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INSPIRATORY MUSCLE TRAINING IN CARDIAC POPULATIONS

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Abstract

Background: *About 50% of patients with chronic heart failure (HF) have inspiratory muscle weakness, which exacerbates dyspnoea, exercise intolerance, and a poor prognosis. Although inspiratory muscle training (IMT) is a low-risk, low-cost technique, its evidence has not been mapped for physiotherapists across cardiac populations, including HF, post-cardiac surgery, and related cardiovascular illnesses. The aim was to map the nature, extent, and quality of evidence for IMT in adult cardiac populations, charting protocols, outcomes, effect directions, and gaps, with critical appraisal of the principal sources.*

Methodology: *Indexed literature (January 2018 - March 2026) was searched and screened; a scoping review was carried out in accordance with JBI and reported in accordance with PRISMA-ScR. Nine sources were retrieved.*

Results: *IMT improves maximal inspiratory pressure, peak oxygen uptake, six-minute walk distance, ventilatory efficiency, and quality of life in HF, with synergistic gains when combined with aerobic or resistance training, according to convergent meta-analytic evidence; recent trials also show benefits for arterial stiffness and cardiac autonomic function. There is limited data on valvular disease in the peri-PCI period, and there is positive but weaker evidence in post-CABG and related cardiovascular disorders. Certainty is limited by protocol heterogeneity, brief follow-up, small sample sizes, and the lack of hard-outcome data.*

Conclusion: *IMT is a promising post-cardiac surgery and well-supported adjunct for functional and symptomatic outcomes in HF, but more high-quality, longer, appropriately powered trials, as well as any evidence for valvular and periprocedural PCI populations are required.*

INTRODUCTION

Global morbidity is largely caused by cardiovascular diseases (CVD), especially heart failure (HF) and coronary artery disease, which requires heart surgery (1). Inspiratory muscle weakening, which clinically presents as dyspnoea, increased tiredness, and severe exercise intolerance, is a very common but often overlooked consequence in these individuals (2). This particular weakness causes an early and excessive respiratory muscle metaboreflex during physical exercise in HF and other CVDs (3). Sympathetic activation, which automatically shifts blood flow from peripheral locomotor muscles to the diaphragmatic region, is triggered by the buildup of metabolites in the working respiratory muscles, such as lactate and hydrogen ions (3). Although this physiological mechanism prevents diaphragmatic ischaemia, it directly reduces global functional capacity and causes exercise to end early (3).

Inspiratory muscle training (IMT) is a scientifically validated, non-pharmacological adjunct to address this physiological impairment, typically involving breathing exercises against a target percentage of maximal inspiratory pressure (MIP) using threshold or resistive loading. By enhancing the strength and stamina of the respiratory musculature, IMT effectively delays the metabolic reflex, thereby maintaining limb perfusion and reducing perceived effort during physical activity (3). Furthermore, IMT presents a compelling option for resource-constrained cardiac rehabilitation settings due to its cost-effectiveness, minimal equipment requirements, and feasibility for home-based administration (4).

To mitigate the risk of postoperative pulmonary complications, which are recognized for substantially escalating hospital expenditures, IMT is increasingly utilized as a proactive perioperative intervention (5). Both pre- and post-surgical protocols have been associated with meaningful reductions in the duration of hospitalisation and significant enhancements in respiratory metrics, including forced vital capacity and expiratory volume (1, 5).

Although its application is well-documented in chronic obstructive pulmonary disease, adding IMT across diverse cardiac cohorts, including heart failure and post-cardiac surgery populations, demands a rigorous synthesis to establish sound therapeutic clinical reasoning. This scoping review maps the current literature, delineates existing protocols, and provides a critical evaluation of the evidence quality.

Review Questions

The following questions were attempted to answer in this scoping review:

1. In which cardiac populations has IMT been studied?
2. What protocols (load, frequency, duration, supervision) are used?
3. What outcomes are reported and in what direction?
4. Where are the principal gaps, particularly valvular disease and the peri-PCI period?

