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RESEARCH

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Prognostic factors of pulmonary exacerbations severity in pediatric bronchiectasis: a retrospective cohort study

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Abstract

Background Pulmonary exacerbations have been found to negatively impact the natural course of pediatric bronchiectasis. However, prognostic factors that might predict the severity of exacerbations are poorly identified. Therefore, this study was designed to identify the best prognostic factors associated with pulmonary exacerbations severity in pediatric bronchiectasis.

Results This retrospective cohort study involved fifty stable bronchiectasis patients including cystic fibrosis (CF) and non-CF bronchiectasis under the age of 18 years. The pulmonary exacerbations during the previous year were reviewed among the studied patients determining their relations with bacterial colonization, inflammatory markers, lung function, and severity scores. The severity of pulmonary exacerbations was directly related to the number of hospitals and ICU admissions ($P<0.001$, $P<0.001$), exacerbations frequency ($P<0.001$), SPEX score ($P=0.002$), inflammatory markers as sputum neutrophil elastase ($P<0.001$), C-reactive protein (CRP) ($P<0.001$), Respiratory and Systemic Symptoms Questionnaire (RSSQ) ($P<0.001$), Acute Respiratory Illness Checklist (ARIC) ($P<0.001$), cough severity score ($P<0.001$), and bronchiectasis severity index (BSI) ($P=0.009$) in all bronchiectasis patients. Additional significant relations were found between exacerbations severity with pseudomonas colonization and FACED score ($P=0.002$, $P=0.010$) among CF patients and with lower body mass index (BMI) and older age ($P=0.035$, $P<0.001$) among non-CF bronchiectasis patients respectively.

Conclusions Pulmonary exacerbations are prevalent among both pediatric CF and non-CF bronchiectasis patients. In this population, the best prognostic factors for pulmonary exacerbation severity were the frequency of ICU admissions and BSI more than 11 identifying their importance during bronchiectasis assessment.

Keywords Bronchiectasis, Colonization, Cystic fibrosis, Exacerbations, Pediatric, Severity

Background

Bronchiectasis is a persistent or progressive condition that is characterized by dilated and often thick-walled bronchi [1], persistent bacterial infection, and recurrent exacerbations that may require hospital admissions [2]. Bronchiectasis is divided into bronchiectasis secondary to cystic fibrosis and bronchiectasis that is not associated with cystic fibrosis, which is defined as non-cystic fibrosis bronchiectasis [3].

Exacerbations of bronchiectasis are the key targets for therapy as they are largest determinants of healthcare costs. They are related to increasing both airways and

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systemic inflammation [4] and progressive lung damage [5]. Furthermore, more severe and more frequent exacerbations are associated with worse quality of life, daily symptoms [6], lung function decrease [7], and mortality [5]. Consequently, the majority of therapeutic interventions are aiming to reducing exacerbations.

Given the clinical significance of pulmonary exacerbations, an understanding of the risk factors that provoke them is needed. In this study, we hypothesized that several factors related to host characteristics, exacerbations frequency, bacterial colonization, lung function, radiological scores, and bronchiectasis severity scores may be associated with developing exacerbations and increasing its severity among pediatric patients diagnosed with bronchiectasis.

Methods

Patients and settings

This retrospective cohort study assessed pulmonary exacerbations in thirty CF and twenty non-CF bronchiectasis children under the age of 18 years during the period between 1st January 2020 and 1st January 2021. The patients were recruited from Pediatric Specialized Pulmonology Clinic and Pulmonology Department, Children's Teaching, Ain Shams University Hospital.

Patients were included if they had the following: (1) confirmed CF diagnosis by using established CF diagnostic guidelines [8] and (2) a documented diagnosis of non-CF bronchiectasis by clinical history of chronic sputum production and/or frequent respiratory infections with confirmed radiological findings of bronchiectasis by high-resolution computed tomography (HRCT) lung scanning with a negative sweat test [9].

Patients were excluded if as follows: (1) the studied patients had any associated comorbidities, or (2) the study subjects had any other major systemic illness.

Ethical issues

The study was approved by the Research Ethical Committee, Faculty of Medicine, Ain Shams University, Children's Hospital. Informed consents were obtained from the parents and the patients older than 8 years prior to the inclusion in the study.

Measurements

A detailed history was reviewed and reordered from all participants and hospital records including respiratory symptoms as cough type, expectoration, dyspnea, respiratory distress, hemoptysis, and cyanosis with a special focus on symptoms suggestive of pulmonary exacerbations over the previous 12 months. The number of courses of intravenous antibiotics in the year preceding the time of the study was recorded as well.

