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Interventions to improve daily activity in individuals with COPD and CHF: A systematic review

Michael J. Shoemaker*, Brian Keenoy, Brad Smith, Patrick Slotman

Department of Physical Therapy, Grand Valley State University, Grand Rapids, USA
Email: *shoemami@gvsu.edu

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ABSTRACT

Introduction: The purpose was to systematically review the literature regarding interventions to improve daily activity in individuals with chronic obstructive pulmonary disease (COPD) and chronic heart failure (CHF). Methods: Articles found by searching CINAHL Plus Full-Text, PubMed, and PsycINFO databases were included in the review if the study examined the effect of exercise- and/or psychosocial-based interventions on daily activity in individuals with COPD or CHF. Article selection, data extraction, and evaluation of methodological rigor and quality were performed by two independent reviewers. Nine articles for COPD and seven articles for CHF met the inclusion criteria and were used in this review. Results: Only four of nine studies in COPD and two of seven studies in CHF resulted in improvement in daily activity, and of those, all but one study included a psychosocial-based intervention. Improvements in daily activity did not occur concurrently with changes in other outcomes such as exercise performance, quality of life, functional status, or anxiety/depression in COPD or CHF. Conclusions: Exercise-based interventions serve a limited, if any, role in improving daily activity in individuals with COPD and CHF. Disrupting the cycle of inactivity and deconditioning requires more than just addressing the deconditioning aspect of this cycle. Psychosocial-based interventions are a promising, but under-investigated, intervention.

Keywords: Heart Failure; Chronic Obstructive Pulmonary Disease; Daily Activity

1. INTRODUCTION

Daily activity is associated with a variety of health outcomes in patients with chronic obstructive pulmonary disease (COPD) and chronic heart failure (CHF), including life expectancy and mortality [1-7]. However, rehabilitative interventions for improving daily activity have not been well-studied. Very low levels of physical activity measured by activity questionnaires are associated with hospitalization due to exacerbation [2,3] and mortality in patients with COPD [2]. Objective measurement of daily activity with accelerometry in patients with COPD reaffirmed this finding; daily activity was an independent prognostic factor for mortality and hospitalization [4]. Similarly, in patients with CHF, low daily activity as measured by accelerometry is associated with lower survival and mortality [5-7]. It is therefore important to understand which interventions are effective for improving daily activity.

Although COPD and CHF have very distinct pathophysiologic mechanisms, both result in exercise intolerance and similar physically-limiting symptoms such as breathlessness and fatigue that lead to activity avoidance and a subsequent cycle of inactivity and deconditioning [8-12].

Chronic obstructive pulmonary disease is characterized by progressive airflow obstruction caused by a loss of elastic recoil and airway narrowing that is not fully reversible in response to bronchodilators [13]. Many individuals with COPD are inactive in daily life, most likely as a strategy to minimize dyspnea [14]. The mechanisms for dyspnea and exercise intolerance are multifactorial and include increased resistance to airflow (especially during expiration) [15], impaired gas exchange resulting in hypoxemia and hypercapnia [15], dynamic hyperinflation [16], inspiratory muscle weakness, and skeletal muscle dysfunction [17].

Chronic heart failure is a syndrome of cardiac dysfunction characterized by insufficient cardiac output [15], resulting in limited exercise performance, abnormal ventilatory response, impaired ventilatory muscle strength, and low perfusion of skeletal muscles with subsequent

*Corresponding author.

skeletal muscle dysfunction [8]. The symptoms that result from these various mechanisms of exercise intolerance lead to activity restriction and further functional deterioration [9].

Although the exertional symptoms associated with limited exercise tolerance may appear to account for inactivity in individuals with COPD and CHF, psychosocial factors such as depression and self-efficacy have also been demonstrated to be significant determinants of participation in daily activities [18,19]. On average, individuals with chronic diseases are 1.5 - 2.0 times more likely to be depressed [20]. Prevalence of major depression in individuals with COPD and CHF have been reported to be as high as 42% and 20%, respectively [21,22]. Although decreased activity is most pronounced in older patients with significant depression, individuals with less severe depression are also at risk for decline in daily activity [23]. The Longitudinal Aging Study Amsterdam found that respondents with emerging depression were more likely to transition to a sedentary lifestyle [24].

Self-efficacy, defined as an individual's beliefs about his or her ability to exercise control over events that affect his or her life [25], is another potentially significant determinant of daily activity. Oka *et al*. [26] found that self-efficacy is a stronger predictor of daily physical activity in individuals with CHF than physical fitness measures or RPE. In individuals with COPD, Arnold *et al*. [27] found greater self-efficacy in those reporting better physical functioning. Specifically with regard to walking, lower walking self-efficacy as measured by the Self-Efficacy Questionnaire-Walking is associated with a decrease in physical activity in individuals with CHF [28], and self-efficacy is associated with objective physical performance measures such as the six-minute walk test (6MWT) in individuals with COPD [29].

