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Breathing retraining and manual therapy for long COVID – A literature review

Rosalba Courtney [a,*], Zoe Steele [b], Imogen Collyer [c]

[a] Southern Cross University, Lismore, NSW, Australia
[b] Te Pukenga/Ara Institute of Canterbury, Christchurch, New Zealand
[c] North Canberra Osteopathy, Australia

A R T I C L E I N F O

Keywords:
"Breathing retraining"
"Dysfunctional breathing"
"Long COVID"
"Manual therapy"

A B S T R A C T

Background: Long COVID continues to have health impacts globally. Dyspnoea, fatigue, exercise intolerance and musculoskeletal symptoms are common and have been linked to pathophysiological mechanisms such as dysfunctional breathing, dysautonomia and neurolymphatic dysfunction that might be assisted by breathing retraining and manual therapy.
Objective: This review sought to identify research describing breathing retraining and manual therapy protocols that might be beneficial for long COVID.
Methods: A literature review was undertaken to identify research describing treatment protocols that included either manual therapy or breathing retraining approaches for long COVID.
Results: There were 17 articles that fit the inclusion criteria; 9 randomised control trials, 4 case series, 3 uncontrolled studies, and one case report. Whilst methodologies varied, all implemented interventions and reported outcomes involving breathing re-training and/or manual therapy, in four broad categories: manual therapy, singing-based breathing protocols, respiratory muscle training – device assisted, and breathing techniques.
Conclusion: Clinical protocols integrating multimodal interventions and patient self-care should be refined through pilot studies targeting specific phenotypes. High-quality research is needed to compare intervention effectiveness and assess long-term outcomes.

Implications for practice

Osteopaths will continue to see long COVID patients in their clinics for treatment of symptoms associated with this illness in the foreseeable future.

Manual therapy, breathing retraining and support of patients with self-care strategies such as relaxation, stress reduction and pacing can all assist patients with long COVID. These treatments may have synergistic effects on underlying pathophysiological mechanisms.

A multifaceted treatment approach that addresses structural as well as functional aspects of health and combines practitioner led treatment with patient self-care is likely to be most effective when addressing complex and chronic conditions such as long COVID.

1. Introduction

Many patients infected by the SARS CoV2 virus suffer from prolonged and significant disability after the initial infection. Terms such as post-acute sequelae of COVID-19 (PASC) and long COVID have been used to describe the diverse cluster of multi-system symptoms which persist beyond 3 months after infection with this virus [1]. Incidence of long COVID varies as new strains of COVID-19 emerge. However, its estimated that long COVID affects between 10 and 30 % of people who become infected with COVID-19, with one in seven patients still symptomatic at 12 weeks [1,2]. Therefore, it can be assumed that osteopaths might continue to see long COVID patients in their clinics for treatment of symptoms associated with this illness.

Surveys of patients with long COVID have found that sufferers can experience a diverse array of symptoms that can be broadly characterized as 4 distinct phenotypes; cardiorespiratory, musculoskeletal, anosmia and neuropsychiatric, with the cardiorespiratory and musculoskeletal phenotypes being the most common [3]. These symptoms are proposed to be related to a number of pathophysiological mechanisms and therapeutic targets including cardiorespiratory dysfunction,

* Corresponding author.
E-mail addresses: rosalba.courtney@gmail.com (R. Courtney), zoe.steele@ara.ac.nz (Z. Steele), imogen.collyer@gmail.com (I. Collyer).

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dysautonomia, immune dysregulation, endotheliopathy, autoimmunity, viral persistence [3,4] and neurolymphatic dysfunction [5].

Dysfunctional breathing (DB), a common cardiorespiratory finding in long COVID, is also proposed to represent a critical pathophysiological explanation for dyspnea, fatigue and exercise intolerance in some patients with long COVID [6–9]. DB has been defined simply as "a group of breathing disorders in which chronic alterations in breathing patterns lead to dyspnea and often non-respiratory symptoms, either in the absence of or disproportionate to any organic respiratory disease" [6]. A broader more holistic definition describes DB as "multidimensional, influencing and being influenced by biochemical, biomechanical and psychophysiological aspects of breathing. It is maladaptive and does not efficiently fulfill the primary or secondary functions of breathing leading to a range of respiratory and non-respiratory symptoms that can occur throughout the unified airway" [7].

It's likely that many of the pathophysiological drivers of long COVID co-exist, their additive effects driving symptom severity and load. Treatments likely to be most effective are those that effectively impact on one or several of the interconnected pathophysiological mechanisms identified as drivers of long COVID symptoms.

While breathing exercises are the primary therapy used to treat dysfunctional breathing patterns manual therapy is also employed either in combination with breathing exercises [8,9] or as stand alone therapy that specifically targets respiratory muscles that drive dysfunctional breathing patterns [10]. and are of interest because of the potential for DB to contribute to cardiorespiratory dysfunction, homeostatic dysregulation, fatigue and exercise intolerance [11,12]. Manual therapy and breathing techniques may also be of benefit in long COVID patients without DB because of their ability to influence other pathogenic mechanisms identified in long COVID such as dysautonomia, immune dysfunction and compromised central and peripheral lymphatic circulation [13,14–17].

Breathing retraining and manual therapy may both potentially benefit particular long COVID patient phenotypes such as those with dysfunctional breathing, compromised lymphatic circulation and dysautonomia and there may be additional benefit in the combined use of these therapies. Traditionally, osteopathic clinical protocols have relied on practitioner -delivered or passive manual therapy techniques. However, in recent years, it has been argued that incorporating more active patient involvement, with inclusion of home exercises, lifestyle advice such as relaxation and breathing techniques improves the quality of patient treatment and is in line with osteopathic principles of patient centered holistic treatment of structure and function [18,19]. The use of modalities such as manual therapy and breathing retraining is not unique to osteopathy and protocols suitable for osteopathic practice that utilize these particular modalities necessitates exploring the broad research literature beyond osteopathy.

This literature review aims to evaluate breathing retraining and manual therapy treatments for their potential to improve symptoms and functional capacity in patients with long COVID. This research also aims to inform future studies on protocols combining manual therapy with active patient involvement, such as breathing exercises, to specifically target long COVID phenotypes.

2. Methods

A literature review was undertaken to identify manual therapy and breathing retraining approaches being used to assist patients with long COVID.

Identification: A literature review was undertaken to identify manual therapy and breathing retraining approaches being used to assist patients with long COVID. A broad search strategy was used to identify relevant research published during the COVID-19 pandemic. The PubMed, CINAHL, as well as IJOM databases were searched. Given the aim to identify and describe breathing retraining and manual therapy treatments for patients with long COVID, all articles which met the inclusion criteria were evaluated regardless of outcome. Diagnostic criteria for Long COVID at this time are defined as those with persistent symptoms or the development of symptoms consistent with COVID- 19 more than twelve weeks after initial infection.

The following search terms were grouped and combined into search strategies.

Group 1: "Long-COVID" OR "Post COVID-19", OR "Post-Acute COVID-10 syndrome"
Group 2: "breathing exercises" OR "breathing retraining" OR "breathing therapy" OR "inspiratory muscle training" OR "respiratory muscle exercises" OR "expiratory muscle training", OR "breath regulation"
Group 3: "manipulation, osteopathic" OR "musculoskeletal manipulations" OR "physical therapy modalities" OR osteopath* OR massage OR "myofascial therapy" OR "spinal manipulation" OR "physical therapy"

Screening: With duplicates removed all studies were screened by title and abstract. Two reviewers screened each study for selection, decreasing the risk of selection bias. Pre-defined inclusion criteria were limited to peer reviewed articles in English from any geographical location, published in the last 5 years that employed interventions based on breathing re-training and/or manual therapy techniques were included, regardless of the methodology patient demographic, measured severity of Long COVID in the patient, or sample size.

