

Respiratory Function and Pulmonary Rehabilitation in individuals with Chronic Rheumatoid Arthritis: A Narrative Review

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Abstract: This narrative review aims to summarize and evaluate the pulmonary dysfunction associated with chronic rheumatoid arthritis (RA) and the potential effectiveness of breathing-based and pulmonary rehabilitation interventions in improving pulmonary function, respiratory muscle strength, exercise capacity, dyspnea, chest expansion, and quality of life. The narrative review was conducted using studies identified through PubMed, Scopus, Virtual Health Library, Google Scholar, and Research Gate. A comprehensive review of 12 studies was conducted, encompassing randomized controlled trials, observational studies, cross-sectional studies and reliability studies. The included studies examined pulmonary function, respiratory muscle strength, chest expansion, exercise capacity, dyspnea, and quality of life in individuals with RA and other respiratory populations. Interventions including incentive spirometry, balloon-blowing exercises, diaphragmatic breathing, and aerobic exercise combined with breathing exercises were reviewed. The findings indicate that individuals with RA may experience pulmonary impairment, respiratory muscle weakness, reduced exercise capacity, dyspnea, and poorer quality of life, with restrictive and obstructive pulmonary patterns reported even among patients with limited or no respiratory symptoms. Breathing and exercise-based interventions were associated with improvements in pulmonary function, chest expansion, exercise capacity, and quality of life. Early pulmonary assessment and accessible respiratory rehabilitation interventions may therefore have an important role in addressing respiratory and functional impairments associated with chronic RA.

Keywords: Breathing exercises, balloon blowing, incentive spirometry, physiotherapy, rheumatoid arthritis.

INTRODUCTION

Rheumatoid arthritis (RA) is a chronic, systemic autoimmune inflammatory disorder that primarily affects the synovial joints.¹ RA represents a significant health burden worldwide, with an estimated prevalence of approximately 0.5–1% among adults and about 0.8% in the general population. Women are affected more

