson correlation | −0.227 | −0.278 | −0.263 | −0.274 |
| Significance (2-tailed) | 0.022 | 0.005 | 0.008 | 0.005 |
| *n* | 102 | 102 | 102 | 102 |

FEV1: Forced expiratory volume in 1 s, FVC: Forced vital capacity

studied the etiology of hemoptysis in patients with normal chest X-ray and found bronchiectasis as the etiology in 20% of the patients.

Unlike the west, where immunological disorders, cystic fibrosis (CF) are common, In India commonest cause of bronchiectasis is TB. In European multicentre bronchiectasis audit and research collaboration (EMBARC) with Indian registry of 2195 patients commonest cause of bronchiectasis were pulmonary TB (35.5%), idiopathic (21.4%), postinfectious (22.4%), and ABPA (8.9%).[18] In our study also TB was the leading cause of bronchiectasis.

Spirometry is an important investigation to evaluate functional impairment in respiratory disorders. Spirometry can be obstructive, restrictive, or normal in bronchiectasis.[19] However, obstruction is the functional characteristic of bronchiectasis.[20] Obstruction in bronchiectasis has been explained by various mechanism like mucosal edema and hyperplasia of glands, excessive airways collapse in expiration, bronchospasm, bronchial plugging by secretions, distortion, and kinking of bronchi

or by excessive dynamic compression of the airways due to greater pliability of the affected bronchi, retained secretions, superadded infections.[20] It is imperative to identify the baseline functional status of patients. Obstructive pattern is associated with higher risk of colonization with pseudomonas infection. The presence of obstruction is one of the poor prognostic indicators.[21] Also, both obstructive and restrictive patterns have been associated with more severe disease and increased risk of hospitalization.[19] Qi *et al*.[20] reported functional impairment in 70% of their patients with obstruction in 60.4%. A study by Sevgili *et al*.[5] observed obstruction in 72.9%, 24.3% had mixed defect and 2.8% had restrictive abnormality. Khalid *et al*.[22] did a retrospective review of PFT of 101 patients and the data revealed obstruction in 70%, mixed pattern in 23%, and restriction in 8%. In the EMBARC registry obstruction was observed in 34.8% and restriction in 26.7%.[18] In our study also obstruction was the most common impairment observed.

The presence of BDR has been taken as an indicator of prescribing bronchodilators and also inhaled corticosteroids (ICSs) in bronchiectasis. Testing for BDR in bronchiectasis is important, as it can guide clinicians to institute individualised treatment and assess prognosis.[23] Guan *et al*.[23] observed that patients with significant BDR show few important characteristics viz: Higher bronchiectasis severity index, higher chances of pseudomonas aeruginosa isolation and infection, poorer lung function at baseline, but not significantly higher blood or sputum eosinophil count, nonsignificant trend toward lower risks of experiencing exacerbations. Retrospective data analysis by Khalid *et al*. did not show significant BDR in majority of patients, i.e., 79%.[22] Another study on 95 patients of bronchiectasis showed the prevalence of bronchoconstriction to inhaled mannitol to be 19.4% in patients on ICS and 27.1% in patients not on ICS. Though the inflammatory profile of patients did not demonstrate the cells and mediators involved

in atopy or asthma. Thereby it has been postulated that infection may be responsible for bronchoreactivity in bronchiectasis.[24] Various other uncontrolled studies have shown variable BDR 5%, 12%, 39%, 47%.[13] However, small sample size is a limitation of these studies. Furthermore, patients of asthma were not excluded which could account for higher airway responsiveness. In our study, patients with asthma and COPD were excluded to account for false-positive cases. ABPA patients were also excluded based on the clinical profile of asthma and central bronchiectasis. de Koning Gans *et al.*[25] presented preliminary data from the screening of FORZA (formoterol-beclamethasone in patients with bronchiectasis) study. The preliminary data of 23 patients showed airway hyperresponsiveness (AHR) in 35% i.e., eight patients in non-CF bronchiectasis, excluding patients with a history of asthma or COPD. Raising an important question if all non-CF bronchiectasis patients should be screened for AHR. In our study, positive BDR was seen in 30%. In view of the clinical significance of BHR, Bulcun *et al.*[8] have proposed that BHR should be taken into consideration as a part of routine clinical evaluation in patients with bronchiectasis.