Eligibility: All types of research design were included. Articles which described exercise (other than breathing exercises) as the only intervention were excluded. Conference abstracts, theses and grey literature were not excluded from the search. In-hospital interventions were excluded, as were those where exercise, not specifically targeting breathing, is the only basis of intervention.

Included: 17 articles which met the inclusion criteria were then used for thematic analysis. Data relating to the common themes of manual therapy, singing-based breathing protocols, respiratory muscle training, and other breathing techniques.

Given the aim to identify and describe breathing retraining and manual therapy treatments for patients with long COVID, all articles which met the inclusion criteria were evaluated regardless of outcome.

3. Results

The initial literature search, using the terms described previously, identified 244 articles, 226 with duplicates removed. Titles and abstracts were screened for relevance and eligibility, leaving 17 articles that fit the inclusion criteria, and are described in [Table 1: Results] PRISMA data is outlined in the flow diagram [Fig. 1: PRISMA Data].

The 17 included studies employed diverse methodologies-including 9 randomised controlled trials (RCTs) [23,27,28,30–35],

4 case series [21,24,25,36], 3 uncontrolled studies [20,22,26] and one case report [29]. Despite methodological variations, all studies focused on interventions involving breathing re-training and/or manual therapy. Please refer to [Table 1: Results] in appendix for specific results.

Consistent themes emerged across 4 types of intervention.

1. Manual Therapy
2. Singing-based breathing protocols
3. Respiratory Muscle Training
4. Breathing Techniques.

These are summarised below.

3.1. Manual therapy

Four studies used manual therapy as an intervention [30,21,25,29].

Table 1
– Summary of results.

Citation	Design	Patient Cohort	Intervention(s)	Outcome Measures	Changes Observed
Cahalan et al., 2022 [20]	Before and After	21 Adults >18yrs, with persisting fatigue and respiratory symptoms post COVID-19 who completed 50 % of classes	SingStrong for Long COVID: • mindfulness, breathing retraining, vocal exercises, and singing. • 10 Weeks 45 min classes 2x/week online delivery	• De Paul Questionnaire Short Form (DSQ-SF) • Yorkshire Rehab Screen-disease severity domain	Improvements in breathlessness symptoms at rest and during activities ($p < 0.001$) Reduced fatigue $p = 0.02$, pain/disability ($p = 0.02$). Improved voice quality, and communication/cognition ($p = 0.03$)
Cevei et al., 2022 [21]	Case Series	6 patients previously diagnosed with SARS-CoV-2 and admitted to rehabilitation programme with loss of autonomy	Rehabilitation Program: • exercise therapy, robotic gait training, occupational therapy, and massages (effleurage, petrissage). • Combined approach delivered over 4 weeks	• Performance in Activities of Daily Living (ADLs)- Barthel Index • Functional Independent Measure (FIM) for Activities of Daily Living (ADL) • Strength and Joint mobility measures • Medical Research Council (MRC) scale for strength • Serum Fibrinogen, C-reactive protein	Barthel index ($p = 0.09$) FIM ($p = 0.02$) Improved motor control in all but one Improved functional ability, balance, co-ordination, and muscle strength in almost all cases. Serum Fibrinogen $p = 0.001$, CRP $p = 0.07$.
Dalbosco-Salas et al., 2021 [22]	Observational Prospective	150 Patients with persistent dyspnoea post COVID-19	Telerehabilitation program: • Supervised exercise including warm-up, breathing exercises, aerobic and/or strength exercises, and stretching. • 9 weeks duration, 2-3x/week, 24 sessions total	• Sit to Stand test 1 min (1-min STST) • 36 item Short Form Health Survey for Quality of life (SF-36) • Modified Medical Research Council dyspnoea scale (mMRC) • Fatigue Visual Analogue Scale	Sit to stand test improved ($p < 0.001$). Quality of life-i.e. Global SF-36 improved significantly $p < 0.001$ Fatigue VAS $p < 0.001$ Dyspnoea mMRC $p < 0.001$
del Corral et al., 2023 [23]	RCT	88 Patients with long term fatigue and dyspnoea post COVID-19	Home-based respiratory muscle training (RMT) programme: • Random assignment to either IMT (inspiratory muscle training), IMT sham, RMT, or RMT sham • 8-week intervention, 40 min/day, 6x/week	• EuroQoL5D for Health-Related Quality of Life • Exercise tolerance Ruffier test • Dyspnoea • Fatigue • Respiratory muscle strength • Inspiratory muscle endurance • Sit to Stand Test 1 min (1-min STST) • Handgrip force • Forced spirometry peak expiratory flow • Psychological status	Health Related Quality of Life EuroQoL5D $p = 0.031$, and VAS $p = 0.004$ Ruffier test post intervention $p < 0.05$ Ruffier test between groups not significant RMT 5-6-fold reduction in dyspnoea as compared to control group. RMT group Peak Expiratory Flow $p < 0.001$ Fatigue measures improved but failed to reach significance. No improvement in exercise tolerance or psychological status.
Golan et al., 2023) [24]	Case Series	6 Patients diagnosed with post-COVID condition presenting with ongoing respiratory symptoms and dysfunctional breathing	Integrative Breathing Therapy Protocol: • Systematic evaluation of biomechanical, biochemical, and psychophysiological dimensions of dysfunctional breathing • Intensive breathing retraining • 6–12 sessions of weekly 1hr group telehealth sessions combined with 2–4 individual sessions	• Manual Assessment of Respiratory Motion (MARM) • Resting End Tidal Carbon Dioxide Capnometry (ETCO2) • Respiratory Rate • Dyspnoea Index (DI) • Nijmegen Questionnaire (NQ) • Self-Evaluation of Breathing Questionnaire (SEBQ) • Breath Hold Time-Involuntary Respiratory Muscle activation (BHT-IRM)	All participants showed improvements in the parameters of dysfunctional breathing measured and also reported a reduction in symptoms and improved daily function.
Heald et al., 2022 [25]	Case Series	20 patients with Long COVID	Perrin Technique: • Effleurage/other manual articulatory techniques performed by Perrin Practitioner • Daily self-massage • Mobility exercises • Weekly sessions	• Profile of Fatigue Related Symptoms (PFRS)-four subscales: emotional distress, cognitive difficulty, fatigue, and somatic symptoms	Symptom reduction of 41.8 % in men and 60.5 % in women All subscales showed a reduction of 50 % post intervention, with the reduction in score relating to a decrease in the severity of symptoms.
Hockele et al., 2022 [26]	Pilot Clinical Trial	29 Patients with mild, moderate, or severe post COVID symptoms	Pulmonary and Functional Rehabilitation Program: • IMT, aerobic exercise, and peripheral muscle strength • 16 sessions	• Manovacuometry • Spirometry • Respiratory Muscle Strength • 6 min Walk Test (6MWT) • Timed Up and Go Test (TUGT) • Hand Grip Dynamometry	Manovacuometry - respiratory muscle strength increased for inspiratory pressure ($p = 0.117$) and expiratory pressure ($p < 0.001$). Spirometry improved- forced vital capacity ($p = 0.004$), forced