Methods

This review was conducted through a structured search of the published literature (PubMed/MEDLINE and allied indexed sources) executed on 1 January 2026, with title/abstract and full-text screening against the eligibility criteria. Flow counts and evidence tables reflect the conducted search.

Population: Adults (≥18 y) with cardiac conditions: HF (reduced or preserved ejection fraction), post-cardiac-surgery (e.g., CABG), valvular disease, and adjacent cardiovascular conditions (e.g., hypertension, pulmonary hypertension) where cardiac relevance is clear.

Concept: IMT delivered alone or as an adjunct to cardiac rehabilitation, including training parameters and measured outcomes.

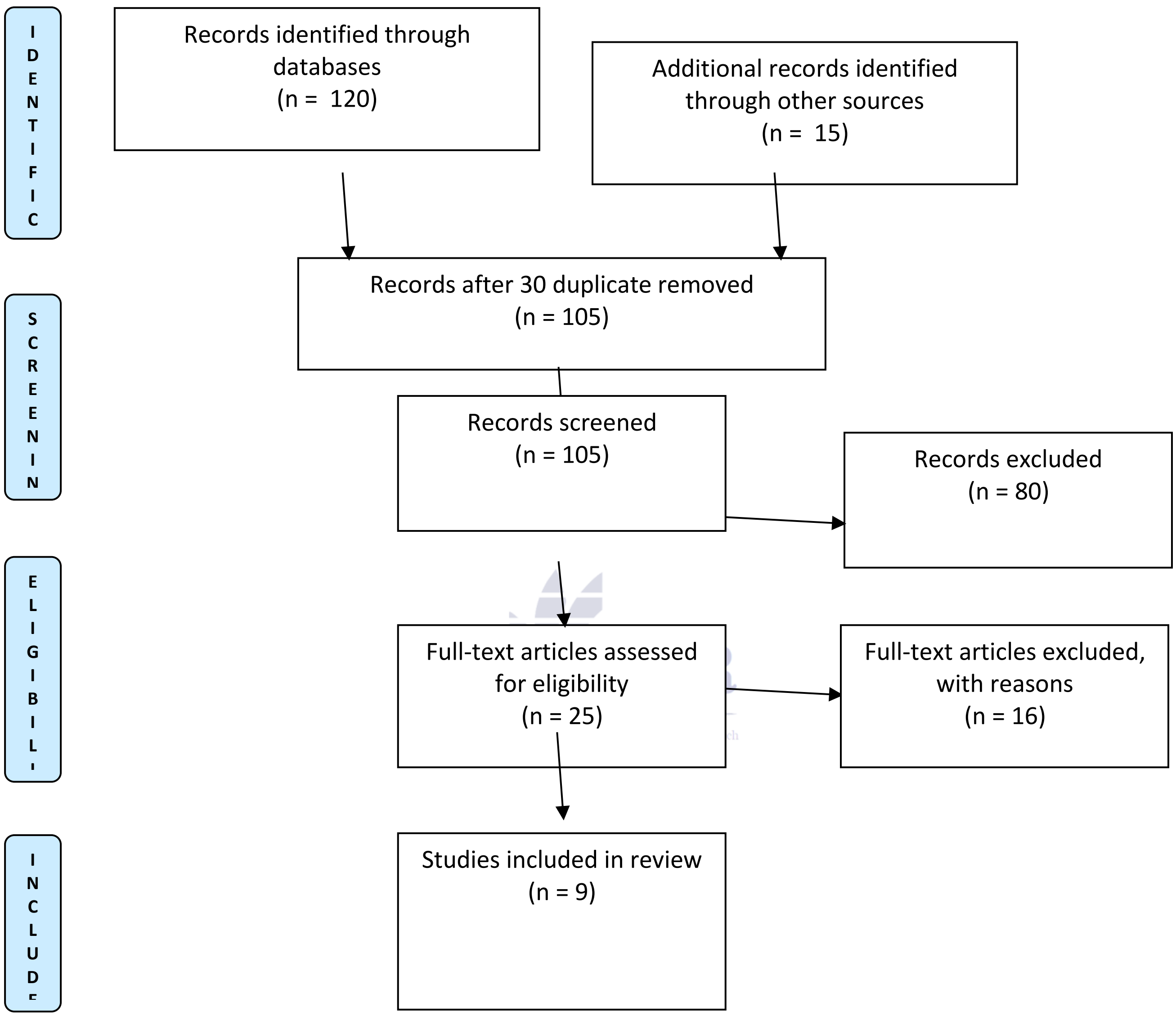
Context: Inpatient, outpatient, or home settings; any country; records January 2018 to March 2026.