Rehabilitative interventions for improving daily activity have not been well-studied. Ng *et al*. [30] systematically reviewed the effect of exercise training on daily activity in individuals with COPD. They found a small effect of exercise training on daily activity based on two randomized trials and five cohort studies. Unfortunately, their review only examined exercise interventions and did not account for other confounding determinants of daily activity. No prior systematic reviews have been conducted to examine interventions for improving daily activity of individuals with CHF, but three studies have failed to demonstrate improvement in daily activity despite improvements in exercise tolerance following exercise training [31-33]. Given that exercise-based intervenetions may not result in substantial changes in daily activity, other interventions that address impairments in psychosocial domains may be more appropriate for improving daily activity [34]. No prior systematic review has addressed non-exercise based interventions for low daily activity in individuals with COPD or CHF.

In summary, COPD and CHF result in a cycle of inactivity and deconditioning due to the symptoms of fatigue and breathlessness associated with exercise intolerance. As daily activity decreases, the risk of adverse health outcomes increases. Furthermore, psychosocial factors may substantially confound this cycle of inactivity and deconditioning such that interventions for improving daily activity may need to account for these additional factors, especially given that exercise-based intervenetions may have a minimal effect. Therefore, the purpose of the present systematic review is to consider and examine a broader range of interventions that are used to improve daily activity in individuals with COPD and CHF.

2. METHODS

2.1. Literature Search

The literature search was conducted by searching within the article text using CINAHL Plus Full-Text (Ebsco), PubMed, and PscyINFO databases on July 31, 2012. The topics of "heart failure" and "COPD" were each searched individually in conjunction with the following keywords: "daily activity", "daily activities", "physical activity", "physical activities", and "energy expenditure".

2.2. Study Selection Criteria

Studies were included if physical- or psychosocial-based interventions were used and if a change in daily activity was assessed after the intervention period had concluded. Only peer-reviewed studies were included in the review and no limitations were imposed regarding year of publication. Studies were excluded if no full text was available or if the article was not published in the English language. To limit selection bias, two authors (BK and BS) independently searched databases and individually selected studies based on inclusion and exclusion criteria. Differences in study selection were discussed with a third author and fourth author (MS and PS), and a consensus was reached by the authors if opinions varied.

2.3. Level of Evidence

Strength of evidence for each study was appraised using levels of evidence as described by Strauss *et al*. [35]. The levels of evidence are ranked 1 to 5, with 1 being the highest level of evidence. Each study was independently assessed by the authors (BK and BS). If level of evidence ratings varied by author, differences were discussed with a third author and fourth author (MS and PS) and a consensus was reached. Articles rated 1b (randomized trial), 2b (cohort study), 3b (individual case control study) and

4 (low quality case control study) were included in this review.

2.4. Methodological Rigor

The methodological quality of studies included was assessed using the Medlicott and Harris [36] scale for methodological rigor. Methodological rigor was rated as follows: "Strong" 71% to 100%, "Moderate" 60% to 70%, and "Weak" 59% or less. Percentages were calculated by dividing the amount of criterion "met" by the total amount of criterion possible that could be "met" for that particular article. Randomized controlled trials with "weak" methodological rigor were given a level of evidence designation "2b." Methodological rigor was independently assessed by the authors (BK and BS). Differences in study selection were discussed with a third author and fourth author (MS and PS) and a consensus was reached by the authors if opinions varied.

3. RESULTS

3.1. Heart Failure

3.1.1. Literature Search

Three hundred and sixteen unique articles were found using the search strategy previously outlined. The most frequent reasons for exclusion were heterogeneous populations, no measure of daily activity, or a lack of a physical or psychosocial intervention. Ultimately, seven studies [37-43] met the inclusion criteria for this review. The results of the search strategy are outlined in **Figure 1**. Included studies were then analyzed for their methods, outcome measures, level of evidence, and methodological rigor. **Tables 1** and **2** summarize the methodological rigor and extracted data of the included studies.

3.1.2. Levels of Evidence

All seven studies [37-43] were Level 1b based on being randomized in design and having a methodological rigor score greater than or equal to 60%.

3.1.3. Methodological Rigor

Methodological rigor scores ranged from 70% to 90% and are summarized in **Table 1**. Five articles [38,40-43] were rated as "strong" ("yes" percentage from 75 - 100), two [37,39] were judged to be "moderate" ("yes" percentage from 50 - 74), and none were determined to be "weak" ("yes" percentage from 0 - 49). The most notable deficiencies in rigor were related to randomization, blinding, and long term follow-up.