(continued on next page)

Table 1 (*continued*)

Citation	Design	Patient Cohort	Intervention(s)	Outcome Measures	Changes Observed
				• COPD Assessment Test for quality of life • Post Covid-19 Functional Status (PCFS) • Modified Medical Research Council dyspnoea scale (mMRC)	expiratory volume in the first second ($p = 0.001$). 6min walk test improved ($p < 0.001$) Dynamometry improved; R p=0.011, L $p = 0.006$ COPD assessment improved ($p < 0.001$) PCFS improved SOB and ADLs $p < 0.001$ in all facets mMRC $p < 0.001$
Jimeno-Almazán et al., 2022 [27]	RCT	80 Patients with respiratory symptoms of Long COVID	Rehabilitation program: • Multicomponent exercise training (resistance and endurance) • IMT • Combination of multicomponent exercise training and IMT • Control • 8 weeks duration	• Cardiovascular fitness (VO2 max) • Muscle strength- Mean propulsive velocity for half squat and bench press at 1RM. • Health Related QoL Short Form-12 Physical Activity and Mental health subscales (HQoL SF-12) • Modified Medical Research Council Scale (mMRC) • Fatigue Severity Scale (FFS) • Chalder Fatigue Scale • Post COVID-19 Functional Scale (PCFS)	VO2 Max Concurrent Training (D 7.5 %; $P < 0.05$) and Concurrent Training and Respiratory Muscle (D 7.8 %; $P < 0.05$) groups Lower body strength improved in Concurrent Training and Concurrent Training and Respiratory Muscle Training (14–32.6 %; ES = 0.27–1.13) cf to RM and CON (−0.3-11.3 % ES = 0.10–0.19) Total number of symptoms decreased in the full sample ($p < 0.001$). CT and CTRM had significant reduction in Patient Reported Outcome Measures with respect to the RM and CON groups ($p < 0.05$). Dyspnoea (mMRC $p < 0.001$), fatigue, and anxiety significantly improve in favour of CT and CTRM groups ($p < 0.05$) PCFS ($p < 0.001$)
McNarry et al., 2022 [28]	RCT	281 Adults recovering from Long COVID	Rehabilitation Strategy: • 8-week IMT or, • "usual care" waitlist control arm	• 15-item King's Brief Interstitial Lung Disease (K-BILD) • Baseline Dyspnoea Index (BDI) • Transitional Dyspnoea Index (TDI) • Fatigue Index Time • Inspiratory Muscle Strength • Chester Step Test • Wearable Device - GT9X • Treatment Self-Regulation Questionnaire • Perceived Competence Scale • Basic Needs Satisfaction Scale	Dyspnoea measures BDI and TDI –greater reduction in ITT ($p = 0.005$) and per- protocol populations ($p = 0.005$), and K-BILD score $p \leqslant 0.001$–0.03 in the ITT population IMT improved Inspiratory Muscle strength in MIP, SMIP and FIT- $p = 0.04$ VO2max improved $p < 0.05$
Monro 2022 [29]	Case Report	60 yrs old Female with Long COVID	Osteopathic Care: • OMT (cranial approach) • Support and reassurance • Approximately 22 sessions over 1 year	• Patient symptom diary • Resting Heart Rate	Reduction in number of symptoms, and overall improvement in relationship to symptoms of breathlessness, chest tightness, and fatigue. Patient reported feeling better in herself and having a steady sense of recovery, better capacity to exercise, felt more herself, her resting heart rate normalised to 70bpm after being 80bpm and elevating to 170bpm with a brief walk.
Nagy et al., 2022 [30]	RCT	52 Men recruited from outpatient chest clinic with post-COVID syndrome	Treatment: • Diaphragm release technique and IMT • Control group received IMT only	• Inspiratory muscle strength using PIMax • Dyspnoea mMRC scale • Fatigue Severity Scale • Serum Lactate • 6-min walk test (6MWT)	All measures improved significantly ($p < 0.001$) in favour of combined interventions study group (IMT and diaphragm release) as compared to control group. MIPs increased 48 % ($p < 0.001$) in combined interventions study group.
Okan et al., 2022 [31]	RCT	52 patients who had received treatment for COVID 2 months prior at a	Breathing exercise: • Respiratory control	• Quality of Live using St Georges Respiratory Questionnaire (SGRQ)	SGRQ ($p_1 < 0.001$, $p_2 < 0.001$, $p_3 < 0.001$) Pulmonary Function Test values

(*continued on next page*)

Table 1 (*continued*)

Citation	Design	Patient Cohort	Intervention(s)	Outcome Measures	Changes Observed
		chest diseases outpatient clinic, now with ongoing dyspnoea	• Pursed lip breathing diaphragmatic breathing • 10 reps of each face-to-face then 10 reps each, 3x/day/7days per week for 5 weeks, 2 h after meals at home • One session was provided via telemedicine with researcher	• Pulmonary Function tests FEV1, FVC, MVV • Dyspnoea -Modified Medical Research Council • 6MWT	were significantly high in the intervention group FEV1: ($p_2 = 0.001$, $p_3 = 0.001$) FVC: ($p_2 = 0.001$, $p_3 = 0.001$) FEV1/FVC: not significant MVV: ($p_1 = 0.001$, $p_2 = 0.001$, $p_3 = 0.001$) MRC dyspnoea index: ($p_1 = 0.001$, $p_2 = 0.001$, $p_3 = 0.001$) 6MWT ($p_1 < 0.001$, $p_2 > 0.001$, $p_3 < 0.001$) p_1: Between-group comparison, p_2: Intra-group comparison, p_3: group × time interaction (Two-way variance analysis was used in repeated measurements)
Palau et al., 2022 [32]	RCT	26 Patients, 3 months post discharge from previous admission due to SARS-CoV-2 pneumonia	2 physiotherapy appointments (First and last of 90 days) and assignment to one of 2 arms: • IMT • "Usual care"	• Cardiopulmonary Exercise Testing (CPET) – peakVO2 • Heart Rate response to Exercise (Chronotropic Index Formula) • Blood Pressure • Health Related QoL European Quality of Life 5 Dimensions 3 Level Version (EQ-5D-3L) • Pulmonary Function	Substantial improvement in physical performance and QoL. CPET- peak VO2 $p < 0.001$ and predicted peakVO2 <0.001 Heart Rate response to Exercise (Chronotropic Index Formula) $p = 0.046$. Health Related QoL EQ-5D-3L significant changes in usual activity and anxiety/depression dimensions ($p = 0.013$ and $p < 0.001$ respectively) Pulmonary Function
Pehlivan et al., 2022 [33]	RCT	34 Patients with history of hospitalization for COVID-19	Patients randomly assigned to one of 2 groups: • Telerehabilitation group received breathing range of motion exercises, active cycle of breathing technique, aerobic training 3x/week for 6 weeks • Control group received an exercise brochure with same content	• Dyspnoea- Modified Medical Research Council (mMRC) • Sit to Stand Test (30STS) • Short Physical Performance Battery (SPPB) • Quality of Live using St Georges Respiratory Questionnaire (SGRQ) • Pain VAS • Fatigue VAS • Beck Depression Inventory	TeleGr: significant improvement of mMRC ($p = 0.035$), 30STS ($P = 0.005$), and SGRQ ($p = 0.042$) More symptomatic improvement was found in TeleGr Control Group: improvement in pain score ($p = 0.039$)
Philip et al., 2022 [34]	RCT	150 Patients referred from Long COVID clinics	Patients randomly assigned to one of 2 groups: • English national Opera Breathe programme; 6 weeks online workshops including exercises and activities for breath control and self-management of breath and anxiety, access to digital resources, weekly 'drop-in' sessions • "Usual care"	• HR QoL using RAND 36 item short form survey Mental Health Composite (MHC) and Physical Health Composite (PHC) • COPD assessment score • Dyspnoea using the VAS for breathlessness and Dyspnoea 12 • Generalised Anxiety Disorder (GAD -7) • Short form 6D	Compared with UC the ENO Breathe Group had improvements in RAND 36 SF MHC ($p = 0.047$), VAS for breathlessness (running) score ($p = 0.0026$). Most secondary outcomes showed numerical improvement, they were not significant.
Sharma & Goswami, 2022 [35]	RCT	30 Participants with post COVID respiratory complications	Patients randomly assigned to one of 2 groups for 6 weeks: • Pulmonary Tele-rehabilitation; breathing and therapeutic exercises • "Conventional care"	• Modified Borg Dyspnoea Rating Scale (MBDR) • VAS for Fatigue (VAS-F)	Significant improvement was shown in both MBDR and VAS-F. Experimental group showed significant improvement ($p = 0.005605$) compared to the control group ($p = 0.001121$)
Shelley et al., 2022 [36]	Qualitative Description	48 Adults with respiratory symptoms of Long COVID	Eight-week IMT rehabilitation programme	• Reflexive thematic analysis – psychological factors, impact on lifestyle, symptoms etc.	Inspiratory Muscle Training (IMT) was associated with perceived improvements in respiratory symptoms, and exercise confidence and capacity which may also have resulted in increased levels of physical activity including ADL's and work. Some patients experiencing fatigue found the training challenging.