Results

Search and selection

Nine substantive sources met the inclusion criteria and were charted (Table 1). The PRISMA-ScR flow diagram is provided in Fig. 1.

Figure 1: PRISMA flowchart of the selection of studies



Existed literature primarily emphasizes chronic heart failure featuring reduced ejection fraction (4, 6, 7, 8, 9, 10). Typical therapeutic protocols involve training at 30–60% of maximal inspiratory pressure, administered between daily and several times per week for an 8–12 week duration, usually integrated as a supplement to aerobic or resistance exercises in cardiac rehabilitation settings (7, 8). One specific regimen utilized daily inspiratory training alongside standard rehabilitation over 12 weeks for individuals with systolic heart failure (ejection fraction < 45%) (8). Within post-surgical cohorts, moderate-to-high-intensity breathing exercises were combined with traditional training following coronary artery bypass grafting (11). Furthermore, two separate trials expanded this intervention to related cardiovascular groups, specifically essential and pulmonary hypertension (12, 13), thereby widening the applicable clinical evidence base.

The available meta-analytical data consistently demonstrate that integrating IMT into heart failure management significantly optimizes respiratory metrics and functional performance. Notably, a synthesis of 17 randomized controlled trials revealed substantial elevations in peak VO_2 (WMD ≈2.5 mL/kg/min) and MIP (≈17 cmH_2O), alongside improved 6MWD and ventilatory efficiency (7). These findings are corroborated by contemporary evidence suggesting that IMT enhances MIP, exercise tolerance, VE/VCO_2 slope, and perceived quality of life, particularly when layered onto aerobic or resistance training protocols (6). Furthermore, high-intensity interval IMT has been shown to elicit superior between-group improvements in autonomic balance, arterial stiffness, and quadriceps strength, while positively impacting diaphragm morphology and frailty (8). In post-CABG cohorts, moderate-to-high loading significantly augmented the effects of multi-modal rehabilitation on functional capacity (11). Additionally, the efficacy of this intervention extends to related cardiovascular conditions, with trials reporting enhanced exercise capacity and peripheral strength in essential and pulmonary hypertension (12, 13).

No included study addressed IMT in valvular heart disease or in the peri-PCI period, and evidence in HF with preserved ejection fraction and in lower-resource and South Asian settings was sparse. Long-term and hard-outcome data are absent.