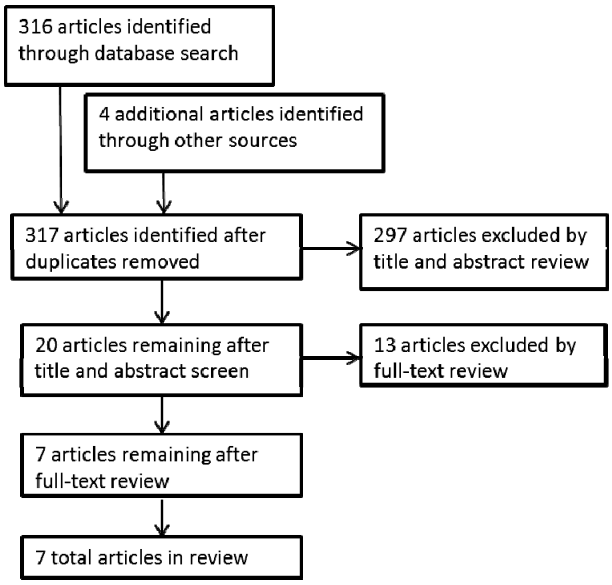

Figure 1. Search results for chronic heart failure.

Table 1. Methodological rigor of included studies in individuals with chronic heart failure.

Author	Randomized	Inclusion/Exclusion Criteria	Group Similarity at Baseline	Replicable	Reliable	Valid	Blinding	Dropouts Reported	Long-Term Results	Adherence	Score as Percentage	Level of Evidence
Gottlieb *et al.* 1990	Y	Y	Y	Y	Y	Y	N	Y	N	Y	80%	1b
Willenheimer *et al.* 2001	Y	Y	Y	Y	N	N	Y	Y	Y	Y	80%	1b
Van den Berg-Emons *et al.* 2004	Y	Y	Y	Y	Y	Y	Y	N	N	Y	80%	1b
Brodie *et al.* 2005	Y	Y	Y	Y	Y	Y	N	Y	N	N	70%	1b
Witham *et al.* 2005	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	90%	1b
Mueller *et al.* 2007	Y	N	Y	Y	Y	Y	N	Y	Y	N	70%	2b
Witham *et al.* 2012	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	90%	1b

Y = yes; N = no.

Table 2. Extracted data for studies in individuals with chronic heart failure.

Study, Level of Evidence, and Rigor	Subjects	Interventions	OUTCOMES	
			Measure of Daily activity	Other
Gottlieb *et al.*	Treatment: N:11	Visits 3x/week for 6 months	***Hip accelerometer* (*kcal/d*)** Treatment + Crossover No Δ 286(149)→361(224)	***Exercise Performance*:** **6*MWT* (*m*)** Treatment 395(49) ↑ by 50(59)*†
1999	M/F: 11/0 Ages: 67(7)	Intensity Increased per patient tolerance using Borg Scale 12 to 13	Control No Δ reported	Control No Δ 410(39) ↓ by 19(41)
RCT	LVEF(%): 22(8) NYHC: II: 5 III:6	Type: UE/LE ergometer and treadmill walking. Progressed to 15 min on bike and 30 min on treadmill	***Doubly labeled water* (*kcal/d*)** Treatment + Crossover No Δ 386(357)→ 273(133)	***Peak VO2* (*mL/kg/min*)** Treatment + Crossover ↑ 15(3)→17(3)*† Control No Δ
Level 1b			Control No Δ reported	
M&HR 80%	Control: N:14 M/F: 11/3 Ages: 64(10) LVEF(%): 25(10) NYHC: II: 4 III: 10	Control Group Usual care unspecified		***Functional Status*:** ***Functional Status Assessment, SF*-36** No Δ in either group
	Crossover: N:5 No characteristics reported for cross-over group			***Quality of Life*:** ***MLHFQ*** No Δ in either group
				Anxiety/Depression*:** ***CES-D No Δ in either group
Willenheimer *et al.*	Treatment N:17 Age: 64(5)	Visits 15 minutes, 2x/wk for first 6 weeks, followed by 45 minutes sessions 3x/wk for 11 weeks (total of 17 weeks), follow-up at 10 months	***Habitual Physical Activity Journal* (*units*)** Training Group: No Δ 70(97)→60(85)→48(41)	***Exercise Performance*:** ***Peak VO2* (*mL/kg/min*)** Treatment No Δ 16.2(3.2)→17.3(4.4)
2001	M/F: 12/5 LVEF: 35(12)		Control Group: No Δ 71(68)→42(55)→32(41)	Control No Δ 16.1(3.3)→16.6(3.6)
RCT	NYHC: 2.1(.7)			***Quality of Life*:** ***Patient Global Assessment of Change in Quality of Life***
Level 1b	Control N:20	Intensity HR corresponding to 80% VO2 max		Training Group: ↑ 0(0)→1.3(1.3)→0.7(0.9)*†
M&HR 80%	Age: 64(8) M/F: 14/6 LVEF: 38(10) NYHC: 2.4(0.7)	Type: Cycle ergometer interval training for 90 seconds followed by 30 second rest		Control Group: No Δ 0(0)→0.4(1.4)→0.0(1.0)
		Control Group Unspecified		
Van den Berg-Emons *et al.*	Treatment N:18 Age: 58.6(12.1) M/F: 12/6	Visits 1 hour, 2x/wk for 3 mos Intensity Target HR 60% of HR Reserve	***Four uni-axial accelerometers*** No statistically significant changes were noted when comparing: duration of dynamic activities, body motility, motility during walking, # of transitions, walking periods >10s, walking periods >5s	***Exercise Performance*:** **6*MWT* (*m*)** Treatment ↑ 455(71)→501(96)*
2004	LVEF(%):24(9) NYHC:			Control ↑ 435(77)→448(84)*
RCT	II: 10 III: 8	Type Cycle ergometer, walking, and games in addition to standard care		***Peak VO2* (*mL/kg/min*)** Treatment ↑ 16.6(4.2)→17.8(4.0)*
Level 1b				Control No Δ 16.1(3.8)→15.8(2.9)
M&HR 80%	Control N:16 Age: 58.6 (10.6) M/F: 13/3 LVEF(%): 27.6(6.0) NYHA class II: 10 III: 6	Control Group Standard medical care		***Extensor Peak Torque* (*Nm/kg*)** Treatment ↑ 0.78(0.29)→0.88(0.32)* Control No Δ 0.74(0.20)→0.73(0.21)