The mechanism of bronchial hyperreactivity in bronchiectasis is postulated to occur secondary to the accessibility of toxins through infected or inflamed bronchial mucosa. Bronchial hyperreactivity possibly affects the clearance mechanism and furthers the vicious cycle of colonization be microbes and inflammation.[5]

Bronchiectasis causes significant impairment of patient's health. Health-related questionnaires form an important communication tool between the patient and the doctor, to target treatment to specific areas of health and assess the effectiveness of therapy.[26] SGRQ questionnaire initially developed for COPD has been validated in bronchiectasis. SGRQ has been four as a valid measurement with good repeatability and internal consistency in bronchiectasis.[8,9] Impaired health at various levels could be adequately identified and differentiated based on SGRQ scores. Changes occurring in health over a period of 6 months in patients of bronchiectasis could be well ascertained with SGRQ score.[9] Chan *et al.*[27] have shown that SGRQ is a better measurement of the overall effect of bronchiectasis than routine measurements of lung function. The co-relation between objective functional aspects and health status by questionnaire in bronchiectasis remains controversial and elusive. Lee *et al.*[28] observed a strong association between 6-min walk distance with all parameters of SGRQ score. In another study, distance walked on the incremental shuttle walk test moderately co-related with SGRQ symptom ($r = 0.30$) and was strongly related to SGRQ activity ($r = 0.65$) and total scores ($r = 0.56$).[28] Eshed *et al.*[29] studied 46 patients of bronchiectasis and even though no correlation was found between CT scores and SGRQ scores. A significant co-relation was observed between the SGRQ scores and respiratory function test

indices. Bronchiectasis health questionnaire (BHQ) and quality of life-bronchiectasis (QoL-B) are bronchiectasis specific validated questionnaires. The association between health status and lung function (FEV1), although weak was statistically significant in BHQ. The study found a significant association between BHQ and FEV1 and breathlessness.[26]A weak association with FEV1 has also been reported for the quality of life questionnaire-bronchiectasis (QoL-B) questionnaire, emphasizing that health status questionnaires evaluate a unique facet of disease severity.[26] Martínez García *et al.*[30] studied 102 patients of bronchiectasis in Spain and found that the components of activity and impact score in the SGRQ questionnaire essentially correlated with lung function parameters (FEV1 in ml after bronchodilation) with $r = 0.62$ and $r = 0.51$, respectively, and the total score on the questionnaire corelated more strongly with the lung function, both the percentage and absolute FEV1 (with correlation coefficient of 0.6). However, Wilson *et al.* found a weak co-relation between SGRQ scores and lung function parameters ($r = 0.07–0.36$), in contrast, Chan *et al.* observed a stronger co-relation with FEV1 ($r = 0.48$).[30] Thereby, the meta-analysis on bronchiectasis questionnaire observed that though SGRQ scores was able to differentiate between patients based on the severity of breathlessness, CT extent of bronchiectasis and FEV1% categories, however, the data on co-relation between the quality of life scores and FEV1% was conflicting with various studies showing weak-to-moderate association r= - 0.31 (- 0.40 to - 0.23).[9]

In the current study, a significant negative correlation was observed in the SGRQ scores of patients suffering from bronchiectasis with respect to their functional impairment, suggesting that it can be used in a resource-constrained environment, where facilities for spirometry are not routinely available. Moreover, it has been observed over the years, that elderly patients and patients in exacerbations are unable to perform spirometry maneuvers as per acceptable technique. SGRQ scores can be used as an alternative in such settings.

SGRQ questionnaire has a limitation in time restraint settings as it is exhaustive and time-consuming.

## CONCLUSION

Bronchiectasis is a common respiratory disease which has significant morbidity and mortality. A microbiological cure of TB or other infections can still lead to substantial pulmonary sequelae in the form of bronchiectasis. In bronchiectasis patient's spirometry and BDR needs consideration for tailored therapy and prognostic monitoring. SGRQ scores have shown a good negative co-relation with functional impairment and can be used in resource constraint settings for health status evaluation in bronchiectasis. It can be utilized in resource constraint settings when the time factor is excluded.

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## Conflicts of interest
There are no conflicts of interest.