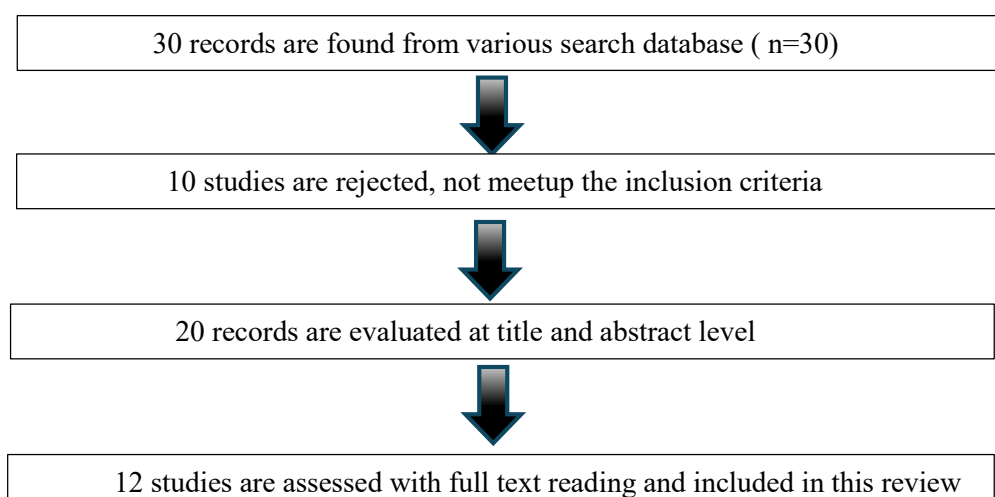
frequently than men, with the prevalence being approximately three times higher in women. Reported incidence rates are around 24.5 per 100,000 in men and 54 per 100,000 in women. In India, the prevalence has been reported to be approximately 0.75%.² RA is characterized by persistent joint pain, swelling, stiffness, and progressive structural damage involving cartilage, bone, tendons, and ligaments. Continued inflammation may result in synovitis, cartilage destruction, juxta-articular bone erosion, and functional limitations. Common clinical manifestations include morning stiffness, particularly lasting for more than 30 minutes, fatigue, fever, weight loss, and painful, swollen, warm joints. The disease commonly develops during adulthood and may follow a fluctuating course with periods of remission and exacerbation. The underlying pathology involves an abnormal immune response in which immune cells recognize the synovial tissue as foreign, resulting in chronic inflammation and subsequent joint damage.^{1,2} In addition to articular manifestations, RA can produce several extra-articular complications involving different organ systems. Among these, pulmonary involvement is particularly important because it can adversely influence prognosis, functional independence, and quality of life. Pulmonary manifestations may involve the pleura, lung parenchyma, or pulmonary vasculature, with interstitial lung disease being one of the important parenchymal manifestations associated with RA.³ Early identification of RA is important for initiating appropriate management and limiting disease progression. Structural joint involvement can be assessed through radiography, ultrasonography, and magnetic resonance imaging. Serological investigations, including rheumatoid factor (RF) and anti-cyclic citrullinated peptide (ACPA) antibodies, can support diagnosis. However, a proportion of patients may be negative for these autoantibodies. The 2010 classification criteria developed collaboratively by the American College of Rheumatology (ACR) and European League Against Rheumatism (EULAR) were designed to facilitate earlier classification of patients with RA. These criteria consider the number and distribution of involved joints, acute-phase reactants, RF or ACPA status, and symptom duration. The combined clinical and laboratory findings generate a score from 0 to 10, with a score of ≥ 6 supporting classification as definite RA.⁴ Management of RA aims to control inflammation, reduce pain and swelling, prevent or limit structural joint damage, improve quality of life, and manage extra-articular manifestations. Pharmacological treatment commonly includes disease-modifying antirheumatic drugs (DMARDs), with methotrexate being an important component of initial treatment. Corticosteroids and non-steroidal anti-inflammatory drugs may also be used to control inflammatory symptoms. In patients who do not achieve adequate disease control with conventional synthetic DMARDs, combination therapy or biological DMARDs, including anti-tumour necrosis factor agents, may be considered. Despite advances in pharmacological treatment, patients may continue to experience fatigue, systemic inflammation, reduced physical performance, and extra-articular problems, particularly respiratory symptoms.⁵ Conservative and non-pharmacological management also forms an important component of RA care. Physiotherapy and occupational therapy can help maintain joint mobility, improve muscular strength, and support functional independence. Regular physical activity and appropriate therapeutic exercises may provide benefits while minimizing excessive joint stress. Activities such as swimming, yoga, and tai chi can promote movement and muscular conditioning with comparatively lower joint loading. Heat or cold applications may also be used around exercise sessions to assist in managing painful symptoms.¹

Pulmonary complications associated with RA can contribute to impaired respiratory function and exercise performance. Consequently, non-pharmacological strategies aimed at improving respiratory function have gained importance. Pulmonary rehabilitation is described by the American Thoracic Society/European Respiratory Society as a comprehensive, patient-tailored intervention based on assessment and incorporating exercise training, education, and behavioural modification to improve physical and psychological health and promote long-term health-enhancing behaviours.⁶ In physiotherapy practice, breathing exercises such as deep

breathing and diaphragmatic breathing are commonly utilized to facilitate ventilation and improve respiratory function. Balloon-blowing exercise is another simple breathing intervention that may be used to promote lung expansion and respiratory muscle activity. The technique involves a deep inspiration followed by expiration against the resistance created by the balloon. Balloon blowing has been proposed as an inexpensive approach that may assist respiratory muscle activity and facilitate lung expansion, thereby supporting oxygen intake and carbon dioxide elimination.⁷ Incentive spirometry is a device-based breathing exercise designed to encourage slow, sustained maximal inspiration with visual feedback. The technique promotes deep inspiration and is intended to maintain or increase inspired lung volume. Incentive spirometry has also been associated with benefits such as facilitating sputum expectoration, supporting lung expansion, and reducing postoperative pulmonary complications.⁸ Thus, both incentive spirometry and balloon-blowing exercises represent relatively simple respiratory interventions that may have potential relevance in individuals with impaired pulmonary function. Assessment of functional exercise capacity is also important when evaluating individuals with respiratory limitations. Walking-based field tests are commonly used to determine functional capacity and assist in establishing appropriate exercise-training intensity. Among the commonly used field-based tests are the six-minute walk test (6MWT), incremental shuttle walk test (ISWT), and endurance shuttle walk test. The 6MWT is particularly useful for evaluating functional exercise capacity because it provides a practical measure of walking performance over a specified period. However, implementation of field exercise tests may sometimes be influenced by factors such as the patient's physical ability, acceptability of the test, available time, and financial or resource limitations.⁹ Therefore, considering the potential pulmonary involvement in RA and the continuing need for accessible non-pharmacological interventions, evaluation of breathing-based techniques such as incentive spirometry and balloon-blowing exercises is clinically relevant. Comparing these approaches may provide useful information regarding their effects on pulmonary function and functional respiratory outcomes in individuals with chronic rheumatoid arthritis.