The demographic and clinical parameters of the fifty studied bronchiectasis patients including age, sex, and body mass index (BMI) percentile [10] in the previous year were obtained from the hospital records. The underlying etiology of bronchiectasis was determined following the British Thoracic Society (BTS) guidelines [1].

Furthermore, the colonization status and pulmonary function tests (PFTs) measurement for cooperative patients older than 60 years which was performed and interpreted according to the American Thoracic Society guidelines [11] during the previous year were recorded. Serum laboratory inflammatory markers as complete blood count and C-reactive protein (CRP) and sputum neutrophil elastase (NE) [12] during the last exacerbation in the previous year were also obtained.

Data analysis

A pulmonary exacerbation was defined based on Fuchs criteria [13] for the CF patients and BTS guidelines [1] for non-CF bronchiectasis patients which were applied on the studied patients by at least two pulmonologists during examination before entering the hospital database. The frequency of exacerbations in the previous 12 months was recorded. Frequent exacerbations were defined as more than three exacerbations per year [14, 15].

A mild-to-moderate exacerbation was further defined as follows: 1 to 2 signs or symptoms present or that the symptom severity was mild. A moderate-to-severe exacerbation was defined as follows: More than 3 new findings or 1 to 2 severe findings (e.g., oxygen desaturation, new crackles) or a mild-to-moderate exacerbation unresponsive to oral or inhaled antibiotics [16].

The microbiological diagnosis of exacerbation was performed using lower respiratory tract samples (either induced, expectorated sputum, or bronchial lavage), using standard clinical microbiological protocols [17, 18]. Sputum and bronchial lavage were processed for Gram and Zel-Nelson strains and for cultures of bacterial, fungal, and mycobacterial pathogens.

Chronic bronchial infection was defined when two or more cultures are positive for the same potentially pathogenic bacteria over a 12-month period in samples collected at intervals of at least 3 months [19].

All the studied patients were assessed using multidimensional clinical and radiological severity scores to assess the risk of exacerbations, hospitalizations, and health status in the previous year and to discriminate between different levels of exacerbations severity (from mild to severe) including FACED score [20], the bronchiectasis severity index (BSI) [5], Shwachman-Kulczycki (SK) score [21], cough severity score [22], and the Simplified Seattle Pulmonary Exacerbation Score (SPEX)

[23], Acute Respiratory Illness Checklist (ARIC) [24], and Respiratory and Systemic Symptoms Questionnaire (RSSQ) [25]. The radiological severity of bronchiectasis was evaluated using the modified Reiff score [26, 27] and Bhalla score [28]. The clinical and radiological scores were performed by a pediatric pulmonologist and a radiology specialist.

Statistical analysis

Data were analyzed in the form of mean ± standard deviation (± SD) and range for quantitive data or frequencies (number of cases) and percentages for qualitative data. *P*-values less than 0.05 were considered statistically significant, and *P* less than 0.01 was considered highly significant. All statistical calculations were done using computer programs SPSS (Statistical Package for the Social Science (SPSS) Inc., Chicago, IL, USA).

Univariate and multivariate logistic regression analysis was used to assess predictors of severity including demographic data, anthropometric measurements, inflammatory biomarkers, lung function measurements, sputum microbiology, and clinical and radiological severity scores among the studied cases. Sample size was calculated using PASS 11.0, which achieved 80% power to detect a difference of between the null hypothesis and the alternative hypothesis correlation adjusting the confidence interval to 95% and the margin of error accepted to 5%.

Results

Patient characteristics

The present study consisted of fifty bronchiectasis pediatric patients under the age of 18 years, which included the following: thirty CF bronchiectasis patients and twenty non-CF bronchiectasis patients. The mean (SD) age for the studied patients was 6.58 (4.16) years, 28 (56.0%) were males, 60% of patients had CF, and 24% of the patients had postinfectious bronchiectasis. Chronic *Pseudomonas* infection was represented among 44% of the study patients. The mean FEV1% of predicted was 70.00 (26.51). The median number of exacerbations per the last year was 2 (1–3). The mean BSI score was 10.36 (2.80) with a range of 6–16. The median FACED score (IQR) was 2 (1–2) with a range of 0–5. The distribution according to the BSI scale was 0 (0%) mild, 12 (24.0%) moderate, 38 (76.0%) severe, and according to FACED scale was 42 (84.0%) mild, 4 (8.0%) moderate, and 4 (8.0%) severe. Only 20% of CF patients were homozygous for the F508del mutation. The patient characteristics, bronchiectasis etiological diagnosis, chronic bacterial infection, number of exacerbations, and severity scores are described in Table 1.