Continued

Brodie *et al.* **2005** **RCT** **Level 1b** **M&HR 70%**	Treatment Alone N:22 M/F: NR Ages: 78(6.1) LVEF(%): 31.0(8.5) NYHC: NR Standard Care N:18 M/F: NR Ages: 76(6.4) LVEF(%): 27.7(5.8) NYHC: NR Combined Treatment/Standard Care N:20 M/F: NR Ages: 79(6.9) LVEF(%): 31.3(5.9) NYHC: NR	Visits 8, 1-hr sessions over 5 months Type Treatment: Motivational interviewing technique to decrease ambivalence to physical activity Standard Care: Advised in structured exercise program including information on local options/opportunities.	***Leisure-time physical activity questionnaire and a* 3-*day physical activity diary*** Treatment Alone Energy Expenditure (kcal/kg/day): ↑ 6.6(2.6)→9(3.3)*ǂ Standard Care Energy Expenditure (kcal/kg/day): No Δ 9.7(4.5)→9.6(4.3) Combined Treatment/Standard Care Energy Expenditure (kcal/kg/day): ↑ 8.3(2.5)→10.5(4.4)*ǂ	***Exercise Performance*:** **6*MWT* (*m*)** Treatment Alone ↑ 97.2(85.4)→119.3(95.7)* Standard Care ↑ 157(100)→181(116.2)* Combined Treatment/Standard Care ↑ 89.5(73.4)→109.5(71.4)*
Witham *et al.* **2005** **RCT** **Level 1b** **M&HR 90%**	Treatment N:41 Age: 80(6) M/F: 26/15 NYHC: II: 25 III: 16 LVSD: mild: 14 moderate: 12 severe: 15 Control N = 41 Age:81(4) M:F = 19:22 NYHC: II: 21 III: 20 LVSD: mild: 15 moderate: 13 severe: 13	Visits 30 minutes, 2x/week for 3 months, followed by 2 - 3x/week at home for 3 months Intensity Borg Scale 11 - 13 Type Gentle seated exercise for first 3 months, then home exercise with assist of video/cassette for 3 months. Activity diary and weekly physiotherapist phone calls for encouragement and walking activity goal-setting were included Control Group Standard medical care	***Triaxial accelerometer*** Treatment 92,565(51,227)→106,021(98,315)→109,150(70,385)*ǂ Control Group No Δ 95,163(62,190)→93,373(62,862)→82,463(53,832)	***Exercise Performance*:** **6*MWT* (*m*)** Treatment No Δ 261(117)→254(107)→262(110) Control No Δ 240(93)→228(102)→246(111) ***Functional Status*:** ***Functional Limitations Profile*** No Δ in either group ***Quality of Life*:** ***Chronic Heart Failure Questionnaire*** No Δ in either group ***Anxiety/Depression*:** ***Hospital Anxiety Depression Score*** No Δ in either group
Mueller *et al.* **2007** **Level 2b** **M&HR 70%**	Treatment N:25 Age: NR M/F: 25/0 LVEF(%): < 40 NYHC: NR Control N:25 Age: NR M/F: 25/0 LVEF: <40 NYHC: NR	Visits 30 minutes 5x/wk, with additional 45 minutes, 2x/week for 1 month, 6.2 year follow-up Intensity 60% - 80% of max HR or Borg Scale 12 - 14 Type 30 minutes cycling, 45 minutes walking Control Group: Standard medical care	***Questionnaire Modeled after Harvard Alumni Study* (*kcal/week*)** Treatment No Δ 2137(2021)→2704(1970) Control No Δ 1269(1162)→2085(1522) (Activity only recorded at 6.2 year follow-up)	***Exercise Performance*:** ***Peak* VO_2 (*mL/kg/min*)** Treatment No Δ 22.0(3.4)→26.7(4.3)*→ 23.6(5.8) *significant immediate post training difference only Control No Δ 19.9(2.7)→20.0(2.9)→20.3(4.5)