METHOD

Studies were searched from the following search engine Pubmed, Goggle scholar, Research Gate. Studies include evaluating the effect of Balloon blowing exercises and incentive spirometry exercises on pulmonary function in individuals with rheumatoid arthritis.



Authors, Year	Objectives	Design	Material and Methods	Outcome Measures	Results
Khair RM, Nwaneri C, Damico RL et al.,(2016)¹⁸	To determine the minimal important difference (MID) for Borg dyspnea and fatigue scores in patients with pulmonary arterial hypertension (PAH).	Prospective observational study.	129 PAH patients assessed at baseline and 3 months using Borg scores and 6MWT; MID determined by distribution- and anchor-based methods.	Borg dyspnea score, Borg fatigue score, and 6MWT distance.	Distribution-based MID was 0.73–1.39 units for Borg fatigue and 0.70–1.24 units for Borg dyspnea. Anchor-based MID for Borg dyspnea was 0.36 units; no anchor-based MID was established for fatigue.
Scanlon EM, Mankad R, Crowson CS et al.,(2017)¹⁷	To determine the relationship between non-invasive measures of arterial health, cardiovascular risk, and RA disease activity.	Observational correlative study.	50 patients with established RA underwent non-invasive arterial health testing. Disease activity and functional status were assessed, and clinical measures from the preceding 3 years were averaged.	Brachial artery reactivity, aortic augmentation index (AIx), pulse-wave velocity (PWV), carotid intima-media thickness (CIMT), carotid plaque, CDAI, tender/swollen joint counts, and HAQ-II.	Higher cumulative RA disease activity was associated with greater arterial stiffness, particularly increased AIx and PWV, supporting a relationship between chronic inflammatory disease activity and cardiovascular risk in RA.
Taylor & Parekh et al., (2018)¹⁰	To assess whether HAQ-II can measure physical function across rheumatic diseases.	Cross-sectional study	882 rheumatology patients completed HAQ-II. Rasch analysis was performed to assess validity and invariance across disease groups.	HAQ-II score, Rasch fit, reliability, unidimensionality, DIF	HAQ-II showed good fit, high reliability (PSI=0.89), and minimal DIF. It was found suitable for comparing physical function across rheumatic diseases.
Reddy RS, Alahmari KA, Silvian PS, Ahmad IA et al., (2019)¹⁶	To determine the intra- and inter-rater reliability of	Observational reliability and correlational study.	70 participants (25 healthy nonsmokers, 25 smokers, 20 COPD patients)	Upper and lower chest expansion; FEV ₁ , FVC, FEV ₁ /FVC, and VC.	Chest expansion showed good-to-very-good reliability (intra-rater ICC 0.85–0.93; inter-rater