Only one of these studies was a randomized controlled trial, two were case series and one was a case study. Manual therapy interventions demonstrated improvements in motor control [21], increased functional ability [30,21], symptom reduction [30,25,29], and reduction in inflammatory markers [21]. All studies also included prescription of at home exercises for strength and mobility [21,25], pacing and relaxation [25,29] and breathing [29]. These findings suggest that manual therapy combined with at home exercises may address physical symptoms through specifically targeted techniques.

Cevei et al. (2022) conducted a rehabilitative case series with 6

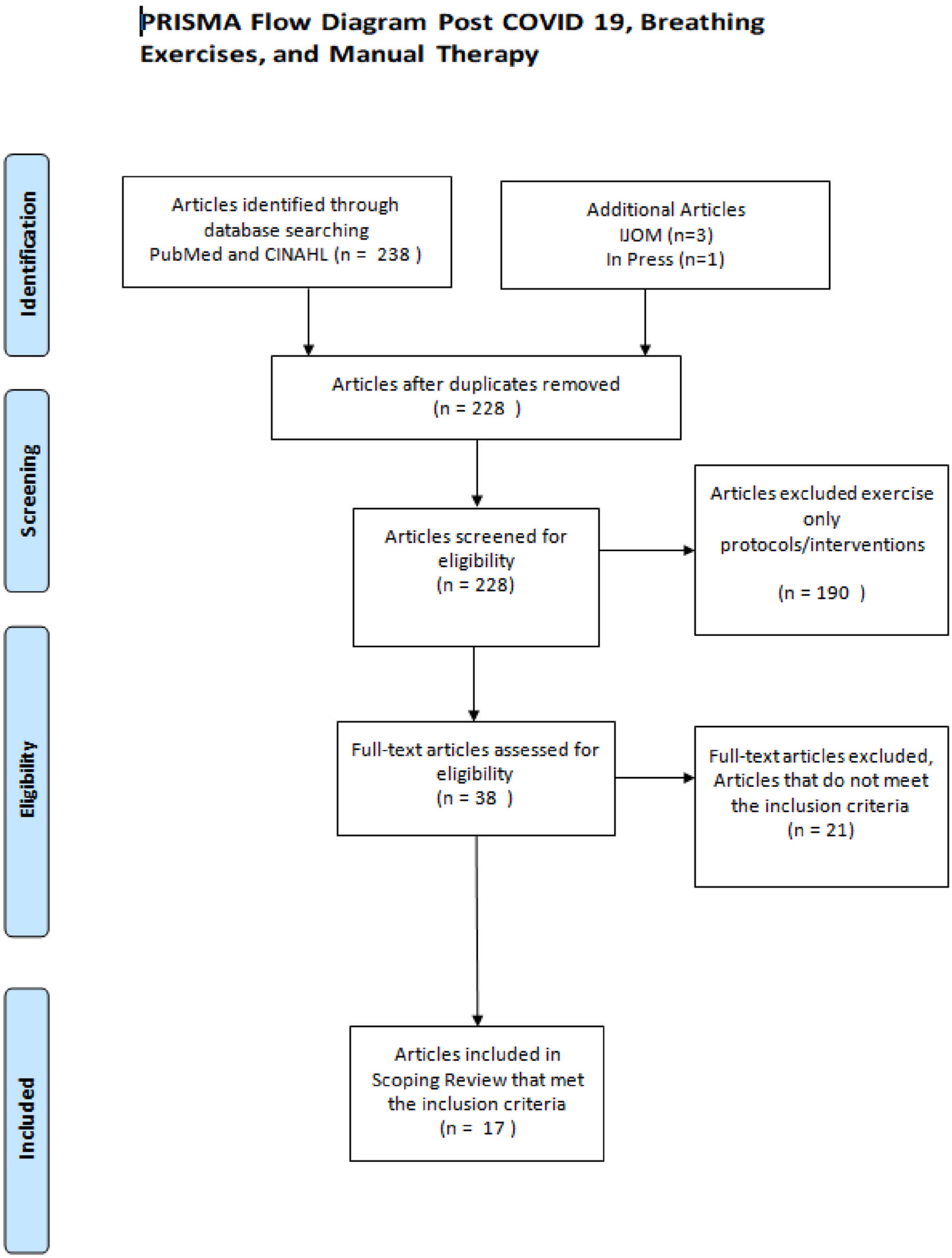

Fig. 1.

geriatric participants over 4 weeks. The intervention included exercise therapy, robotic gait training, occupational therapy, and 20 min daily massage; consisting of effleurage of the cervical, thoracic, and lumbar spine, in addition to the lower limbs. Improved motor control was reported in all but one participant, and improved functional ability (Functional Independence Measure (FMI) $p = 0.02$), balance, co-ordination, and muscle strength in most cases, and improvement in C-reactive protein, and fibrinogen ($p = 0.07$, and $p = 0.001$ respectively) [21].

Heald et al. (2022), conducted a case series of 20 participants attending private clinics providing the Perrin Technique. Manual therapy included effleurage, mobilisation/stretching of paraspinal, sub-occipital and respiratory muscle as well as techniques focused on improving lymphatic drainage. Participants had manual therapy for an average of 9.7 weeks and were given self-massage and mobility exercises to do at home. Symptom reduction of 41.8 % in men, and 60.5 % in women was reported in Profile of Fatigue Related States (PRFS) outcome measure [25].