Table 1 Baseline characteristics of the studied patients

Baseline characteristics; *N* (50)	
Age (years; mean ± SD)	6.58 ± 4.16
Range	1–17
Gender (% male)	28 (56.0%)
Consanguinity	24 (48.0%)
Socioeconomic status	
Middle	16 (32.0%)
Low	34 (68.0%)
Body mass index (kg/m^2)	14.48 ± 2.55
Range	10.9–19.8
Etiology of bronchiectasis	
• Cystic fibrosis	30 (60%)
• Post-infective	12 (24%)
• Allergic bronchopulmonary aspergillosis	4 (8%)
• Kartagener syndrome	2 (4%)
• Idiopathic	2 (4%)
FEV1% predicted	
Mean ± SD	70.00 ± 26.51
Range	45–110
Chronic infection, *n* (%)	
P. aeruginosa	22 (44.0%)
MRSA[a]	18 (36.0%)
Streptococcus pneumoniae	4 (8%)
Klebsiella	2 (4%)
Escherichia coli	2 (4%)
Enterococci	2 (4%)
Median sputum neutrophil elastase (ng/ml) (IQR)	30 (24–64)
Range	6–140
Bronchiectasis severity index (mean ± SD)	10.36 ± 2.80
Range	6–16
Median FACED score (IQR)	2 (1–2)
Range	0–5
Modified Reiff score (mean ± SD)	6.72 ± 1.26
Range	3–8
Bhalla score (mean ± SD)	16.44 ± 3.73
Range	12–24
Cough severity score (mean ± SD)	25.60 ± 7.31
Range	14–38
Median exacerbations last year (IQR)	2 (1–3)
Range	1–6
CFTR genotype	
Homozygous F508del	6 (20.0%)
Heterozygous F508del	4 (13.3%)
Other/others	14(46.6%)

[a] Methicillin-resistant *Staphylococcus aureus*

Table 2 Pulmonary exacerbation characteristics among the studied patients

Pulmonary exacerbations characteristics; *N* = 124	
Frequency of exacerbations in last year	
< 3 times	30 (60.0%)
≥ 3 times	20 (40.0%)
Severity of exacerbations in the last year	
Mild	12 (24.0%)
Moderate	18 (36.0%)
Severe	20 (40%)
Number of hospital admissions in the last year	
Median (IQR)	2 (1–2)
Range	0–6
Number of ICU admissions in the last year	
Median (IQR)	1 (0–3)
Range	0–3
The use of intravenous antibiotics in the last year	
Median (IQR)	2 (1–2)
Range	0–6
Duration of exacerbations (in days)	
Median (IQR)	6 (5–10)
Range	4–21
SPEX[a] score	
Median (IQR)	10 (7–11)
Range	6–14

[a] Simplified Seattle Pulmonary Exacerbation Score

Pulmonary exacerbation characteristics

As shown in Table 2, frequent pulmonary exacerbations were found among 40% of the studied patients. A total of 36% of the patients had moderate exacerbations, while severe exacerbations were presented among 40% of the patients. The median SPEX score of pulmonary exacerbations was 10 (7–11) with a range of 6–14. The median duration of exacerbations was 6 (5–10) days.

Exacerbations among CF and non-CF bronchiectasis

As presented in Fig. 1, moderate-to-severe pulmonary exacerbations were more prevalent among CF (80%) than among non-CF bronchiectasis patients (70%) ($P = 0.659$). In addition, frequent pulmonary exacerbations were found among 46.7% and 40% of CF and non-CF bronchiectasis patients respectively ($P = 0.642$). However, the difference was statistically non-significant.

Prognostic factors of exacerbations severity

The values of sputum NE, cough severity score, BSI, and SPEX score were significantly higher among severe exacerbations (72 (62–130), 33.30 ± 2.39, 11.60 ± 2.91, 11 (8–13)) than mild-to-moderate ones (25 (16–30), 20.47 ± 4.30, 9.53 ± 2.43, 7 (6–11)) ($P < 0.001, < 0.001, 0.009, 0.002$) (Fig. 2). In addition, severe pulmonary exacerbations were associated with increased exacerbations frequency, increased number of hospital admissions, ICU admissions, and use of intravenous antibiotics ($P < 0.001, < 0.001, < 0.001, < 0.001$) (Fig. 3). Additional significant associations were found between elevated CRP, ARIC, and RSSQ and severe exacerbations than mild and moderate ones ($P < 0.001, < 0.001, < 0.001$).