	chest expansion measurements and examine their correlation with pulmonary function.		underwent chest expansion measurement and computerized spirometry.		ICC 0.78–0.84) and significant correlations with FEV ₁ , FVC, FEV ₁ /FVC, and VC (p < 0.001), strongest with FEV ₁ /FVC (r = 0.78 upper and 0.68 lower chest expansion).
Ganga B, Ahamed S, Krishna GG et al., (2020)¹⁵	To assess the need for pulmonary screening and identify pulmonary involvement in patients with rheumatoid arthritis (RA).	Cross-sectional observational study.	122 patients with respiratory difficulties and suspected RA underwent clinical assessment and PFT, followed by HRCT when indicated. Functional status was assessed using 6MWT, dyspnea assessment, and pulse oximetry.	PFT, HRCT findings, 6MWT, dyspnea, and SpO ₂ .	RA patients showed restrictive/obstructive PFT patterns, predominantly NSIP on HRCT, and post-6MWT desaturation with increased dyspnea; pulmonary involvement increased with disease duration.
Derasse M, Lefebvre M, Liistro G, Reyhler G et al., (2021)¹⁴	To investigate the relationship between thoracic/chest expansion and pulmonary function in adults.	Cross-sectional observational study.	251 adults aged 18–88 years, including healthy individuals and patients with pulmonary disease, were assessed. Chest expansion was measured at upper and lower thoracic levels, while pulmonary function was assessed using spirometry.	Chest expansion, TLC, FVC, and FEV ₁ ; age, BMI, and sex were also evaluated in relation to chest expansion.	Chest expansion showed only a weak correlation with TLC, FVC, and FEV ₁ , indicating poor validity as an indicator of pulmonary function. Expansion decreased with increasing age and BMI and was significantly lower at the lower thoracic level in obese individuals.
Khoiriyah K, Rahayu FA, Nurhidayati T et al., (2022)⁷	To determine the effect of balloon therapy on dyspnea in patients with COPD.	Quasi-experimental, one-group pre-test–post-test study.	36 COPD patients were selected using simple random sampling. Balloon therapy involved	Modified Medical Research Council (mMRC) dyspnea scale.	Mean dyspnea score decreased from 2.50 on day 1 to 1.89 on day 7 and 1.06 on day 14. Balloon therapy significantly reduced dyspnea (p = 0.000).

			blowing a 7-inch balloon, 5 times/day for 14 days.		
Kusumawardani RI, Tinduh D, Andriati, Poerwandari D, Marhana IA, et al., (2023)⁸	To evaluate the effect of incentive spirometry exercise on pulmonary function in COVID-19 survivors.	Randomized controlled trial with pretest–posttest controlled-group design.	20 COVID-19 survivors aged 18–59 years were randomly allocated into an incentive spirometry group (n=10) and diaphragmatic breathing group (n=10). Both interventions were performed 5 times/day, 10 repetitions/session for 4 weeks.	Peak expiratory flow (PEF) measured using a peak flow meter before and after intervention.	PEF improved significantly in both groups, with no significant between-group difference, though incentive spirometry showed a greater effect.
Elgayar et al., (2024)¹¹	To investigate the effect of aerobic exercise combined with breathing exercises on ventilatory function in women with rheumatoid arthritis (RA).	Randomized controlled trial (RCT).	66 women with RA were randomized into two groups: aerobic + diaphragmatic breathing exercises and diaphragmatic breathing alone, for 12 weeks.	FVC, FEV ₁ , TLC, chest expansion, VO ₂ max, and quality of life.	Both groups improved significantly, with greater improvements in pulmonary function, chest expansion, exercise capacity, and quality of life in the aerobic exercise group.
Nagy A, Nagy T, Fritsch K, Marton N, Vincze K, et al., (2024)¹²	To investigate the relationship between patient-reported outcomes and early lung involvement in patients with rheumatoid arthritis (RA).	Prospective observational study.	370 consecutive RA patients underwent pulmonary function testing, low-dose chest CT, exposure assessment, and patient-reported questionnaires.	FVC%, FEV ₁ %, DLCO, EQ-5D-3L, VAS for health, and PSQI.	Symptomatic RA patients had lower FVC% and FEV ₁ %, poorer QoL and sleep quality, and greater lung involvement, suggesting early pulmonary impairment.
Hassan AM, Osman AA, Ali IA et al., (2024)¹³	To assess the effect of rheumatoid arthritis on pulmonary	Analytical cross-sectional, hospital-based study.	32 nonsmoking RA patients aged 20–60 years	FEV ₁ , FVC, FEV ₁ /FVC ratio, and PEFR.	Abnormal PFTs were found in 93.8%, predominantly showing a

	function in asymptomatic RA patients.		underwent digital spirometry (FEV ₁ , FVC, FEV ₁ /FVC, PEFR), with the best of three readings compared with matched reference values.		restrictive pattern (78.1%), with significantly reduced FEV ₁ , FVC, and PEFR.
Berger et al., (2025)³	To assess and compare handgrip strength and respiratory muscle strength in patients with rheumatoid arthritis (RA) and healthy controls, and to examine their relationship with functional exercise capacity.	Prospective, exploratory, single-centre, matched-pair analysis study.	72 participants (36 RA patients and 36 matched controls). PImax, handgrip strength, FVC, and 6MWD were assessed, and group differences and correlations were analyzed.	PImax, handgrip strength, FVC, and 6MWD, with correlations among PImax, handgrip strength, and 6MWD analyzed.	RA patients had lower handgrip strength and a non-significant reduction in PImax; PImax was positively correlated with handgrip strength and 6MWD.