Continued

Witham *et al.*	Treatment	Visits	***Triaxial accelerometer***	***Exercise Performance*:**
	N:53	60 minutes, 2x/week for	No difference in change between	**6*MWT* (*m*)**
2012	Age: 80(6)	8 weeks, followed by 16	groups at 8 or 16 weeks	No difference in change between
	M/F: 35/8	weeks of home exercise		groups at 8 or 16 weeks
Level 1b	NYHC:			
MH&R 90%	II: 37	Intensity		***Quadriceps Strength***
	III: 16	Based on dyspnea		No difference in change between
	LVSD:			groups at 8 or 16 weeks
	mild: 28	Type		
	moderate: 13	Gentle seated exercise		***Functional Status*:**
	severe: 9	for first 3 months, then		***Functional Limitations Profile***
		home exercise with		No difference in change between
	Control	assist of video/cassette		groups at 8 or 16 weeks
	N=54	for 3 months.		
	Age:80(5)	Group-based, guided		
	M:F=37:14	discussions regarding		***Quality of Life*:**
	NYHC:	exercise, support calls		***Chronic Heart Failure***
	II: 48	by physiotherapist every		***Questionnaire***
	III: 6	2 weeks for 8 weeks,		No difference in change between
	LVSD:	then monthly support		groups at 8 or 16 weeks
	mild: 22	calls for 16 weeks.		
	moderate: 17			***EuroQoL***
	severe: 14	Control Group		No difference in change between
		Standard medical care		groups at 8 or 16 weeks
				***Anxiety/Depression*:**
				Hospital Anxiety Depression
				Score
				No difference in change between
				groups at 8 or 16 weeks

*Statistically significant within-group difference; ‡Statistically significant between-group difference compared to control; values represent mean (standard deviation); MH&R = Medlicott & Harris rating of methodological rigor; LVEF = left ventricular ejection fraction; NYHC = New York Heart Association Classification; NR = not reported; UE = upper extremity; LE = lower extremity; 6MWT = 6 Minute Walk Test; VO_2 = peak oxygen consumption; CES-D = Center for Epidemiologic Studies Depression Questionnaire; LVSD = left ventricular systolic dysfunction.

3.1.4. Follow-Up

Only two studies [39,41] measured long-term results (6-month or greater follow-up). The majority [37,38,40, 42,43] of studies had no follow-up after intervention concluded.

3.1.5. Intervention Type and Dosage

Five studies [38-43] used exercise interventions, one study [37] used psychosocial intervention, and two studies [42,43] used an exercise intervention with a psychosocial component. The average length of intervention was 3.33 months, with a range of 1 month [39] to 6 months [38,43]. Frequency of intervention ranged from two times per week [40] to seven times per week [39], with the other four studies at 2 - 3 times per week.

3.1.6. Daily Activity Measures and Outcomes

Several different daily activity measures were utilized. Four [38,40,42,43] of the seven studies used accelerometry, while the other three [37,39,41] used either a questionnaire or an activity diary. One study [38] used doubly-labeled water in conjunction with accelerometry. Only two studies [37,42] showed between-group improvements in daily activity. The remaining five studies [38-41,43] demonstrated no improvements in daily activity.

3.1.7. Exercise Performance Measures and Outcomes

Measurements included the 6MWT [37,38,40,42,43], peak VO_2 [38,40,41], heart rate [39], and various muscular performance tests. Two studies [38,40] demonstrated improvements across multiple measures of exercise performance. The most commonly used measures were peak VO_2 [38,40,41] and the 6MWT [37,38,40, 42,43]. Significant between-group changes in 6MWT [38], peak VO_2 [38,40], exercise duration [38], and peak torque [40] were found in two of seven studies.

3.1.8. Quality of Life Measures and Outcomes

Five studies [38,40-43] measured quality of life (QOL). Measures included: Minnesota Living with Heart Failure Questionnaire [38], Medical Outcomes Study-SF 36 [38], Philadelphia Geriatric Morale Score [42], Chronic Heart Failure Questionnaire [42,43], Patient Global Assessment of Change in Quality of Life [41], and EuroQoL [43]. Significant between-group differences as a result of the intervention were only found in one study using the Patient Global Assessment of Change in Quality of Life [41].

3.1.9. Anxiety/Depression Measures and Outcomes

Three studies [38,42,43] measured anxiety/depression outcomes. Depression/anxiety measures included the Center for Epidemiologic Studies Depression Questionnaire [38] and the Hospital Anxiety and Depression Scale [42,43]. No changes in anxiety/depression were found.

3.1.10. Functional Status Measures and Outcomes

Three studies measured functional status [38,42,43]. Measures included the Function Status Assessment [38] and the modified Functional Limitations Profile [42,43]. No study reported significant between-group differences in any of the aforementioned measures.