Furthermore, among CF patients, severe exacerbations were significantly associated with higher rates of chronic *Pseudomonas* infection (100.0%) ($P = 0.002$), elevated liver enzymes (52.33 ± 23.98) ($P = 0.005$), elevated FACED score (2.67 ± 1.78) ($P = 0.010$), and longer duration of

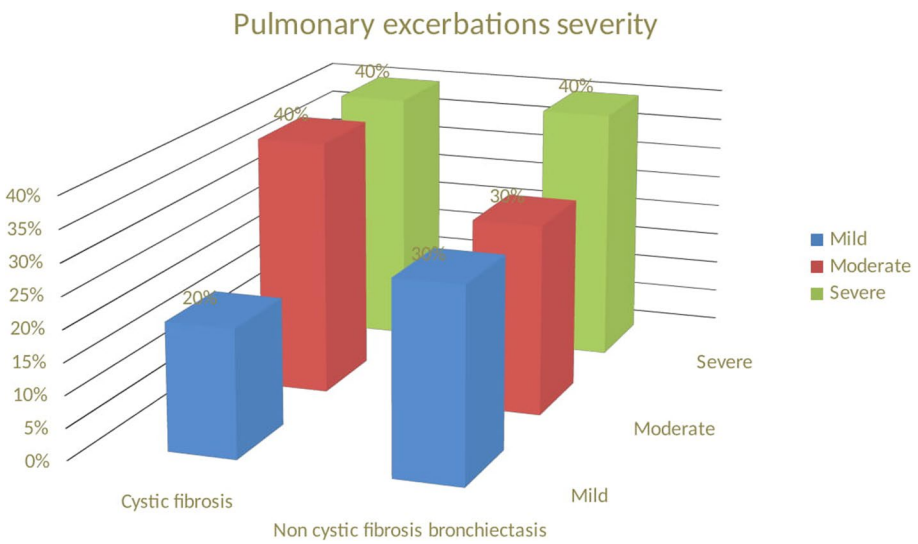

Fig. 1 Comparison of exacerbations severity among CF and non-CF bronchiectasis

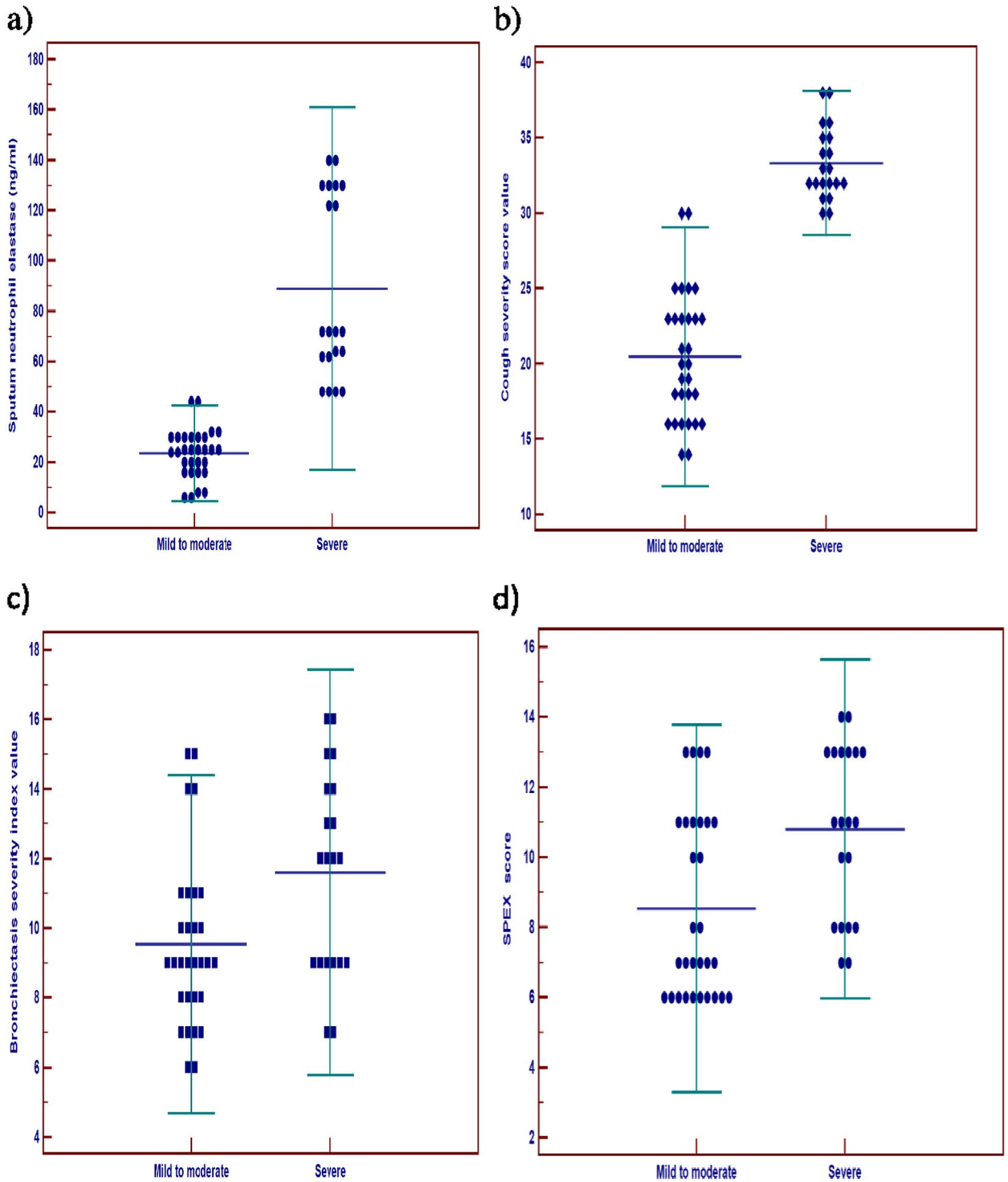

Fig. 2 Relations between pulmonary exacerbations severity and sputum NE (**a**), cough severity score (**b**), BSI (**c**), and SPEX score (**d**) among all the studied patients

exacerbation (10 (7–14)) ($P=0.024$) than mild and moderate exacerbations (44.4%, 28.00 ± 20.08, 1.33 ± 0.84, 5 (5–7)) (e-Table 1).

Moreover, lower BMI, and older age, were more observed with severe exacerbations (13.35 ± 0.61, 11.08 ± 1.55) than with mild and moderate ones