Nagy et al. (2022) conducted a 6-week RCT comparing inspiratory muscle training (IMT) combined with diaphragm release (DR), to only IMT. The combined intervention group received IMT and diaphragm release 3 times per week with significant improvement noted in all measured outcomes ($p < 0.001$) [30].

A case study by Monro (2022), used a cranial osteopathy manual therapy approach, focusing on the autonomic nervous system, the thoracic diaphragm, and the vascular endothelium including lymphatic vessels. Patient education of symptoms and pacing exercise/activities, and controlled breathing was incorporated [29].

3.2. Singing based breathing protocols

Singing based interventions that integrated mindfulness and breathing exercises improved both physical and psychological outcomes. [34,20]. Cahalan et al. (2022) found significant reductions in breathlessness ($p < 0.001$) and fatigue ($p = 0.03$). Phillip et al. (2022) reported improved mental health ($p = 0.047$) and breathlessness during physical activity ($p = 0.0026$). This suggests dual benefits of singing-based protocols for respiratory function and mental well-being.

Cahalan et al. (2022) conducted a 10 week before and after pilot study. Each 45-min intervention included mindfulness, breathing retraining, vocal exercises, and singing. Data analysed from the 21 participants showed for those who completed at least 50 % of the classes, significant improvements in all breathlessness ($p < 0.001$), fatigue ($p = 0.03$), usual activities, pain/disability ($p = 0.03$), voice quality, and communication/cognition ($p = 0.04$). Qualitative feedback from the focus group was overwhelmingly positive with all reporting improvements in breathing and general well-being [20].

Philip et al. (2022), conducted a 6-week RCT with 150 participants allocated to either the intervention group English National Opera (ENO) Breathe, or usual care (UC). The ENO Breathe intervention consisted of mind-body 'warm-ups', posture and breath control instruction, self-management of anxiety/breathlessness and specific homework exercises. Participants were encouraged to connect with other participants and rehearsed a culturally diverse lullaby. The intervention group reported improvement in mental health ($p = 0.047$), and breathlessness (running) $p = 0.0026$. Thematic analysis revealed improvements in symptoms overall, feelings that the programme was complementary to standard care, and the suitability of singing and music to address symptoms [34].

3.3. Respiratory muscle training- Device assisted

Six articles assessed inspiratory muscle training (IMT) as an intervention [27,28,30,32,36,26]. One article investigated IMT and expiratory muscle training (EMT) [23]. Across these studies there were consistent reports of improvements in functional capacity [36,26], respiratory muscle strength [23,28,26], aerobic fitness [27,28,32], dyspnea [23,27,28,26] and quality of life metrics [27,28,32,26].

A clinical trial conducted by Hockele et al. (2022) assessed a pulmonary and functional post COVID rehabilitation program which incorporated IMT, aerobic exercises, and peripheral muscle strengthening over two months. Significant improvements were reported in functional capacity (6 min walk test), quality of life (Chronic Obstructive Pulmonary Disease Assessment Test $p < 0.001$), spirometry (FEV1 $p = 0.001$, FVC $p = 0.004$), respiratory muscle strength and peripheral muscle strength, and dyspnoea (Modified Medical Research Council (mMRC) $p < 0.001$) [26].

Jimeno-Almazán et al. (2022) found that eight weeks of concurrent training, with or without IMT was significantly better than the control group who followed the World Health Organisation (WHO) 'Support for Rehabilitation: Self-Management after COVID-19-Related Illness" recommendations or IMT alone on cardiopulmonary fitness (VO_2MAX $p < 0.05$), strength, and symptom severity outcome measures, dyspnoea (mMRC $p < 0.001$), quality of life (12 Item Short Form $p < 0.001$) and total number of symptoms [27].

McNarry et al. (2022) reported that 3 sessions per week for 8 weeks of IMT elicited significant improvement in breathlessness and chest symptom domains of the King's-Brief Interstitial Lung Disease ($p \leqslant 0.001–0.03$) outcome measure as well as breathlessness according to Transition Dyspnoea Index ($p = 0.005$). IMT was also reported to improve respiratory muscle strength, aerobic fitness and VO_2Max [28].

Palau et al. (2022) conducted an RCT in which participants were instructed on diaphragmatic breathing and IMT, followed by a 12 week home based IMT program consisting of weekly physiotherapy assessment and adjustment to IMT resistance as appropriate, or usual care control group (UC). Significant improvement was reported in peakVO2 $p < 0.001$ and predicted peakVO2 <0.001. Health Related Quality of Life (HRQoL) also significantly improve in the intervention group in the dimension of usual activity and anxiety/depression ($p = 0.013$ and $p < 0.001$ respectively) of the QoL European Quality of Life 5 Dimensions 3 Level Version (EQ-5D-3L) [32].

A qualitative perceptive study by Shelley et al. (2022) explored how people living with post COVID-19 experienced an eight-week course of IMT. IMT was associated with perceived improvements in respiratory symptoms, and exercise confidence and capacity which may also have resulted in increased levels of physical activity including activities of daily living (ADL's) and work. Some patients experiencing fatigue found the training challenging [36].

A RCT by Del-Corral et al. (2022), reported a significant and large improvement in Quality of life (EuroQoL5D $p = 0.031$), but not in exercise tolerance for the respiratory muscle training (RMT) group compared with the sham intervention group. The RMT group had 5-6-fold greater reduction in breathlessness than the sham groups, whereas the IMT group had a 5-fold reduction. Both training groups reported a large Increase in inspiratory muscle strength/endurance, and lower limb strength compared with sham groups, and reported reduction in fatigue, but this did not reach significance. Only RMT group showed significant improvements in peak expiratory flow ($p < 0.001$). Improved Quality of Life was associated with improved respiratory muscle strength and endurance [23].

3.4. Breathing Techniques

Five articles reported on a variety of breathing techniques including: controlled breathing, pursed lip breathing, and diaphragmatic breathing [31,33,35,24,22]. These consistently reported improvement in quality of life metrics and functional capacity [33,35,24,22] reduced dyspnea [31,33,35,24] and in a comprehensive protocol that target multiple dimensions of dysfunctional breathing there was reduction of both signs and symptoms of dysfunctional breathing [24]. These findings suggest that structured breathing programs can improve both physical symptoms and quality of life. Controlled breathing methods such as diaphragmatic breathing and pursed-lip breathing were effective across delivery modes including telehealth [31,22].

A retrospective case series by Golan et al. (2023) described the delivery of Integrative Breathing Therapy (IBT) as 2–4 individual sessions and 6 group classes for patients seeking treatment for Long COVID symptoms. Patients reported being better able to manage symptoms and improvement in all outcome measures of dysfunctional breathing [24].

Okan et al. (2022) evaluated the effectiveness of breathing exercises in a RCT delivered via Telemedicine. The intervention group participants were prescribed 10 exercises each, 3 sessions every day for 5 weeks. Exercises included: respiratory control, pursed lip breathing and diaphragmatic breathing. Two-way variance analysis was used in repeated measurements-p1: Between-group comparison, p2: Intra-group comparison, p3: group × time interaction. Significant improvements in pulmonary functional tests, Quality of Life (St Georges Respiratory Questionnaire (SGRQ) p1<0.001, p2< 0.001, p3 <0.001), dyspnoea (mMRC p1 = 0.001, p2 = 0.001, p3 = 0.001) [31].