3.1.11. Concurrent Changes between Daily Activity and Secondary Outcomes

Figure 2 summarizes the relationship between changes in daily activity concurrent with changes in other secondary outcome measures by plotting the within-group effect sizes of the intervention groups for all measures across all seven studies. Overall, a positive linear relationship did not exist, with the greatest changes in daily activity not occurring concurrently with changes in other measures. Furthermore, only one study [37] demonstrated a within-group effect size greater than 0.50 for daily activity.

When assessing concurrent changes in daily activity and anxiety/depression, there were no consistent results; two studies [38,43] showed no changes in daily activity or anxiety/depression, another study [42] demonstrated an increase in daily activity without a concurrent improvement in anxiety/depression, while yet another study [40] showed improvement in anxiety/depression without an improvement in daily activity. No studies found concurrent change in daily activity and anxiety/depression.

In evaluating concurrent change in daily activity and QOL, three studies [38,40,43] showed no change in either daily activity or QOL. One study [41] showed increased daily activity but no improvement in QOL. Another study [41] showed improvement in QOL but no increase in daily activity. No studies found concurrent change in daily activity and QOL.

In the assessment of concurrent change in daily activity and functional status, three studies [38,41,43] found no change in daily activity or functional status. Two studies [37,42] found increased daily activity without an increase in activity participation. No study showed an increase in daily activity and activity participation concurrently.

In comparing concurrent changes among daily activity and exercise performance, three studies [39,41,43] showed no change in daily activity or exercise performance. Two studies [37,42] showed increases in daily activity without associated changes in exercise performance. Two studies [38,39] demonstrated improvements in exercise performance but no increase in daily activity. No studies found concurrent change in daily activity and exercise performance.

3.2. COPD

One hundred and eighty four unique articles were found using the search strategy previously outlined. Ultimately, nine studies [44-52] met the inclusion criteria for this review: three randomized control trials [45,47,48], one

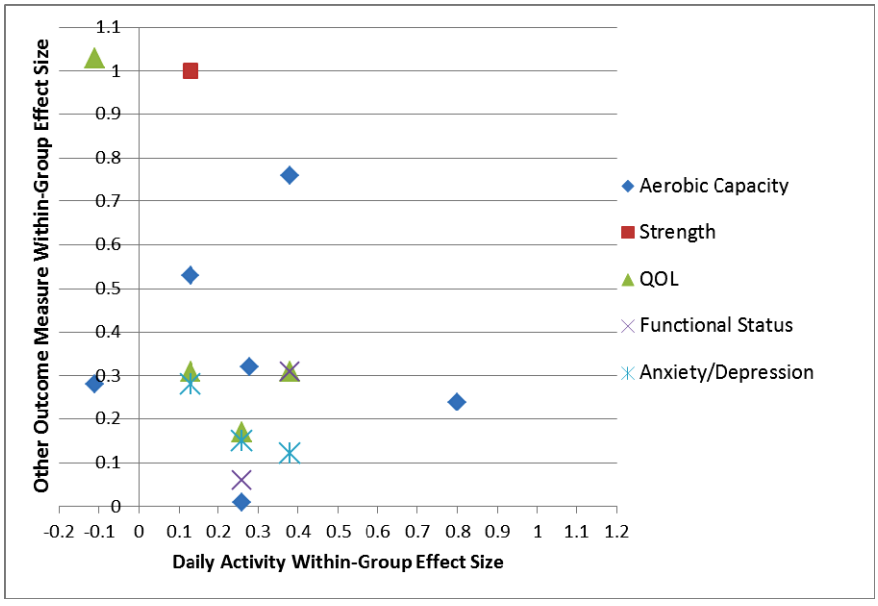

Figure 2. Concurrent intervention within-group effect sizes for daily activity and other outcome measures in CHF studies.

cohort study [44], and five case control studies [44, 46,49,51,52] (**Figure 3**). Methodological rigor scores ranged from 40% [51] to 90% [45]. One study [44] was rated as "strong", seven studies [44,46-50,52] were judged to be "moderate", and one study [50] was determined to be "weak". Of these nine studies, two [47,49] were unique to this search from the previous systematic review and meta-analysis by Ng *et al*. [30]. As discussed previously, Ng *et al*. [30] concluded that exercise training had little-to-no effect on physical activity in patients with COPD. For further details regarding the results and details of these seven included studies, refer to the full text article by Ng *et al*. [30].

The two additional articles found by the present literature search reported similar conclusions. Slinde *et al*. [49] explored how total daily energy expenditure changes when underweight patients with COPD enter a physiotherapy program. Fourteen subjects meeting the inclusion criteria of severe COPD, as indicated by FEV1 less than 50%, and body mass-index of less than twenty-one kg/m2, completed the study. In total, subjects attended eight, 90-minute physical therapy sessions consisting of moderate physical activity and an educational intervention. The authors concluded, based on accelerometer and doubly-labeled water measurements, that the mean total energy expenditure actually decreased 6% during the intervention period as compared to the control, with between-group results not statistically significant.