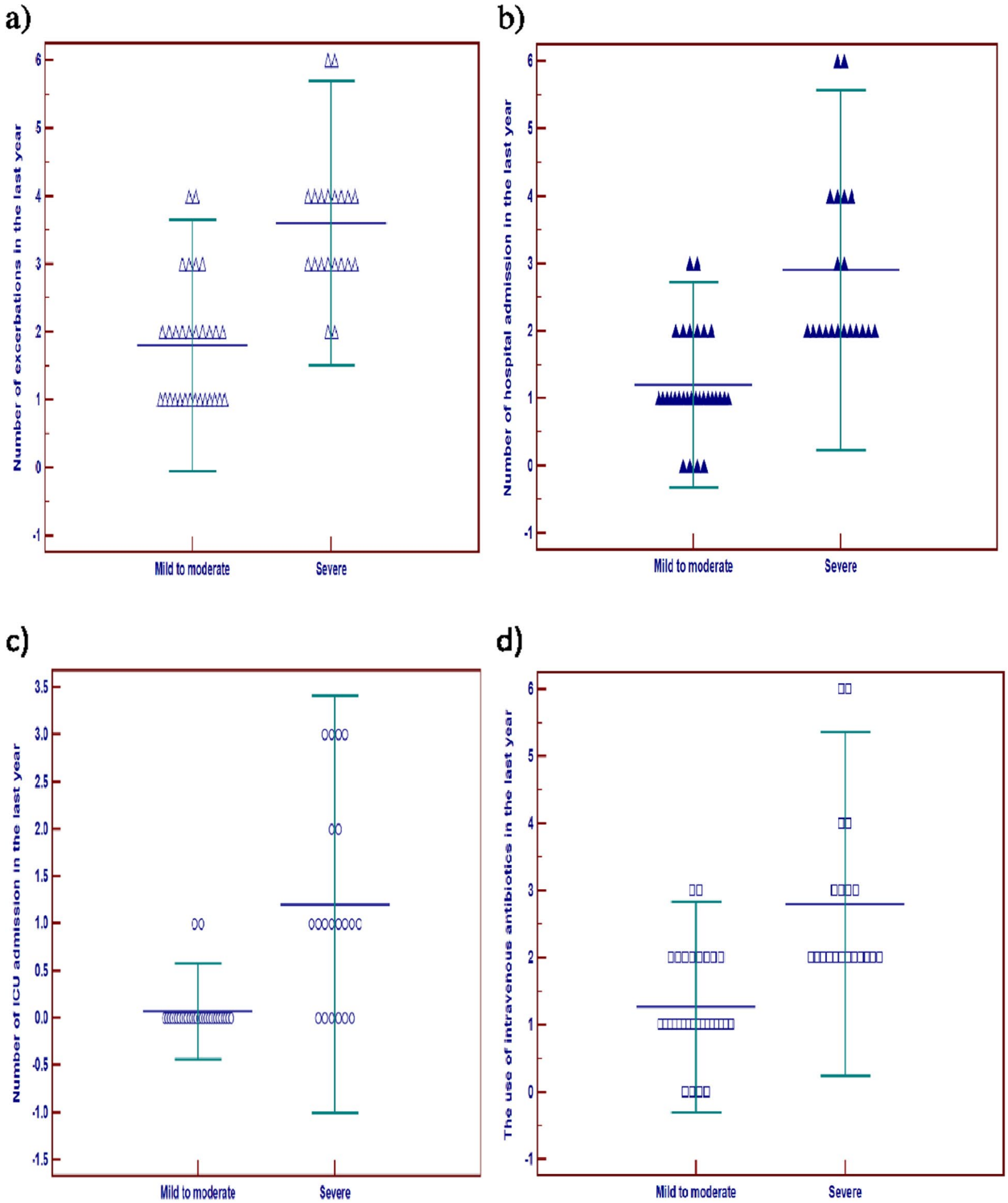

Fig. 3 Relations between pulmonary exacerbations severity and number of exacerbations (**a**), number of hospital admissions (**b**), number of ICU admissions (**c**), and number of intravenous antibiotics use (**d**) among all the studied patients

(16.02 ± 3.25, 5.38 ± 3.95) ($P = 0.035, < 0.001$) among non-CF bronchiectasis patients (e-Table 2).

Multivariable statistical regression analysis for each of the factors found to be significant was done for identifying the best independent risk factors for predicting pulmonary exacerbations severity (e-Table 3) which revealed that BSI more than 11 and ICU admissions at least once were the most important predictors of pulmonary exacerbations severity ($P = 0.006, < 0.001$) among all the studied patients. Additional independent risk factors were found specifically among CF patients which included cough severity index ($P = 0.012$), ARIC score ($P = 0.023$), while increased pulmonary exacerbations frequency ($P = 0.042$) and ARIC score ($P = 0.026$) were found among non-CF bronchiectasis patients.

Discussion

Despite the importance of pulmonary exacerbations in the clinical course of bronchiectasis and its relevant association to bronchiectasis morbidity and mortality, consensus on the prognostic factors of pulmonary exacerbations severity is lacking. The aim of the current study was to identify these factors to detect patients at high risk of developing severe pulmonary exacerbations who may benefit from early recognition and intensification of therapy.

Based on the results of the current study, we demonstrated the best indices for identifying pulmonary exacerbation severity. BSI more than 11, ICU admissions more than once, frequent exacerbations more than 3 times per year, and cough severity index were the strongest predictors of pulmonary exacerbation severity in pediatric bronchiectasis. Thereafter, these factors might be used during the assessment of pulmonary exacerbations.