DISCUSSION

The comprehensive review examined 12 studies which indicates that rheumatoid arthritis (RA) is associated with important pulmonary, muscular, functional, and quality-of-life impairments. Studies have demonstrated reduced respiratory and peripheral muscle strength, impaired pulmonary function, reduced exercise capacity, and poorer quality of life in individuals with RA. Berger et al. (2025)³ reported reduced handgrip strength and a tendency toward reduced inspiratory muscle strength, with PImax positively related to handgrip strength ($r = 0.51$, $p = 0.0017$) and 6-minute walk distance, although this association was not statistically significant in the study. Similarly, Nagy et al. (2024)¹² and Hassan et al. (2024)¹³ highlighted the occurrence of early pulmonary abnormalities in rheumatoid arthritis, demonstrating significant pulmonary function impairment even in asymptomatic patients, emphasizing the importance of early pulmonary assessment. They found that patients with respiratory symptoms had significantly lower but still within the normal range—FVC% and FEV1%, and RA-associated lung involvement on CT was more frequent in this group. Ganga et al. (2020)¹⁵ further supported pulmonary screening by reporting restrictive and obstructive patterns, desaturation and increased dyspnea among RA patients, because the authors reported that all participants had some degree of breathlessness, with greater MMRC grades in patients with longer RA duration. They further observed a fall in SpO₂ after the 6MWT, particularly in those with RA for ≥ 10 years, and increasing post-exercise Borg dyspnea scores with disease duration.

The literature also supports the role of physiotherapy and breathing-based interventions in improving respiratory and functional outcomes. Elgayar et al. (2024)¹¹ found that aerobic exercise combined with diaphragmatic breathing produced greater improvements in pulmonary function, chest expansion, exercise capacity, and quality of life than diaphragmatic breathing alone. This was demonstrated by significant improvements in FVC (10.2% vs. 4.8%), FEV₁ (8.9% vs. 4.07%), chest expansion, maximal oxygen consumption (30.7% vs. 15.01%), and physical and mental quality-of-life scores in the aerobic exercise group compared with diaphragmatic breathing alone. Incentive spirometry has also demonstrated improvement in expiratory flow, although Kusumawardani et al. (2023)⁸ found no significant difference compared with diaphragmatic breathing. Balloon therapy was shown by Khoiriyah et al. (2022)⁷ to significantly reduce dyspnea. However, these studies were conducted mainly in other respiratory populations, such as COPD and COVID-19 survivors, rather than chronic RA. Therefore, their findings provide supportive evidence but cannot be directly generalized to RA. Studies examining chest expansion have also produced varying findings, with Derasse et al. (2021)¹⁴ reporting weak associations with pulmonary function, lung-function parameters including TLC, FVC, and FEV₁ ($P = .01$), indicating that chest expansion alone may not adequately reflect pulmonary function. While Reddy et al. (2019)¹⁶ demonstrated good reliability and significant correlations. Overall, the available evidence suggests a need for accessible, simple respiratory interventions specifically evaluated in patients with chronic RA.

CONCLUSION

The available literature indicates that rheumatoid arthritis is associated with multidimensional respiratory and functional impairments, including altered pulmonary function, respiratory and peripheral muscle weakness, reduced exercise capacity, dyspnea, and poorer quality of life. Although physiotherapy and breathing-based interventions have shown beneficial effects on pulmonary and functional outcomes, much of the evidence for incentive spirometry and balloon-based exercises comes from non-RA respiratory populations, limiting its direct applicability to chronic RA. There is a need for simple, accessible, and targeted respiratory interventions specifically evaluated in individuals with chronic RA, with assessment of pulmonary function, exercise capacity, chest expansion, dyspnea, and quality of life. Therefore, further research comparing these simple, inexpensive respiratory techniques is warranted to determine their effectiveness in improving pulmonary function and related functional outcomes in individuals with chronic RA.

