Unravelling the role of heart rate recovery in bronchiectasis: do we need to establish a cutoff value?

Arietta Spinou [1,2] and Ioannis D Laoutaris [3]

[1]School of Life Course and Population Sciences, King's College London, London, UK. [2]King's Centre for Lung Health, London, UK. [3]Cardiac Rehabilitation Laboratory, Onassis Cardiac Surgery Center, Athens, Greece.

Corresponding author: Arietta Spinou (arietta.spinou@kcl.ac.uk)

Shareable abstract (@ERSpublications)
Heart rate recovery after a field walking test could be a key indicator in bronchiectasis management. Establishing a clear cutoff value in future research will enhance its clinical utility. #HeartRateRecovery #Bronchiectasis #PulmonaryRehabilitation https://bit.ly/4fNAWXe

Cite this article as: Spinou A, Laoutaris ID. Unravelling the role of heart rate recovery in bronchiectasis: do we need to establish a cutoff value? *ERJ Open Res* 2025; 11: 01119-2024 [DOI: 10.1183/23120541.01119-2024].

Received: 29 Oct 2024
Accepted: 7 Nov 2024

Bronchiectasis is a chronic respiratory disease with substantial clinical and socioeconomic impacts [1]. The condition is characterised by chronic inflammation and dilatation of the airways and often leads to persistent respiratory symptoms such as cough, sputum production and frequent infections; all significantly associated with impaired quality of life [2–5]. Additionally, these chronic symptoms and their pathophysiology place a strain on the respiratory system, which can in turn or in parallel influence the cardiovascular function [6]. Indeed, evidence underlines a higher risk of coronary heart disease and stroke for people with bronchiectasis compared with the general population, even after adjusting for known risk factors of cardiovascular disease [6, 7]. Similar associations have been previously identified in people with COPD and asthma [8, 9].

Heart rate can assess cardiac autonomic function and response through indicating normal physiological function and pathological processes [10], but it is an often overlooked clinical indicator in people with bronchiectasis. There are several known factors influencing heart rate, which also play a potentially key role in bronchiectasis. Increased inflammatory response is a common mechanism in bronchiectasis and cardiovascular diseases [11, 12], with particularly respiratory exacerbations and frequent infections provoking systemic inflammation [13–17]. During these acute exacerbations, heart rate typically increases as part of the body's inflammatory response, whilst fever and increased metabolic demands during infection can also lead to elevated heart rates [18]. Dyspnoea, chronic hypoxia and increased respiratory effort have similar effects due to higher oxygen demands through a compensating mechanism. This increases the demands on the heart and can contribute to cardiovascular strain over time [19]. In addition, other associated conditions can contribute to increased heart rate in advanced bronchiectasis, such as pulmonary hypertension and deconditioning. Specifically for deconditioning, patients with bronchiectasis can present reduced physical activity and exercise tolerance [20], which can lead to cardiovascular deconditioning, thus an elevated heart rate even during minimal physical exertion.

Overall, most published heart rate assessments focus on the prognostic utility of the heart rate recovery (HRR) as a measure of autonomic activity. Studies in this area date back to the 1930s and the work of D.B. Dill in the Harvard fatigue laboratory [21]. HRR after exercise is conventionally divided into "fast" and "slow" phases that correspond to HRR following the first minute of exercise cessation and subsequent HRR during the more prolonged period required to reach baseline heart rate. The fast phase of HRR is primarily mediated by rapid vagus nerve reactivation, whereas the slow phase represents both parasympathetic reactivation and sympathetic withdrawal [22].

In that respect, the prospective longitudinal studies investigating the HRR after exercise testing in patients with bronchiectasis may provide useful information both concerning a potential autonomic imbalance in this population and a prognostic role of HRR [23]. A high sympathovagal balance associated with poor lung function was previously recorded in patients with bronchiectasis, suggesting, similarly to patients with COPD, an impaired autonomic modulation [24].

In their recent study, Sáez-Pérez *et al.* [23] presented data on the HRR following a six-minute walk test (6MWT), a commonly used field exercise test of submaximal exertion in patients with bronchiectasis [25]. The authors investigated 104 people with bronchiectasis, while the HRR after the first minute (HRR1) (calculated as below) and the second minute (HRR2) of recovery in the 6MWT were measured at both baseline and after 12 months of follow-up. A delayed recovery was defined as HRR1⩽14 beats per minute, indicating a marker of cardiac autonomic function where a delay in HRR signifies lower exercise capacity [23]. Two major findings were reported. The first key finding was a delayed HRR1 in 36% of patients, which was associated with a shorter distance walked and higher disease severity compared to the group with no HRR delay. The second key finding was a delayed HRR1 in the presence of at least two exacerbations during the follow-up period, with exacerbations being the only predictor of the delayed HRR1, albeit in a small number of participants who completed the longitudinal part of the study (24% of the 45 participants) [23].

$$HRR_{1\ min} = HR_{peak} - HR_{1\ min}$$

Where: HR_{peak} is the heart rate at the end of exercise; and $HR_{1\ min}$ is the heart rate measured one minute after the end of exercise.