The present study showed that the studied subjects' mean age was 6.58 ± 4.16 which ranged from 1 to 17 years. Males represented 56.0% of the studied patients. The mean BMI of the studied patients was 14.48 (2.55). The mean BSI score was 10.36 (2.80) indicating a population with moderate-to-severe bronchiectasis (Table 1). Frequent and severe pulmonary exacerbations were presented among 40% of the studied patients. The median number of hospital admissions in the last year was 2 with a range of 1–6; the median SPEX score was 10 (7–11) with a range of 6–1. The median duration of exacerbations was 6 (5–10) days (Table 2).

Our results go parallel with the results of another study conducted by Athanazio and colleagues [29] including six-hundred and fifty-one bronchiectasis patients, taken from six Latin American hospitals, who found that the mean BSI, FACED, and E-FACED scores were 7 (4.12), 2.36 (1.68), and 2.89 (2.03), respectively. The mean number of exacerbations per year was 0.95 (0.9), while the number of hospitalizations per year was 0.4 (0.5).

The higher rates of hospitalizations and annual number of pulmonary exacerbations in the current study may be due to delayed recognition of high-risk patients and lack of routine scoring of bronchiectasis severity.

The current study showed that frequent and moderate-to-severe pulmonary exacerbations were observed among both CF and non-CF bronchiectasis which were slightly higher among CF (46.7%, 80%) than non-CF bronchiectasis patients (40%, 70%), although the difference was not statistically significant ($P = 0.642$) (Fig. 1).