An observational prospective study by Dalbosco-Salas et al. (2022) measured significant improvement in physical capacity, quality of life (36 item Short Form Health Survey for Quality of Life (SF-36) p < 0.001), fatigue visual analogue scale (p < 0.001), and dyspnoea (mMRC p < 0.001) after a telehealth intervention. Sessions were delivered 2–3 time per week until 24 sessions had been completed. The program included a warm-up (5 min), breathing exercise (3 min), aerobic and/or strength exercises (20–30mins), and stretching (5 min) [22].

Pehlivan et al. (2022) investigated the effectiveness of a tele-rehabilitation exercise program. The program included participant education, paced running/walking, breathing exercises, range of motion exercise, and standing squats performed 3 sessions per week, for 6 weeks. There was significant improvement of dyspnoea (mMRC p = 0.035), Sit to Stand (p = 0.005), and HRQoL in SGRQ (p = 0.042) in the intervention group [33].

Sharma & Goswami, 2022 investigated a telehealth programme, 4 days per week of active cycle of breathing, cough etiquette, pursed lip and/or straw breathing. Improvement was shown in both dyspnea as measured by the Modified Borg Dyspnea Rating Scale (MBDR), p = 0.005 and fatigue as measured by visual analogue scale for fatigue (VAS-F), p = 0.01. Improvements in the control group also reached statistical significance for MBDR, p = 0.01 and for VAS-F, p = 0.03.

4. Discussion

This literature review evaluated the potential for breathing retraining and manual therapy treatments to alleviate symptoms and enhance functional capacity in patients with long COVID, while also providing insights to guide future research on integrative protocols that combine manual therapy with active patient involvement, such as breathing exercises, tailored to specific long COVID phenotypes.

Dyspnea, characterized by difficulty breathing, is a common symptom in long COVID and is often associated with exercise intolerance, fatigue and reduced quality of life. [12,37–39]. Emerging research highlights distinct phenotypes of dyspnea in long COVID, which may guide targeted rehabilitation strategies. Two primary phenotypes have been identified: one with pronounced fatigue despite normal pulmonary function tests and another with pronounced pulmonary abnormalities linked to reduced lung function metrics [40]. These phenotypes suggest differing underlying mechanisms, with fatigue-related dyspnea potentially stemming from systemic factors like mitochondrial dysfunction or dysautonomia while pulmonary-related dyspnea reflects structural or functional lung impairments [40,41].

Breathing rehabilitation has shown promise in improving dyspnea across these phenotypes. Interventions such as singing based protocols [20], respiratory muscle training [28,30], and diaphragmatic breathing exercises [31] and comprehensive protocols have targeted multiple dimensions of dysfunctional breathing [24] have all yielded benefits. The variable quality of research design across these interventions make it difficult to compare efficacy of specific methods of breathing training. Randomised controlled trials (RCTs) were only conducted for singing [34] and respiratory muscle training [23,27,28,30,31] and respiratory muscle training with the addition of manual therapy [30].

Improvements in dyspnea were often accompanied by improvements in respiratory parameters [28,30–32,24,26], fatigue and exercise capacity [23,27,28,30,32,33,20,22], general symptoms and quality of life scores [23,27,28,32–34,24,22] as well as for cognitive function and mental health [34,20]. Breathing training was often used in conjunction with therapeutic modalities used such mindfulness and relaxation [20], singing [34,20] physical exercise training [27,33,26,22] and manual therapy [30] and the combination of these modalities may have additional benefits. However, respiratory muscle training and breathing exercises were often used, as the only intervention so improvements in dyspnea, respiratory function, fatigue and other symptoms can be presumed to have occurred primarily as a result of the breathing training alone [23,28,31,32,35,24,36]. This suggests that breathing techniques are indicated for patients with dyspnea, respiratory dysfunction and fatigue as the primary symptoms and that further improvements might occur with the inclusion of other modalities.

The four studies that included manual therapy techniques varied in quality of study design and also in treatment aims. The single study that utilized an RCT design targeted respiratory function, comparing the effects of respiratory muscle training alone with the addition of diaphragm release. In this study it was demonstrated that the addition of manual therapy led to greater improvement of respiratory symptoms and diaphragm function suggesting that the combination of manual therapy with breathing retraining may have synergistic effects on the respiratory dysfunctions in long COVID [30]. This is supported by previous research showing that the combination of manual techniques with breathing retraining is feasible and led to improvement in multiple dimensions of dysfunctional breathing [9].

The other three studies on manual therapy which included a case study [29], case series [21,25] did not focus primarily on the respiratory system and instead focused on improving functional capacity by targeting the musculoskeletal system and motor function [21] or. central and peripheral lymphatic system function [25,29], dysautonomia and endothelial dysfunction [29].

Musculoskeletal phenotypes of long COVID are the most likely seek osteopathic treatment [42]. However, only one study identified in this review targeted the musculoskeletal system and the focus was on movement and motor control rather than pain. This study by Cevei et al. (2022) combined daily massage with rehabilitation techniques for motor control, balance and other physical functions [21]. The study also reported improvements in dyspnea, fatigue, exercise tolerance and functional capacity. A recent systematic review reported that rehabilitation interventions lessen disability in long COVID [43]. It's not clear from this study if addition of massage improved the effects of rehabilitation. Studies are currently in progress to specifically investigate how the addition of osteopathic manual therapies adds to treatment effects of rehabilitation [44].

The study by Heald, Perrin and colleagues [25], used massage and a range of osteopathic techniques plus patient home exercises and self-massage to specifically target the brains glymphatic system and peripheral lymphatic function to assist in clearance of neurotoxic substances proposed to be drivers of ME/CFS type symptoms in long COVID [5]. The patients in this study showed improvements in fatigue and other symptoms of long COVID similar to those found in ME/CFS [5]. Lymphatic techniques have long been used by osteopaths to enhance immunity and recovery from respiratory infection [45]. Recent research has shown that these traditional osteopathic manual techniques have significant effect on lymphatic circulation and immune function and inflammatory markers [17,45,46]. The results of this study suggest that treatments which are useful for enhancing lymphatic circulation might help long COVID patients with presentations similar to ME/CFS.

There are some similarities in the style of treatment and patient presentation reported in the Heald et al. (2022) study and the single case study by Monro (2022). In the case study the patient presented with fatigue, breathing difficulties, brain fog and other symptoms suggestive of ME/CFS type presentation. Dysautonomia, diaphragm dysfunction lymphatic and vascular dysfunction were targeted as symptoms drivers [29]. Similar to the Heald study, in addition to the manual therapy the patient was given advice about relaxation, pacing and other forms of self-care as well as breathing exercises.

Manual techniques aiming to improve immune function via the lymphatic system and cerebrospinal fluid flow through the glymphatic system might be assisted by the addition of breathing techniques. Breathing is a key extrinsic driver of lymphatic circulation [47]. CSF flow velocity through cerebral ventricles and basal cisterns is known to be increased with deep and slow breathing and CSF has been shown to move in synchrony with phase of respiration [48,49]. Thus there are valid reasons for including breathing exercises in home treatment regimens for patients in whom we wish to promote central and peripheral lymphatic circulation.