Probst *et al*. [47] compared the effect of a high intensity, whole-body endurance and strength program to a low-intensity calisthenics-and-breathing exercise program to improve daily activity. Forty individuals with COPD were randomized into two equal treatments groups and completed 36 therapy sessions over a 12 week period. Based on accelerometry, Probst *et al*. [47] concluded that neither high- nor low-intensity treatment had a significant impact on improving daily energy expenditure.

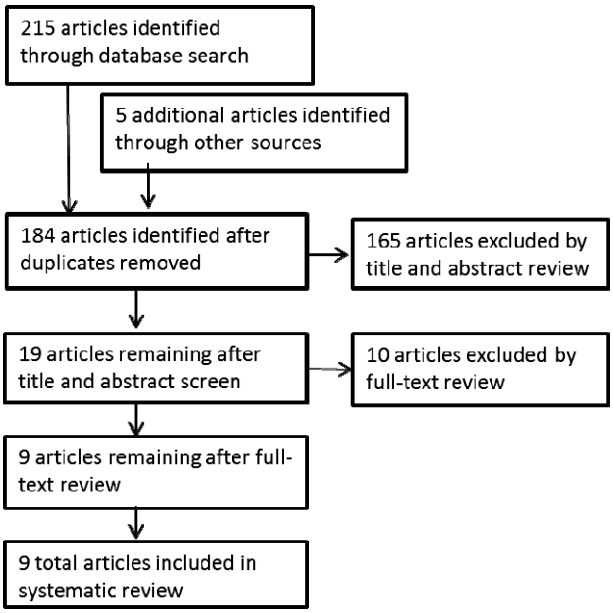

Figure 3. Search results for chronic obstructive pulmonary disease.

Concurrent Changes between Daily Activity and Secondary Outcomes

Figure 4 summarizes the relationship between changes in daily activity concurrent with changes in other secondary outcome measures by plotting the within-group effect sizes of the intervention groups for all measures across all nine studies. Overall, a positive linear relationship did not exist, with the greatest changes in daily activity not occurring concurrently with changes in other measures. Furthermore, only one study [45] demonstrated a within-group effect size greater than 0.50 for daily activity, with small-to-no effects in all other outcome measures when daily activity effect sizes where greater than 0.50.

When assessing concurrent changes in daily activity and anxiety/depression, one study [50] showed no changes in daily activity or anxiety/depression and another demonstrated a large effect on daily activity but no effect on anxiety/depression [45]. Only one study [52] showed concurrent increase in daily activity and improved anxiety/depression.

With regard to concurrent changes in daily activity and QOL, four studies [45,47,48,50] showed no change in either daily activity or QOL. One study [44] showed improved QOL with no increase in daily activity. Two studies [46,52] demonstrated concurrent change in increased daily activity and improved QOL.

In the assessment of concurrent change in daily activity and functional status, four studies [45,47,48,50] found no change in daily activity and participation. One study [44] showed increased functional status with no positive effect on daily activity. Two studies [46,52] showed concurrent change in increased daily activity and improved functional status.

In comparing concurrent changes among daily activity and exercise performance, two studies [45,48] showed no change in daily activity or exercise performance. One study [52] showed increased daily activity without associated improvement in exercise performance. Three studies [44,47,50] demonstrated improvements in exercise performance but no increase in daily activity. Only one study [46] found a concurrent increase in daily activity and improved exercise performance.

4. DISCUSSION

The purpose of the present review was to evaluate the efficacy of exercise- and psychosocial-based intervenetions for improving daily activity in patients with COPD

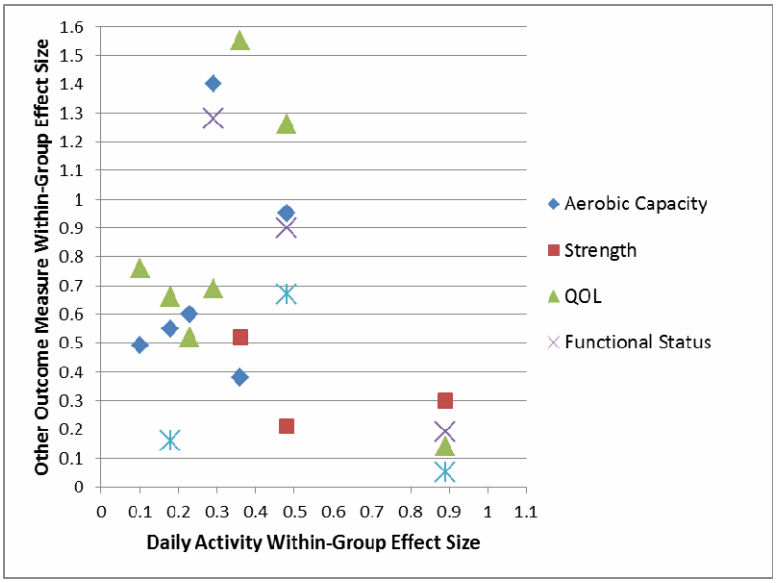

Figure 4. Concurrent intervention within-group effect sizes for daily activity and other outcome measures in COPD studies.

and CHF. The results of the present review highlight several important limitations of the existing literature. More importantly, however, the present review provides insight into interventions utilized for disrupting the cycle of inactivity and deconditioning in individuals with COPD and CHF. Overall, the present results indicate that exercise-based interventions play a limited role in improving daily activity, and psychosocial-based interventions are a promising, but under-investigated, intervention.

