REVIEW ARTICLE

Resistance Exercise for Patients with COPD: A Systematic Review of Existing Literature

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Abstract

Chronic obstructive pulmonary disease (COPD) has not only been the third leading cause of death worldwide, but also causes a very high morbidity rate while treatment strategies are applied under the theme of prescribed practices according to its research and innovation. Accordingly, a systematic review was conducted to determine the effectiveness of various resistance trainings in patients with COPD. Cochrane, PeDro, Embase, CINAHL, PubMed, and Google Scholar databases were searched for relevant research articles. After screening, 9 articles including 8 RCTs and 1 phase were included in the review according to the criteria. The characteristics and findings of all studies were tabulated and assessed for risk of bias using the Cochrane risk of bias checklist.

Keywords: *COPD, FEV1, Exercise capacity, Functional capacity, Health status, Quality of life, Resistance, Strength training.*

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Introduction

Chronic obstructive pulmonary disease accounts for 251 million cases annually worldwide and has been graded as the third highest claimant of lives and cause of disability after cardiovascular disease and cancer[1-2]. The World Health Organization (WHO) estimates that up to 90% of global mortality rates are attributable to COPD, which is more common in low socioeconomic developing countries[3]. In addition to this, 13.5% of the population in Asia is affected by COPD, particularly in Pakistan, where every tenth person has been found suffering from COPD[4]. Additionally, COPD has become a challenge for 21st-century clinicians regarding its immediate and rehabilitative management [5].

According to National Institute for Health and Care Excellence (NICE) recommendations, patients over 35 years with a history of smoking and symptoms such as exerted breathing, chronic cough with productive secretions/ sputum, adventitious wheezing sounds, and decreased tolerance to exercise are at risk of developing COPD[6]. Consequently, exacerbations or co-morbidities, as well as the significant financial burden brought on by hospitalizations, time away from work, and disability, all contribute to the severity of the patients' conditions[7]. These reports, published by NICE, also correspond with the financial and economic burden for COPD management, including hospital admission, medication, and supplies, excluding the financial losses due to absenteeism and less work productivity. This cost ranges from $1544 to $2335 in Asian countries annually[8]. Specifically in Pakistan, this expense has been reported up to 27,023 USD per year[9]. A wide range of drug-based and non-drug-based treatments are readily accessible for COPD patients; however, studies suggest that a multidisciplinary treatment care program consisting of multiple aspects of care for COPD patients is effective[10]. NICE guidelines, on the other hand, have designated pulmonary rehabilitation as the cornerstone in the management of COPD, and stressed upon the inculcation of pulmonary rehabilitation program as mandatory for all individuals with COPD, including even those who have recently experienced an acute episode of hospitalization[6]. Despite this, a pulmonary rehabilitation program that includes a customized and structured exercise program, regimes, and self-care skills has improved symptoms of COPD and its manifestations along with tolerance of exercise performance, reducing resource costs associated with rehospitalization and duration of stay[11]. According to the literature, resistance training improves muscle strength more than endurance exercise, causing less dyspnea while performing activities[11]. As a result, "resistance exercise" is more tolerable than "endurance exercise". According to the literature, combining the "resistance" and "endurance training" protocol resulted in a substantial betterment in pulmonary parameters[12]

Methodology

The "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" guidelines were observed during the systematic review.

Criteria for Eligibility of Studies

All studies evaluating the impact of "resistive exercise training" on "functional exercise capacity", "health related quality of life", and respiratory functionality in people with chronic obstructive pulmonary disease were included in the review, considering they adhered to the eligibility criteria. "Resistance training", "anaerobic exercise", "pulmonary function", "FEV1", "FVC", "minute ventilation", and "functional capacity" were all searched for in the research articles included in the review. The entirety of the articles was published in English. On the contrary, all the studies published in languages other than English were not included. Studies with unspecified outcome measures or interventions were excluded. Similarly, all the conference papers, editorials and other letters or theses were not included.

Sources of Information and Strategy of Search

To find studies evaluating the impact of resistance training on patients with COPD's "respiratory function", "health-related quality of life", and "exercise capacity", an electronic search was conducted in "Cochrane", "PeDro", "Embase", "CINHAL", "PubMed", and "Google Scholar". At first, all studies that met the criteria for inclusion and were published between 2015 and 2020 were included in the review; however, because there were not enough studies that fit the subject's predetermined publication period, studies from 2010 to 2020 were also considered.