Breathing techniques combined with manual therapy might also have additive effects in improving regulation of the autonomic nervous system (ANS). Dysautonomia is common in long COVID and responsible for a broad range of symptoms including gastrointestinal symptoms and Postural Orthostatic Tachycardia Syndrome (POTS) [50]. While the effects of manual therapy on dysautonomia in long COVID has not to our knowledge been explored, manual therapies have been found to assist dysautonomia presenting in patients with functional gastrointestinal disorders and idiopathic POTS [51,52]. Breathing modulation using slow frequency breathing has been demonstrated to have significant impacts on ANS regulation and vagal tone [53]. Breathing retraining protocols that incorporate slow and diaphragmatic breathing have also been shown to assist patients with breathlessness, POTS and functional gastrointestinal disorders [54,55].

Osteopaths have traditionally focused on manual therapy as the primary treatment for most complaints, however its being argued that patient centered therapy should engage patients in their own self-care and focus less on fitting manual therapy to each condition regardless of symptoms mechanisms [18]. This review showed that successful outcomes for manual therapy treatments in long COVID have involved the patient in their own self-care either by providing instruction regarding breathing exercises, pacing, relaxation or lifestyle and stress management. It seems that osteopaths can best assist patient recovery in complex conditions such as long COVID treatments by providing quality information and support on phenotype specific rehabilitation and self-care strategies in addition to appropriate and individualised manual therapy.

Practitioners should remain aware that serious pathology can sometimes underlie patient symptoms in long COVID. For example, dyspnea can be due to pathology of the heart and the lungs and cardiac symptoms such as palpitations and chest pain require medical investigation [37]. If cardiac and lung pathology is excluded the patient should be assessed for dysfunctional breathing using specific breathing and cardiopulmonary examination and questionnaires [37]. In patients experiencing symptoms due to dysautonomia or other causative mechanisms, multidisciplinary approaches that build on existing evidence based treatments and rehabilitation strategies around Long COVID are advisable [37,56].

This current review identified a range of manual techniques and manual therapy approaches that appear to be feasible and worthy of further investigation. These include diaphragm release, massage and osteopathic manual therapy (OMT) for central and peripheral lymphatic circulation and dysautonomia. It seems feasible to use these in combination with respiratory training that focuses on diaphragm strengthening and correction of dysfunctional breathing well as breathing techniques to assist lymphatic circulation and dysautonomia [37]. It also seems advisable to recommend that patients be given guidelines and support to facilitate at home treatment and self-care. Clinical protocols that include these measures should firstly be evaluated in a pilot study to determine feasibility and efficacy.

The limitations of this review include the heterogeneity of study designs, which combined lower quality evidence, such as case studies, with higher quality experimental evidence such as randomised controlled trials (RCTs). Additionally, the small number of studies on manual therapy restricted the ability to fully assess its effectiveness and determine its optimal applications. While a larger number of studies focused on breathing retraining and active patient self-care or rehabilitation approaches, most failed to specifically identify or target distinct long COVID phenotypes that might be more responsive to these therapies. No formal quality assessment tool such as the ROBINS-1 or Cochrane RoB-2have been employed in this initial literature review. Most studies had short-term outcome assessments and did not include long-term follow-up periods because Long COVID was a novel virus, and long-term outcomes were not attainable. Likewise, the data on safety and adverse events of these initial interventions were not known.Additional limitations of this review include outcome measure heterogeneity of interventions which prevent a more systematic review of bias and a more rigorous methodology like meta-analysis.

Future research should begin with pilot studies to optimize phenotype targeted protocols combining multimodal therapies (e.g. manual therapy, breathing retraining) with structured patient self care components. These feasibility trials should inform the development of standardized, reproducible intervention packages which can be tested in randomised controlled trials.

5. Conclusion

Breathing retraining and manual therapy show promise in managing long COVID symptoms, particularly phenotypes that involve dyspnea, respiratory dysfunction and fatigue. Combining these approaches may synergistically address diaphragm dysfunction, lymphatic circulation, and dysautonomia. For musculoskeletal issues, further research is needed to evaluate the role of manual therapy in rehabilitation. Clinical protocols integrating multimodal interventions and patient self-care should be refined through pilot studies targeting specific phenotypes. High-quality research is then needed to compare intervention effectiveness and assess long-term outcomes.

CRediT authorship contribution statement

Rosalba Courtney: Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization. **Zoe Steele:** Writing – review & editing, Writing – original draft, Methodology. **Imogen Collyer:** Writing – review & editing, Writing – original draft, Formal analysis.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Davis HE, et al. Characterizing long COVID in an international cohort: 7 months of symptoms and their impact. eClinicalMedicine 2021;38:101019.
[2] Rivera-Izquierdo M, et al. Long COVID 12 months after discharge: persistent symptoms in patients hospitalised due to COVID-19 and patients hospitalised due to other causes—a multicentre cohort study. BMC Med 2022;20(1):1–10.
[3] Kenny G, et al. Long COVID: clinical characteristics, proposed pathogenesis and potential therapeutic targets. Front Mol Biosci 2023;10:262.
[4] Tate WP, et al. Towards a better understanding of the complexities of myalgic encephalomyelitis/chronic fatigue syndrome and long COVID. Int J Mol Sci 2023; 24(6):5124.
[5] Perrin R, et al. Into the looking glass: post-Viral syndrome post COVID-19. Med Hypotheses 2020;144:110055.
[6] Boulding R, et al. Dysfunctional breathing: a review of the literature and proposal for classification. Eur Respir Rev 2016;25(141):287–94.
[7] Courtney R. Integrative breathing therapy: perspectives on dysfunctional breathing in voice and upper airway disorders. Perspectives of the ASHA special interest groups 2025. https://doi.org/10.1016/j.jvoice.2023.04.024. Epub ahead of print. PMID: 37316403.
[8] Jones M, et al. Does manual therapy provide additional benefit to breathing retraining in the management of dysfunctional breathing? A randomised controlled trial. Disabil Rehabil 2015;37(9):763–70.