This study is of a particular interest, with the findings warranting further discussion. The delayed HRR1 associated with low exercise capacity and disease severity suggests a promising role of HRR as a prognostic marker in patients with bronchiectasis, but HRR was not found to be associated with lung function or symptoms. It is possible that HRR⩽14 beats per minute is a high cutoff value that influenced the study outcomes. The authors selected this cutoff value based on studies in people with COPD which showed that HRR⩽14 beats per minute after a symptom-limited incremental exercise test can strongly predict mortality and is associated with higher exacerbation risk during the subsequent 12 months [26, 27]. The criteria defining normality in these studies were based on small sample sizes (<150 patients with COPD) and similarly did not find an association between HRR and pulmonary function or symptoms [26, 27]. On the other hand, the literature also employs a HRR1 cutoff of 12 beats per minute [28, 29] and a study by Zhao *et al.* [30] with 2127 participants with COPD (of these, 385 were followed-up 5-years) identified a strong association in HRR⩽10 beats per minute after the 6MWT with more severe expiratory flow limitation, worse dyspnoea and quality of life, and future exacerbations. In addition, low HRR was independently associated with airway wall thickening in smokers with or without COPD, suggesting that airway morphologic changes may influence autonomic function [30]. Furthermore, patients with COPD who presented HRR⩽10 beats per minute had greater risk for symptoms and frequent exacerbations than those with HRR>10 beats per minute. Therefore, a lower cutoff value for HRR following the 6MWT may be more appropriate for patients with bronchiectasis. Similar to individuals with other respiratory diseases, these patients often reach symptom limitation before cardiovascular limitation during exercise, which may affect their HRR measurements. This means that lower peak heart rate during exercise would also predispose towards smaller HRR and is consistent with the observation by Sáez-Pérez *et al.* [23] that patients with more severe bronchiectasis were less able to increase their heart rate during 6MWT, and, thus, potentially less able to recover by HRR>10 beats per minute.

The second finding, which supports an association between HRR1 and disease exacerbations during follow-up, provides valuable insight into the potential prognostic role of HRR in bronchiectasis [23]. This association suggests that HRR could be a promising predictive measure and outcome measure. Further studies will be essential to assess HRR as an independent predictor of exacerbations over a 12-month period, especially given that only a small number of patients completed the follow-up in this study. Additionally, incorporating data on participants' exacerbation history in future study designs would be beneficial, as prior-year exacerbations are a well-established predictor of future episodes [30].

Overall, Sáez-Pérez *et al.* [23] highlight the importance of measuring HRR1 in patients with bronchiectasis after a field walking test. HRR is rarely analysed in papers on pulmonary rehabilitation for bronchiectasis, despite field walking tests consistently being performed. Monitoring heart rate in bronchiectasis patients could provide valuable information about disease progression and response to treatment. For instance, persistent tachycardia at rest or during minimal exertion may suggest worsening hypoxia, infection or cardiovascular complications such as pulmonary hypertension or heart failure. By investigating potential determinants for a delayed HRR in the short term and predictors of a HRR delay in a 12-month follow-up period, this study is one of the first studies of the promising importance to monitoring HRR in bronchiectasis. Since 6MWT is a common clinical outcome in pulmonary rehabilitation for people with bronchiectasis, a wider implementation of recording HRR in patients with bronchiectasis seems definitely feasible. This study demonstrates that is also potentially critical [23].

In conclusion, the valuable evidence from SÁEZ-PÉREZ *et al*. and an increased interest in the predicted value of HRR support a need for further studies to establish a cutoff value for HRR following 6MWT, and the potential association of this outcome with lung function, dyspnoea, quality of life and future exacerbations, as well as with morbidity and mortality in people with bronchiectasis.

Provenance: Commissioned article, peer reviewed.

Conflict of interest: The authors declare no conflicts of interest.