Studies Selection

Electronically selected experimental studies were used to conduct systematic reviews with COPD patients as the target population. These researchers used "resistance training" using elastic bands, their tubes, hamburgers, weights, in addition to the supplementary kind of resistance compared to "aerobic" or "endurance" exercises that had been administered separately or in conjunction with "resistance training". Variables encompassed "lung function", "physical activity level", "aerobic capacity" and overall wellness and health status. A "quasi-experimental study" was also incorporated because there was a dearth of pertinent literature on the subject in accordance with selection criteria, even though randomized controlled trials were preferred.

Data Items and Collection Procedures

Two authors reviewed each article to check if the heading and text theme of the opted study met selection criteria. Successively, characteristic information was taken from the chosen research articles and organized into a standardized table with each of the first author's name and the year in which the study was published, the total of participants recruited entirely as a sample and the number of participants randomized to the experimental and control groups, according to the "mode", "duration", and "frequency of the intervention", the "outcome measures", and the "results", as shown in Table-1.

Criteria for Assessment of Bias

Using "Cochrane standard checklist", the risk of bias was assessed across studies by taking into account five domains, including random generation of sequence, allocation concealment in to

the groups, participants' and outcome assessors' blinding, and reporting bias. For each of the aforementioned categories, each study was rated as low, moderate or high risk of bias.

Results

Flow of included studies

Initially, our electronic search strategy yielded a sizable 17,400 articles for review. We conducted a thorough screening process to ensure the selection of relevant and high-quality studies. We evaluated factors such as the availability of full-text articles, the presence of duplicate publications, the language of publication, and the alignment of the content with our research topic and publication dates during this screening. We found 642 studies that met our inclusion criteria using this method. We identified and retained 9 studies that met our inclusion criteria as a result of this meticulous full-text screening. These criteria were created specifically to include "randomized controlled trials" and "quasi-experimental studies" that investigated at the effectiveness of resistive exercise interventions for individuals with COPD, particularly in comparison to "aerobic exercise" regimens.