[9] Courtney R, et al. Improvements in multi-dimensional measures of dysfunctional breathing in asthma patients after a combined manual therapy and breathing retraining protocol: a case series report. Int J Osteopath Med 2019;31:36–43.
[10] Fernandez-Lopez I, et al. Effects of manual therapy on the diaphragm in the musculoskeletal system: a systematic review. Arch Phys Med Rehabil 2021;102 (12):2402–15.
[11] Motiejunaite J, et al. Hyperventilation: a possible explanation for long-lasting exercise intolerance in mild COVID-19 survivors? Front Physiol 2021;11.
[12] Frésard I, et al. Dysfunctional breathing diagnosed by cardiopulmonary exercise testing in 'long COVID' patients with persistent dyspnoea. BMJ Open Respiratory Research 2022;9(1):e001126.
[13] Peirce S, et al. A physiotherapy framework to managing long COVID: a clinical approach. Cardiopulm Phys Ther J 2025;36(1):19–29.
[14] Carnevali L, et al. Exploring the effects of osteopathic manipulative treatment on autonomic function through the lens of heart rate variability. Front Neurosci 2020; 14.
[15] Rechberger V, Biberschick M, Porthun J. Effectiveness of an osteopathic treatment on the autonomic nervous system: a systematic review of the literature. Eur J Med Res 2019;24(1). 36-36.
[16] Russo MA, Santarelli DM, O'Rourke D. The physiological effects of slow breathing in the healthy human. Breathe 2017;13(4):298–309.
[17] Schander A, et al. Lymphatic pump treatment repeatedly enhances the lymphatic and immune systems. Lymphatic Res Biol 2013;11(4):219–26.
[18] Thomson OP, MacMillan A. What's wrong with osteopathy? Int J Osteopath Med 2023;48:100659.
[19] Rhon DI, Deyle GD. Manual therapy: always a passive treatment? J Orthop Sports Phys Ther 2021;51(10):474–7.
[20] Cahalan RM, Meade C, Mockler S. SingStrong—A singing and breathing retraining intervention for respiratory and other common symptoms of long COVID: a pilot study. Can J Respir Ther: CJRT= Revue Canadienne de la Thérapie Respiratoire: RCTR 2022;58:20.
[21] Cevei M, et al. Rehabilitation of post-COVID-19 musculoskeletal sequelae in geriatric patients: a case series study. Int J Environ Res Publ Health 2022;19(22): 15350.
[22] Dalbosco-Salas M, et al. Effectiveness of a primary care telerehabilitation program for post-COVID-19 patients: a feasibility study. J Clin Med 2021;10(19):4428.
[23] Del Corral T, et al. Home-based respiratory muscle training on quality of life and exercise tolerance in long-term post-COVID-19: randomized controlled trial. Annals of physical and rehabilitation medicine 2023;66(1):101709.
[24] Golan H, Courtney R, Wolfberg J. Novel respiratory therapy for the improvement of post COVID condition symptoms: a case series. J Voice 2023. https://doi.org/10.1016/j.jvoice.2023.04.024. Epub ahead of print. PMID: 37316403.
[25] Heald AH, et al. Reducing fatigue-related symptoms in long COVID-19: a preliminary report of a lymphatic drainage intervention. Cardiovascular endocrinology & metabolism 2022;11(2).
[26] Hockele LF, et al. Pulmonary and functional rehabilitation improves functional capacity, pulmonary function and respiratory muscle strength in post COVID-19 patients: pilot clinical trial. Int J Environ Res Publ Health 2022;19(22):14899.
[27] Jimeno-Almazán A, et al. Effects of a concurrent training, respiratory muscle exercise, and self-management recommendations on recovery from post-COVID-19 conditions: the RECOVE trial. J Appl Physiol 2022;134:95–104.
[28] McNarry MA, et al. Inspiratory muscle training enhances recovery post COVID-19: a randomised controlled trial. Eur Respir J 2022;60(4):1–10.
[29] Monro M. A long COVID patient and their experience of osteopathic care: a case report. Int J Osteopath Med 2022;44:40–5.
[30] Nagy EN, et al. Influence of manual diaphragm release technique combined with inspiratory muscle training on selected persistent symptoms in men with post-Covid-19 syndrome: a randomized controlled trial. J Rehabil Med 2022;54. jrm00330-jrm00330.
[31] Okan F, Okan S, Duran Yücesoy F. Evaluating the efficiency of breathing exercises via telemedicine in Post-Covid-19 patients: randomized controlled study. Clin Nurs Res 2022;31(5):771–81.
[32] Palau P, et al. Effect of a home-based inspiratory muscle training programme on functional capacity in postdischarged patients with long COVID: the InsCOVID trial. BMJ Open Respiratory Research 2022;9(1):e001439.
[33] Pehlivan E, et al. The effectiveness of POST-DISCHARGE telerehabilitation practices in COVID-19 patients: tele-COVID study-randomized controlled trial. Ann Thorac Med 2022;17(2):110.
[34] Philip KEJ, et al. An online breathing and wellbeing programme (ENO breathe) for people with persistent symptoms following COVID-19: a parallel-group, single-blind, randomised controlled trial. Lancet Respir Med 2022;10(9):851–62.
[35] Sharma P, Goswami SK. Pulmonary tele-rehabilitation in patients (post Covid-19) with respiratory complications: a randomized controlled trial. Indian Journal of Physiotherapy & Occupational Therapy Print- 2022;16(2):182–9 (ISSN 0973-5666) and Electronic–(ISSN 0973-5674).
[36] Shelley J, et al. Perceptions of inspiratory muscle training in adults recovering from COVID-19. PLoS One 2022;17(11):e0270620.
[37] Evans R, et al. Breathing difficulties after covid-19: a guide for primary care. Br Med J 2023;381:e074937.
[38] Farr E, et al. Diaphragm dysfunction in severe COVID-19 as determined by neuromuscular ultrasound. Annals of clinical and translational neurology 2021;8 (8):1745–9.
[39] Deo PP, et al. Sonographic diaphragm dysfunction is an unexpectedly frequent feature of long COVID with non-specific dyspnea and fatigue. medRxiv 2022.
[40] Smith MP, et al. Factors associated with phenotypes of dyspnea in post-COVID-19 condition: a cross-sectional study. Sci Rep 2024;14(1):13387.
[41] Koleničová V, et al. A review article on exercise intolerance in long COVID: unmasking the causes and optimizing treatment strategies. Med Sci Monit 2023;29: e941079.
[42] Orrock PJ. Profile of members of the Australian osteopathic association: part 2 – the patients. Int J Osteopath Med 2009;12(4):128–39.
[43] Fugazzaro S, et al. Rehabilitation interventions for post-acute COVID-19 syndrome: a systematic review. Int J Environ Res Publ Health 2022;19(9):5185.
[44] Curi ACC, et al. Osteopathy and physiotherapy compared to physiotherapy alone on fatigue in long COVID: study protocol for a pragmatic randomized controlled superiority trial. Int J Osteopath Med 2022;44:22–8.
[45] Chikly B. Manual techniques addressing the lymphatic system:origins and development. J Am Osteopath Assoc 2005;105(10):457–64.
[46] Knott E, et al. Increased lymphatic flow in the thoracic duct during manipulative intervention. J Am Osteopath Assoc 2005;105(10):447–56.
[47] Bordoni B, Zanier E. Anatomic connections of the diaphragm: influence of respiration on the body system. J Multidiscip Healthc 2013;6:281–91.
[48] Yildiz S, et al. Quantifying the influence of respiration and cardiac pulsations on cerebrospinal fluid dynamics using real-time phase-contrast MRI. J Magn Reson Imag 2017;46(2):431–9.
[49] Chen L, et al. Dynamics of respiratory and cardiac CSF motion revealed with real-time simultaneous multi-slice EPI velocity phase contrast imaging. Neuroimage 2015;122:281–7.
[50] Barizien N, et al. Clinical characterization of dysautonomia in long COVID-19 patients. Nature Scientific Reports 2021;11(14042).
[51] Cromeens B, Gamber R. Osteopathic manipulative treatment in a patient with idiopathic dysautonomia: a case presentation. Osteopathic Family Physician 2010; 2(5):144–7.
[52] Goodkin MB, Bellew LJ. Osteopathic manipulative treatment for postural orthostatic tachycardia syndrome. J Osteopath Med 2014;114(11):874–7.
[53] Bernardi L, et al. Modulatory effects of respiration. Auton Neurosci 2001;90(1–2): 47–56.
[54] Reilly CC, et al. Breathlessness and dysfunctional breathing in patients with postural orthostatic tachycardia syndrome (POTS): the impact of a physiotherapy intervention. Auton Neurosci 2020;223:102601.
[55] Eherer AJ, et al. Positive effect of abdominal breathing exercise on gastroesophageal reflux disease: a randomized, controlled study. Am J Gastroenterol 2012;107(3):372–8.
[56] Davis HE, et al. Long COVID: major findings, mechanisms and recommendations. Nat Rev Microbiol 2023:1–14.