References

1 Chalmers JD, Mall MA, McShane PJ, *et al.* A systematic literature review of the clinical and socioeconomic burden of bronchiectasis. *Eur Respir Rev* 2024; 33: 240049.
2 Chalmers JD, Elborn S, Greene CM. Basic, translational and clinical aspects of bronchiectasis in adults. *Eur Respir Rev* 2023; 32: 230015.
3 Spinou A, Siegert RJ, Guan WJ, *et al.* The development and validation of the Bronchiectasis Health Questionnaire. *Eur Respir J* 2017; 49: 1601532.
4 Spinou A, Fragkos KC, Lee KK, *et al.* The validity of health-related quality of life questionnaires in bronchiectasis: a systematic review and meta-analysis. *Thorax* 2016; 71: 683–694.
5 McLeese RH, Spinou A, Alfahl Z, *et al.* Psychometrics of health-related quality of life questionnaires in bronchiectasis: a systematic review and meta-analysis. *Eur Respir J* 2021; 58: 2100025.
6 Gramegna A, Barone I, Alicandro G, *et al.* The impact of cardiovascular events in bronchiectasis: a systematic review and meta-analysis. *ERJ Open Res* 2024; 10: 01032-2023.
7 Navaratnam V, Millett ER, Hurst JR, *et al.* Bronchiectasis and the risk of cardiovascular disease: a population-based study. *Thorax* 2017; 72: 161–166.
8 Pollevick ME, Xu KY, Mhango G, *et al.* The relationship between asthma and cardiovascular disease: an examination of the Framingham offspring study. *Chest* 2021; 159: 1338–1345.
9 André S, Conde B, Fragoso E, *et al.* COPD and cardiovascular disease. *Pulmonology* 2019; 25: 168–176.
10 Armstrong R, Wheen P, Brandon L, *et al.* Heart rate: control mechanisms, pathophysiology and assessment of the neurocardiac system in health and disease. *QJM* 2022; 115: 806–812.
11 Huang JT, Kuzmanova E, Dicker AJ, *et al.* Serum desmosine is associated with long-term all-cause and cardiovascular mortality in bronchiectasis. *Am J Respir Crit Care Med* 2020; 202: 897–899.
12 Mozos I, Malainer C, Horbańczuk J, *et al.* Inflammatory markers for arterial stiffness in cardiovascular diseases. *Front Immunol* 2017; 8: 1058.
13 De Angelis A, Johnson ED, Sutharsan S, *et al.* Exacerbations of bronchiectasis. *Eur Respir Rev* 2024; 33: 240085.
14 Müllerová H, Marshall J, de Nigris E, *et al.* Association of COPD exacerbations and acute cardiovascular events: a systematic review and meta-analysis. *Ther Adv Respir Dis* 2022; 16: 17534666221113647.
15 Meier CR, Jick SS, Derby LE, *et al.* Acute respiratory-tract infections and risk of first-time acute myocardial infarction. *Lancet* 1998; 351: 1467–1471.
16 Donaldson GC, Hurst JR, Smith CJ, *et al.* Increased risk of myocardial infarction and stroke following exacerbation of COPD. *Chest* 2010; 137: 1091–1097.
17 Yu S, Lee SC, Hong JH, *et al.* Cardiovascular and cerebrovascular mortality in patients with preceding asthma exacerbation. *Respirology* 2023; 28: 281–286.
18 Karjalainen J, Viitasalo M. Fever and cardiac rhythm. *Arch Intern Med* 1986; 146: 1169–1171.
19 Han MK, McLaughlin VV, Criner GJ, *et al.* Pulmonary diseases and the heart. *Circulation* 2007; 116: 2992–3005.
20 Lee AL, Gordon CS, Osadnik CR. Exercise training for bronchiectasis. *Cochrane Database Syst Rev* 2021; 4: CD013110.
21 Cotton FS, Dill DB. On the relation between the heart rate during exercise and that of the immediate postexercise period. Rockville, American Journal of Physiology, 1935, 193.061.206.009.
22 Dewar A, Kass L, Stephens RCM, *et al.* Heart rate recovery assessed by cardiopulmonary exercise testing in patients with cardiovascular disease: relationship with prognosis. *Int J Environ Res Public Health* 2023; 20: 4678.
23 Sáez-Pérez JA, Abbasi A, Casaburi R, *et al.* Heart rate recovery after the 6-min walk test in people with bronchiectasis. *ERJ Open Research* 2024; 11: 00694-2024.
24 Rached S, Amaral TS, De Angelis K, *et al.* Abnormal heart rate variability in patients with bronchiectasis. *European Respiratory Journal* 2015; 46: Suppl., 59, PA1042.

25 Lee AL, Hill CJ, Cecins N, *et al.* Minimal important difference in field walking tests in non-cystic fibrosis bronchiectasis following exercise training. *Respir Med* 2014; 108: 1303–1309.

26 Lacasse M, Maltais F, Poirier P, *et al.* Post-exercise heart rate recovery and mortality in chronic obstructive pulmonary disease. *Respir Med* 2005; 99: 877–886.

27 Rodríguez DA, Kortianou EA, Alison JA, *et al.* Heart rate recovery after 6-min walking test predicts acute exacerbation in COPD. *Lung* 2017; 195: 463–467.

28 Cole CR, Foody JM, Blackstone EH, *et al.* Heart rate recovery after submaximal exercise testing as a predictor of mortality in a cardiovascularly healthy cohort. *Ann Intern Med* 2000; 132: 552–555.

29 Seshadri N, Gildea TR, McCarthy K, *et al.* Association of an abnormal exercise heart rate recovery with pulmonary function abnormalities. *Chest* 2004; 125: 1286–1291.

30 Zhao D, Abbasi A, Casaburi R, *et al.* Identifying a heart rate recovery criterion after a 6-minute walk test in COPD. *Int J Chron Obstruct Pulmon Dis* 2021; 16: 2545–2560.