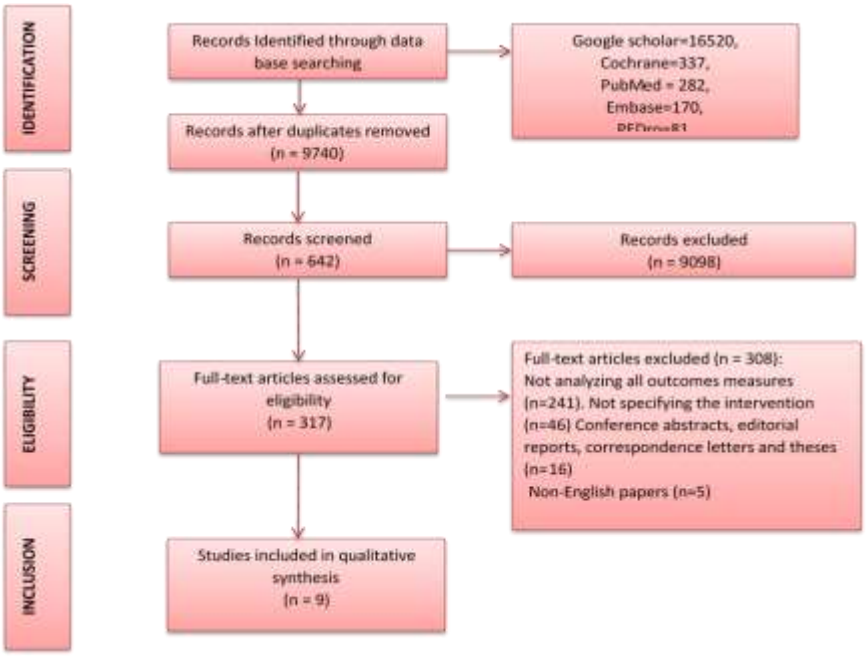

Figure-1 showing flow of studies

Table-1 Characteristics of research articles included in systematics review

S. No	Author	Group	n	Target Population	Study Design	Intervention	Outcome Measures	Results	p-Value
1	Edvardsen 2014 [13]	Training	30	COPD	RCT	High-intensity endurance and strength training that lasts 60 minutes and is done three times per week for 20 weeks.	FEV1, TLCo, and PO Uptake in Minutes	PO Uptake and TLCo showed significant results, but FEV1 and MVV did not.	0.002, 0.007 0.738, 0.064 resp.
		Control	31			No intervention			
2	Pothirat 2015[1]	Experimental	30	COPD	Quasi	8 weeks of incremental strength and endurance with two 35-40 minute sessions per week	Pulmonary Function Testing	There were no significant changes in lung function.	>0.05
3	Zambom-Ferraresi 2015[14]	Combined Training	14	COPD	RCT	1 day/week, resistance 1 day/week endurance training Total duration of 12 weeks	PFT, MIP, MEP, Muscle Strength, BODE index, Functional Capacity,	non- significant	>0.05
		Resistance Training	14			2 days/week resistance training Total duration of 12 weeks			
		Control	8			No intervention		Significant.	< 0.05
4	Vonbank 2012 [15]	Endurance Training	12	COPD	RCT	ergometer cycle twice a week total duration 60 minutes at intensity of 60% MHR	Cardiopulmonary exercise testing FEV1 and FEV1/FVC	Not significant	>0.05
		Progressive Ttrength Training	12			Leg press, bench press, and bench pull should be performed twice a week, with 8-15 repetitions per set.			
		Combination	12			Combination of both aforementioned			
5	Tarigan 2019 [16]	Intervention	22	COPD	Quasi	combined training of resistance and endurance	Clinical Impact (CAT), Functional Capacity (6 MWT)	significant	<0.05
6	Freire 2020[17]	Elastic Resistance band	48	COPD	RCT	Elastic resistance band upper and lower limb exercise / 12 weeks	Dynamometry, CAT, 6MWT,	Non-significant	>0.05

		Elastic tube Conventional Resistance				Elastic tubing using lemgruber weight machine equipment			
7	**Rodrigues 2019** [18]	COPD ACO	74	COPD+ COPD with asthma overlap	RCT	high intensity ET for 3days/week, 3 months,36 sessions	Spirometry, 6 minute walk test bioelectrical impedance, SGRQ, LCADL	Significant improvement in SRGQ, PF, 6 MWT. In significant in between the group analysis	Pre-post <0.05 ,
8	**Silva 2019**[19]	Conventional Resitance Training (GCT)	10	COPD	RCT	RESITANCE EXERCISE USING CONVENTIONAL WEIGHT MACHINE WTH THE INTENSITY OF FOR 12 WEEKS WITH 3DAYS/WEEK DURATIONS 60 MINUTES	Pulmonary function (FEV1, FVC, FEV1/FVC) and Peak Expiratory Flow (PEF)	non-Significant for Pulmonary Function Values	p > 0.05
		Elastic tubing (GET)	9			RESISITANCE EXERCISE WITH ELASTIC TUBE WTH INTENSITY FOR 12 WEEKS WITH 3DAYS/WEEK DURATIONS 60 MINUTES		Significant for Peak Expiratory Flow	p < 0.05
9	**Silva 2018**[20]	Control-Group	25 .	COPD.	RCT	Stretching exercises succeeded by a session of warm-up, aerobic exercise, inspiratory muscle training massage therapy	Muscle strength MIP, MEP, upper-limb strength, Functional exercise capacity, Dyspnea, Health-related quality of life	Significant	P < 0.05
		Treatment-Group	26 .			Stretching exercises, 3 sets of upper limb resistance exercises, Aerobic warm-up, and massage therapy are the next steps.			

Qualitative Analysis

In six of the nine studies, "The qualitative analysis revealed that the resistance exercise program had a substantial effect on functional exercise capacity. Except for a single research investigation that showed a significant improvement in the experimental groups total lung capacity (p value 0.05), however, none of the studies included in this review showed a substantial improvement in the lung function as consequence to resistance exercise. The aforementioned article also represents the outcomes of PO uptake in the index group. Likewise, Silva BSA et al. found that

the Elastic tubing group improved significantly more than the conventional resistance training group in terms of peak expiratory flow. Further, three studies advocated for a significant improvement in the status on either the SGRQ or the BODE index.