# REFERENCES

1. King PT. The pathophysiology of bronchiectasis. Int J Chron Obstruct Pulmon Dis 2009;4:411-9.
2. Altenburg J, Wortel K, van der Werf TS, Boersma WG. Non-cystic fibrosis bronchiectasis: Clinical presentation, diagnosis and treatment, illustrated by data from a Dutch Teaching Hospital. Neth J Med 2015;73:147-54.
3. Nehad AS, Al-Jahdali HH, Al Shimemeri A. Pathogenesis, etiology and treatment of bronchiectasis. Ann Thorac Med 2006;1:41.
4. Habesoglu MA, Ugurlu AO, Eyuboglu FO. Clinical, radiologic, and functional evaluation of 304 patients with bronchiectasis. Ann Thorac Med 2011;6:131-6.
5. Sevgili S, Hasanoğlu HC, Karalezli A, Er M. Bronchial reversibility in the patients with bronchiectasis. Tuberk Toraks 2009;57:38-47.
6. Goeminne PC, Scheers H, Decraene A, Seys S, Dupont LJ. Risk factors for morbidity and death in non-cystic fibrosis bronchiectasis: A retrospective cross-sectional analysis of CT diagnosed bronchiectatic patients. Respir Res 2012;13:21.
7. Onen ZP, Gulbay BE, Sen E, Yildiz OA, Saryal S, Acican T, *et al*. Analysis of the factors related to mortality in patients with bronchiectasis. Respir Med 2007;101:1390-7.
8. Bulcun E, Arslan M, Ekici A, Ekici M. Quality of life and bronchial hyper-responsiveness in subjects with bronchiectasis: Validation of the Seattle obstructive lung disease questionnaire in bronchiectasis. Respir Care 2015;60:1616-23.
9. Spinou A, Fragkos KC, Lee KK, Elston C, Siegert RJ, Loebinger MR, *et al*. The validity of health-related quality of life questionnaires in bronchiectasis: A systematic review and meta-analysis. Thorax 2016;71:683-94.
10. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, *et al*. Standardisation of spirometry. Eur Respir J 2005;26:319-38.
11. Tsang KW, Tipoe GL. Bronchiectasis: Not an orphan disease in the East. Int J Tuberc Lung Dis 2004;8:691-702.
12. Morrissey BM. Pathogenesis of bronchiectasis. Clin Chest Med 2007;28:289-96.
13. O'Donnell AE. Bronchiectasis. CHEST J 2008;134:815-23.
14. Pasteur MC, Bilton D, Hill AT. British thoracic guidelines for non-CF bronchiectasis. Thorax 2010;65 Suppl 1:i1-58.
15. Pappalettera M, Aliberti S, Castellotti P, Ruvolo L, Giunta V, Blasi F. Bronchiectasis: An update. Clin Respir J 2009;3:126-34.
16. Singh SK, Tiwari KK. Etiology of hemoptysis: A retrospective study from A tertiary care hospital from northern Madhya Pradesh, India. Indian J Tuberc 2016;63:44-7.
17. Magu S, Malhotra R, Gupta KB, Mishra DS. Role of computed tomography in patients with hemoptysis and a normal chest skiagram. Indian J Chest Dis Allied Sci 2000;42:101-4.
18. Dhar R, Singh S, Talwar D, Mohan M, Tripathi SK, Swarnakar R, *et al*. Bronchiectasis in India: Results from the European Multicentre Bronchiectasis Audit and Research Collaboration (EMBARC) and respiratory research network of India registry. Lancet Glob Health 2019;7:e1269-79.
19. Stretton R, Poppelwell L, Salih W, Chalmers J, Fardon T. Patterns of spirometry in bronchiectasis patients and relationship to markers of disease severity and hospitalisation. Eur Respir J 2013;42: P2695.
20. Qi Q, Wang W, Li T, Zhang Y, Li Y. Aetiology and clinical characteristics of patients with bronchiectasis in a Chinese Han population: A prospective study. Respirology 2015;20:917-24.
21. Loebinger MR, Wells AU, Hansell DM, Chinyanganya N, Devaraj A, Meister M, *et al*. Mortality in bronchiectasis: A long-term study assessing the factors influencing survival. Eur Respir J 2009;34:843-9.
22. Khalid M, Al Mandeel B, Bazarbashi M, Zeitouni M, Sharawani N. Common pulmonary function test findings and response to inhaled bronchodilators (salbutamol) in patients with postinfectious, noncystic fibrosis, bronchiectasis in KINGDOM of Saudi Arabia. Chest 2000;118:196S.
23. Guan WJ, Gao YH, Xu G, Li HM, Yuan JJ, Zheng JP, *et al*. Bronchodilator response in adults with bronchiectasis: Correlation with clinical parameters and prognostic implications. J Thorac Dis 2016;8:14-23.
24. King PT, Daviskas E. Pathogenesis and diagnosis of bronchiectasis. Breathe 2010;6:342-51.
25. de Koning Gans M, Kamphuis LS, Hoek RA, Bakker M, Aerts JG, Van Der Eerden MM. Late breaking abstract-airway hyperresponsiveness in bronchiectasis. Eur Respir J 2019;54 Suppl 63:OA4944.
26. Spinou A, Siegert RJ, Guan WJ, Patel AS, Gosker HR, Lee KK, *et al*. The development and validation of the bronchiectasis health questionnaire. Eur Respir J 2017;49:1601532.
27. Chan SL, Chan-Yeung MM, Ooi GC, Lam CL, Cheung TF, Lam WK, *et al*. Validation of the Hong Kong Chinese version of the St. George Respiratory Questionnaire in patients with bronchiectasis. Chest 2002;122:2030-7.
28. Lee AL, Button BM, Ellis S, Stirling R, Wilson JW, Holland AE, *et al*. Clinical determinants of the 6-minute walk test in bronchiectasis. Respir Med 2009;103:780-5.
29. Eshed I, Minski I, Katz R, Jones PW, Priel IE. Bronchiectasis: Correlation of high-resolution CT findings with health-related quality of life. Clin Radiol 2007;62:152-9.
30. Martínez García MA, Perpiñá Tordera M, Román Sánchez P, Soler Cataluña JJ. Internal consistency and validity of the Spanish version of the St. George's respiratory questionnaire for use in patients with clinically stable bronchiectasis. Arch Bronconeumol 2005;41:110-7.