REFERENCES

1. Bullock J, Rizvi SAA, Saleh AM, Ahmed SS, Do DP, Ansari RA, Ahmed J. Rheumatoid arthritis: a brief overview of the treatment. *Med Princ Pract*. 2018;27(6):501–507.
2. Goud DT, Sudhan SHH, Khatoon MR, Rani MS, Malanbee AS, Jagadeesh A. Prevalence of rheumatoid arthritis and DMARDs usage in Indian population: A cross-sectional study. *Asian J Pharm*. 2021;15(3).
3. Berger M, Zimmermann M, Thomas L, Strunk J, Kroppen D, Majorski DS, et al. Respiratory muscle strength in rheumatoid arthritis. *J Clin Med*. 2025;14:6455.
4. Sakellariou G, Scirè CA, Zambon A, Caporali R, Montecucco C. Performance of the 2010 classification criteria for rheumatoid arthritis: a systematic literature review and meta-analysis. *PLoS One*. 2013;8(2):e56528.
5. Azam TA, Odeyinka O, Alhashimi R, Thoota S, Ashok T, Palyam V, et al. Rheumatoid arthritis and associated lung diseases: a comprehensive review. *Cureus*. 2022;14(2):e22367.
6. Chandran V, Raychaudhuri SP. Rheumatoid arthritis. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024.

7. Khoiriyah, Rahayu FA, Hidayati TN, Baidhowy AS. Balloon therapy to reduce shortness of breath in chronic obstructive lung disease patients. *Jurnal Aisyah: Jurnal Ilmu Kesehatan*. 2022;7(S2):79-84.
8. Kusumawardani RI, Tinduh D, Andriati, Poerwandari D, Marhana IA, Melaniani S. The effectiveness of incentive spirometry exercise on pulmonary function in COVID-19 survivors: a randomized controlled trial study. *Bali Med J*. 2023;12(1):539-544.
9. Xie M, Cui L, Liu J, Wang W, Li J, Xiao W. Impacts of different spirometry reference equations and diagnostic criteria on the frequency of airway obstruction in adult people of North China. *Int J Chron Obstruct Pulmon Dis*. 2020; 14:909-918.
10. Taylor WJ, Parekh K. Rasch analysis suggests that health assessment questionnaire II is a generic measure of physical functioning for rheumatic diseases: a cross-sectional study. *Health Qual Life Outcomes*. 2018;16:108. doi:10.1186/s12955-018-0939-2.
11. Elgayar SL. Effect of aerobic exercises on ventilatory functions in women with rheumatoid arthritis: a randomized controlled trial. *Women Sport Phys Act J*. 2024. doi:10.1123/wspaj.2024-0069.
12. Nagy A, Tóth NM, Nagy T, Fritsch K, Marton N, Vincze K, et al. Exploring the relationship between patient-reported outcomes and early lung involvement in rheumatoid arthritis: a prospective study. *Eur Respir J*. 2024;64(Suppl 68):PA2154.
13. Hassan AM, Osman AA, Ali IA. Pulmonary function tests in asymptomatic rheumatoid lung disease patients: a hospital-based study. *Discover Medicine*. 2024;1:9. DOI: 10.
14. Derasse M, Bautin N, Humeau A, et al. Chest expansion and lung function for healthy subjects and individuals with pulmonary disease. *Respir Care*. 2021;66(3):421–428. doi:10.4187/respcare.08350
15. Ganga B, Ahamed S, Krishna GG. Need for pulmonary screening in rheumatoid arthritis patients: An observational study. *Indian J Respir Care*. 2020;9(2):186-190. doi:10.4103/ijrc.ijrc_55_19.
16. Reddy RS, Alahmari KA, Silvian P, et al. Reliability of chest wall mobility and its correlation with lung functions in healthy nonsmokers, healthy smokers, and patients with COPD. *Can Respir J*. 2019;2019:5175949. doi:10.1155/2019/5175949.
17. Scanlon EM, Mankad R, Crowson CS, Kullo IJ, Mulvagh SL, Matteson EL, et al. Cardiovascular risk assessment in patients with rheumatoid arthritis: a correlative study of noninvasive arterial health testing. *Clin Rheumatol*. 2017;36(4):763-771. doi:10.1007/s10067-016-3515-3.
18. Khair RM, Nwaneri C, Damico RL, Kolb T, Hassoun PM, Mathai SC. The minimal important difference in Borg dyspnea score in pulmonary arterial hypertension. *Ann Am Thorac Soc*. 2016;13(6):842–849.

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