Several studies [5, 14] have shown that severe exacerbations have been associated with poor prognosis in bronchiectasis patients, such as lung function affection and higher mortality. For this reason, the current study evaluated factors associated with pulmonary exacerbations severity among both CF and non-CF pediatric bronchiectasis patients.

Our study demonstrated significant relationships between sputum NE, cough severity score, BSI, SPEX score, and severe exacerbations than among mild and moderate ones ($P < 0.001, < 0.001, 0.009, 0.002$) (Fig. 2).

These results are in concordance with a prospective cohort study conducted by Chalmers and coworkers [30] on a total of 433 bronchiectasis patients who demonstrated that during a 3-year follow-up, elevated sputum elastase activity was associated with a higher frequency of exacerbations ($P < 0.0001$), and they added that neutrophil elastase showed good discrimination for severe exacerbations with an area under the curve of 0.75. Additional previous studies [31, 32] among CF patients showed that sputum NE is an important biomarker in pulmonary exacerbation which has been shown to decrease following exacerbation treatment.

Additionally, a recent cohort study [33] involved 69 children with non-CF bronchiectasis who were prospectively followed for 13 months which revealed that wet cough and cough severity (score 2) over 72 h were the best predictors of an exacerbation with area under the curve of 0.85 and 0.84, respectively.

The current study results are also consistent with the results of previous studies [34–36] which reported that patients with advanced phases of disease and high BSI or FACED scores have an average of two or more exacerbations per year [35] and trend towards longer hospital stays [34, 36].

Similar observation was reported by Keller and colleagues [23] who recruited data from 234 consecutive consultations and found that the ROC curve data of the SPEX with a score of at least 4 had 89.4% sensitivity and 84% specificity in classifying 85.3% of patients as experiencing a pulmonary exacerbation with AUC of 0.91.

Our results may be explained by the fact that the higher bronchial and systemic inflammation developed during severe exacerbations [37] might aggravate the infection-inflammation cycle which could have a negative effect on prognosis.

Our results have also revealed that severe exacerbations were associated with increased exacerbation frequency, higher rates of hospital admissions, ICU admissions, and use of intravenous antibiotics in the last year ($P<0.001, <0.001, <0.001, <0.001$) (Fig. 3).

Similarly, Menéndez and colleagues [38] conducted a cohort study consisted of 319 bronchiectasis patients followed up for 1 year and separated into an outpatient group and a hospitalized group and reported that the age, previous hospitalization due to bronchiectasis, chronic infections by pathogens, and severity scores as BSI and FACED were associated factors for severe pulmonary exacerbations. Also, they added that previous hospitalization was an independent risk factor for a new exacerbation requiring hospital admission.

Additionally, previous studies [39] reported that severe pulmonary exacerbations among non-CF bronchiectasis patients were associated with increased hospital admission.

Similar findings were reported by several studies which revealed that the frequent exacerbations were observed in more severe disease [40] and unmanaged bronchiectasis [41]. In addition, Chalmers et al. [14] concluded that the frequent exacerbator phenotype in bronchiectasis is the best predictor of future exacerbations.

In addition, our study concords with a previous study [42] that has demonstrated that previous history of multiple exacerbations has been combined with increased pulmonary exacerbations severity.

The current study also found that higher rates of intravenous antibiotic use were significantly associated with severe exacerbations ($P<0.001$). This goes parallel with the results of recent studies [43] which included 241 bronchiectasis patients, who reported that a recent history of intravenous antibiotics use in pulmonary exacerbation has been associated with eight-fold increase in the future risk of intravenous antibiotics use. The present study revealed that significant associations were observed between elevated CRP, ARIC, and RSSQ and severe exacerbations than mild and moderate ones ($P=<0.001, <0.001, <0.001$).

Similarly, a previous study [33] reported that elevated levels of CRP were significantly associated with a severe exacerbation state.

The current study showed that there were no gender differences regarding the pulmonary exacerbation severity. Similarly, Jarad and colleagues [44] reported that gender did not correlate with frequency or severity of pulmonary exacerbations.

These findings were inconsistent with previous observations [45, 46], which have revealed that male gender was associated with a higher *Pseudomonas* colonization and a more severe disease.

Moreover, a lower BMI, and an older age, were more observed with severe exacerbations (13.35 ± 0.61, 11.08 ± 1.55) than mild and moderate ones (16.02 ± 3.25, 5.38 ± 3.95) ($P=0.035, <0.001$) respectively among non-CF bronchiectasis patients (e-Table 2). Similarly, previous studies [47, 48] reported that pulmonary exacerbation rates increase with age which may be due to more progression of the inflammatory process and more severe pulmonary impairment. On the other hand, Jaime and coworkers [43] and Jarad and colleagues [44] reported that age was not significantly correlated with pulmonary exacerbations severity.