Risk of Bias Assessment

Cochrane's standardized checklist for risk of bias was used to assess all 9 studies taken into account in the systematic review. The result included evaluating “randomly generated sequence”, “concealing participants”, “group allocation”, “blinding of personnel”, “outcome assessors”, and additionally “selective data reporting” among the articles on the authors' verdict as shown in the Table-2.

Table-2 Authors' assessment of the risk of bias in the studies

S.no.	Author.	Selection Bias.		Performance Bias.	Attrition Bias.	Reporting Bias.
		Random Sequence generation	Allocation Concealment	Blinding of Participant.	Blinding of Outcome Assessment.	Selective Reporting.
1	Edvardsen	X	✓	✓	X	X
2	Pothirat	X	X	✓	X	X
3	Zambom-Ferraresi	✓	✓	?	X	X
4	Vonbank	✓	✓	?	X	X
5	Tarigan	X	X	X	?	✓
6	Freire	✓	✓	X	X	✓
7	Rodrigues	X	X	X	✓	✓
8	Silva	✓	✓	✓	X	✓
9	Silva e Silva	✓	✓	?	?	✕

Discussion

A modest risk of bias was identified when the consistency of the study was examined across all of the studies. The risk of bias was evaluated using the Cochrane checklist, which includes selective reporting, blinding of subjects, allocation concealment, and randomized sequence generation. Ultimately, 17400 articles were retrieved, which were first reduced to 642 and then,

after the full-text screening, increased to 9 articles on resistance training for treating COPD. The chosen studies by various authors examined different facets of resistive exercise training for COPD patients. Numerous studies have shown significant improvements in elements like Minute Ventilation, TLCo, and PO uptake. FEV1 and FVC measurements of overall pulmonary function did not significantly improve. After strength and endurance training, Pothirat C 2015 found no appreciable changes in lung function. Pulmonary function measurements from Zambom-Ferraresi F 2015's combined training produced non-significant results. Despite doing endurance and strength training, Vonbank K. (2012) found no discernible changes in pulmonary function. Tarigan AP 2019 significantly improved Clinical Impact and Functional Capacity with combined resistance and endurance training. Exercises using elastic resistance bands did not significantly improve performance, according to Freire APCF 2020.Indeed, three of the included studies showed a statistically significant improvement in health-related quality of life. The BODE index or the St. George Respiratory Questionnaire were used to assess this improvement. It is worth noting, however, that this specific outcome measure was not included in the meta-analysis[21]. Surprisingly, Iepsen et al.'s study found only minor effects of "resistance training" on participants' quality of life. Additional, parameters and measurements, in addition to "quality of life", were reported in the included studies. "Mean inspiratory" and "expiratory pressures", "maximum heart rate", "clinical significance", "muscle strength", and "bioelectrical impedance" were among them[22]. In addition to this, several gaps were identified among the indexed studies. For instance, Fieire et al. 2020, enrolled participants from grade I to grade IV of COPD, which, despite all the efforts of randomization, are potentially much different from each other in terms of severity and characteristic features and response in exercise. Moreover, this study lacks pulmonary function as an outcome measure that, despite being a gold standard outcome measure, also plays a vital role in demonstrating the prognostic aspects of the study. In contrast, a similar study conducted by Santos et al. 2021 incorporated participants only from COPD grade II to grade IV and found a significant difference in the outcomes between the groups[23]. Similarly, Nyberg et al. 2021 studied the impact of resistance training on grades I and II of COPD, and their findings also demonstrated significant improvements [24]. This deficiency has also been evident in the indexed study conducted by Silva et al. 2019; which included 28 COPD patients irrespective of the GOLD staging, and in line with Fieire et al. 2020, their results also showed statistically non-significant improvement or difference[20,26].

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Conflict of Interest
None.

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None.

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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design: Hashmi A

Acquisition, Analysis or Interpretation of Data: Hashmi A, Kumar S, Faisal Muhammad, Javeria H

Manuscript Writing & Approval: Hashmi A, Rajar H, Ali S

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.