Table 1. Charted sources and extracted findings

Study (first author, year)	Design / N	Key findings
Siddiqi AK, 2025 (6)	SR/MA	IMT improves MIP, 6MWD, VE/VCO_2, QoL; synergy with aerobic/resistance.
Beaujolin A, 2022 (3)	SR/MA (17 RCTs)	↑peakVO_2 (≈2.5), ↑MIP (≈17); ↑6MWD, ventilatory efficiency.
Tanriverdi, 2023 (7)	Single-blind RCT	H-IMT ↑HRV, arterial stiffness, MIP, quadriceps, diaphragm thickness, function, QoL.
Leite, 2020 (8)	RCT protocol	IMT 7×/wk + CR over 12 wk; sympathetic activity/function endpoints.
Santos TDD, 2019 (11)	RCT (post-CABG)	Moderate-high IMT augments combined-training exercise capacity.
Sadek, 2020 (9)	RCT	HIIT + IMT in CHF with inspiratory weakness; functional gains.
Farghaly A, 2022 (10)	RCT	Breathing training within HF CR improves outcomes.
Hüzmeli İ, 2025 (12)	3-arm RCT	Functional IMT ↑exercise capacity and peripheral strength.
Alrashedi, 2026 (13)	SR/MA (PH)	IMT ↑respiratory function and exercise capacity in pulmonary HT.

Discussion

The existing evidence base supports a robust clinical conclusion. Inspiratory muscle training (IMT) consistently improves inspiratory muscle strength, subsequently enhancing functional capacity, ventilatory efficiency, and health-related quality of life in patients with chronic heart failure (CHF). Systematic evidence indicates that the magnitude and consistency of these improvements are optimized when IMT is integrated with aerobic or resistance training protocols, rather than utilized as a monotherapy (6, 7).

This synergistic effect is underpinned by a plausible physiological mechanism: the attenuation of the inspiratory metaboreflex, which facilitates improved peripheral blood flow distribution to locomotor muscles during whole-body exercise. Emerging data further suggest that IMT may positively modulate cardiac autonomic balance and mitigate arterial stiffness (8). Given these findings, IMT represents a viable, scalable, and cost-effective adjunct for resource-constrained cardiac rehabilitation settings. It is highly portable, facilitates home-based adherence, and functions as a complementary intervention that enhances, rather than replaces, conventional exercise modalities.

Three clinical implications emerge from this evidence. First, IMT should be positioned as an adjunct therapy characterized by objective titration; prescribing training intensity as a percentage of maximal inspiratory pressure (MIP), paired with serial re-assessment, provides a standardized metric for dose progression and protocol-driven practice. Second, clinical priority should be directed toward populations with the strongest evidence base, specifically those with heart failure with reduced ejection fraction (HFrEF) and demonstrated inspiratory muscle weakness, as baseline impairment is a significant predictor of therapeutic responsiveness (8). Third, owing to a paucity of data regarding valvular heart disease and the peri-percutaneous coronary intervention (PCI) period, IMT cannot currently be recommended for routine application in these cohorts; clinical extrapolation should be exercised with caution and remain strictly individualized.

Strengths include a contemporary multi-population scope, transparent charting, an explicit critical appraisal, and PRISMA-ScR alignment. Limitations included reliance on indexed rather than full database exports, inclusion of one protocol and two adjacent-population trials (clearly flagged), and the exclusion of pre-2018 foundational trials that remain physiologically informative. Publication bias toward positive IMT results is plausible and was not formally assessed.

Future research priorities must focus on adequately powered, multicenter, sham-controlled trials that extend follow-up beyond three months and assess hard clinical endpoints. Additionally, targeted investigations are warranted for specific clinical subpopulations, particularly patients with valvular heart disease, heart failure with preserved ejection fraction (HFpEF), and those in the peri-percutaneous coronary intervention (PCI) phase. Finally, pragmatic trials conducted within resource-constrained environments, specifically including South Asian demographics, are necessary to evaluate real-world feasibility, intervention delivery, and long-term adherence.

Conclusion

Inspiratory muscle training (IMT) is a cost-effective, evidence-based adjunct that improves respiratory strength, functional capacity, and quality of life in chronic heart failure, with preliminary evidence suggesting cardiovascular and autonomic benefits. However, current clinical certainty is constrained by methodological limitations, including small sample sizes and brief follow-up periods. Key research gaps persist regarding its efficacy in patients with valvular disease, HFpEF, and the peri-PCI phase, as well as the need for robust data on hard clinical endpoints.

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