The current study revealed that chronic *Pseudomonas* infection was significantly represented among CF patients with severe exacerbations (100.0%) ($P=0.002$) than mild and moderate exacerbations (44.4%) (e-Table 1).

Our study goes parallel with Jarad and colleagues [44] who conducted a cross-sectional study on adult CF patients in the South West of England and found that, reduced FEV1, infection with *Pseudomonas aeruginosa* was correlated with increased rate of exacerbations.

The current study revealed that among all the study subjects, lower mean FEV1% of predicted was associated with severe pulmonry excerbation (66.75 ± 19.07) than mild and moderate ones (71.63 ± 29.99), although the difference was not statistically significant ($P=0.681$). This may be due to age limitation which did not allow PFTs to be performed among all the studied patients.

Our results go parallel with a previous study [33] which reported that frequent and severe pulmonary exacerbations have been associated with worse lung functions among CF and non-CF bronchiectasis. Furthermore, Kapur et al. [7] and Ellerman et al. [49] added that recurrent exacerbations are associated with progressive deterioration of lung function.

Inconsistent with these results, a previous retrospective review [39] conducted on 16 non-CF bronchiectasis children reported that they did not find any significant change in FEV1 with an exacerbation.

The current study has a number of limitations. First, this was an observational study using a convenience sample of patients which may need larger prospective cohort studies to confirm its results and evaluate their relations to future risk of exacerbations and mortality. Second, the age range limits pulmonary function testing of all the studied patients. Finally, the self-reported data might

be subjected to inaccuracy of reported information and recall bias; therefore, the hospital records were used to confirm the accuracy of the data. However, this study is one of the fewest pediatric studies that accurately determined the prognostic factors associated with pulmonary exacerbation severity among both CF and non-CF bronchiectasis in pediatric patients.

Conclusions

According to our results, BSI more than 11, ICU admissions more than once, frequent exacerbations, and cough severity index were the best factors which may help to predict more frequent and severe pulmonary exacerbations and to identify high-risk bronchiectasis patients who need more extensive close follow-up, extra care, intensive management, and preventive strategies hoping to improve prognosis, reducing the disease severity and the healthcare costs among pediatric bronchiectasis patients.

Abbreviations

CF	Cystic fibrosis
SPEX	Simplified Seattle Pulmonary Exacerbation Score
NE	Neutrophil elastase
CRP	C-reactive protein
RSSQ	Respiratory and Systemic Symptoms Questionnaire
ARIC	Acute Respiratory Illness Checklist
BSI	Bronchiectasis severity index
FACED	FEV1, age, colonization by *Pseudomonas*, extension of bronchiectasis, and dyspnea
BMI	Body mass index
BTS	British Thoracic Society
PFTs	Pulmonary function tests
FEV1	Forced expiratory volume in first second

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s43054-023-00180-z.

Additional file 1: e-Table 1. Relations between pulmonary exacerbation severity with demographic data, chronic bacterial infection, and bronchiectasis severity scores among cystic fibrosis patients. a; Body Mass Index, b; Total leucocytic count, **p-value <0.05 S; **p-value <0.001 HS*. **e-Table 2.** Relations between pulmonary exacerbation severity with demographic data, chronic bacterial infection, and bronchiectasis severity scores among non-CF bronchiectasis patients. a; Body Mass Index, b; Total leucocytic count, **p-value <0.05 S; **p-value <0.001 HS*. **e-Table 3.** Multi-Regression analysis using exacerbation severity as a dependent variable among all the studied patients.

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Authors' contributions

All authors revised and approved the manuscript and agree to publish it in the Egyptian Pediatric Association Gazette (EPAG). All authors made substantial contributions to the conception and design, acquisition of data, and/or analysis and interpretation of data. HA, designed the study, followed the patients, analyzed the data, drafted, and writing and revised the manuscript. MS, performed all radiological investigations of the study, shared in paper drafting, and writing. MA, performed all laboratory investigations of the study, shared in paper drafting, and writing. All authors were involved in the critical analysis of the final version of the manuscript. All authors approved the manuscript as submitted and agree to be accountable for all aspects of the work.

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Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

The Research Ethics Committee of the Faculty of Medicine, Ain Shams University, approved the protocol. Written consent was obtained from the patients' guardians. The reference number is FWA 000017585.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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