With regard to limitations of the existing literature on interventions for improving daily activity in individuals with COPD and CHF, there are several noteworthy study design and measurement deficiencies. Although there were a greater number of studies of patients with COPD, few utilized a randomized design compared to all six of the studies in patients with CHF being randomized controlled trials. However, the measurement of daily activity in the CHF literature included an objective measurement (e.g. accelerometry) in only four studies, compared to objective measures being used in all nine in the COPD literature. It is therefore helpful to draw upon evidence from both populations when evaluating intervention efficacy. Indeed, similar findings were noted in both, with exercise-based interventions having little effect on daily activity.

With regard to the role of either exercise- and/or psychosocial-based interventions for disrupting the cycle of inactivity and deconditioning, psychosocial interventions appeared to have the greatest efficacy. Only four of nine studies [45,46,48,52] in patients with COPD showed within-group improvement in daily activity, and none demonstrated between-group changes. Similarly, two of seven studies [37,42] in patients with CHF resulted in statistically significant effects on daily activity. However, among the studies that demonstrated a statistically significant effect on daily activity, three of the four studies in those with COPD [45,46,48] and both of the studies in those with CHF [37,42] included a psychosocial component or were entirely a psychosocial-based intervention.

With regard to the cycle of inactivity and deconditioning, the results of the present study could be interpreted in two ways: 1) inactivity and deconditioning are not interrelated as previously proposed [8-12], or, 2) only directing interventions towards the deconditioning component of the cycle is insufficient for making changes in daily activity. In patients with CHF, Shoemaker *et al.* [53] observed that clinically meaningful changes in 6MWT performance were not accompanied by changes in daily activity over time (no intervention was provided). Furthermore, as noted in the present review, changes in exercise performance in response to exercise interventions did not occur concurrently with changes in daily activity (e.g. studies that demonstrated improved exercise performance did not improve in daily activity and vice versa). As previously discussed, nearly all of the studies in both populations that included at least a psychosocial intervention component resulted in improvements in daily activity.

Therefore, psychosocial-based interventions for improving daily activity, although relatively under-investigated in COPD and CHF, may be a promising new intervention. It is not clear whether psychosocial-based interventions alone or in combination with exercise-based interventions are most effective. Furthermore, it is not known which psychosocial interventions are effective, as

highlighted by the 2005 and 2012 studies by Witham *et al*. The very low intensity, seated exercise intervention in the 2005 study that resulted in significant improvement in daily activity included subjects keeping "a diary of their daily activities [that was] used as a basis for a weekly telephone liaison [to] give encouragement and agree on new targets for daily walking activity." The high intensity exercise intervention in the 2012 study that failed to demonstrate improvement in daily activity included "guided discussion sessions based on cognitive and behavioral techniques [that focused] on benefits of exercise [and] goals and how to work toward them" in addition to telephone calls every 2 weeks for the first 4 months followed by monthly phone calls for 4 months. Thus, the key components of psychosocial support or intervention for promoting changes in the habitual routines that impact daily activity are not clear.

Finally, the present review found that changes in QOL, anxiety/depression, and functional status did not occur concurrently with changes in daily activity. Although daily activity has been shown to be associated with anxiety/depression, QOL, and functional status [18,19,24,26-28,54], it is not clear why *changes* in these measures did not consistently occur concurrently. No included study investigated the effect of pharmacologic or functional training interventions directed at improving anxiety/depression or functional status or how such interventions might impact daily activity. It is important to note that none of the included studies specifically accounted for baseline depression, anxiety, or low selfefficacy as possible factors that could confound response to intervention.

In summary, based on the results of the present systematic review, it can be concluded that exercise-based interventions alone are unable to promote an increase in daily activity within the COPD and CHF populations. Given the association between daily activity and other important outcomes such as hospitalization and mortality, clinicians should consider daily activity as clinical outcome, and should also consider the psychosocial needs of patients as they pertain to daily activity.

Future research should focus on expanding the application of psychosocial-based interventions in subjects with COPD and CHF. While current evidence of psychosocial-based intervention is promising, the volume of studies is limited. Future research should also compare the efficacy of exercise-based intervention versus psychosocial-based interventions versus a combination of exercise and psychosocial intervention to improve daily activity in individuals with COPD and CHF.

5. CONCLUSION

Exercise-based interventions serve a limited, if any, role in improving daily activity in individuals with COPD and CHF. Disrupting the cycle of inactivity and deconditioning requires more than just addressing the deconditioning aspect of this cycle. Psychosocial-based interventions are a promising, but under-investigated, intervention.

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