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Resistance Exercise and Knee Osteoarthritis

Vincent KR, Vasilopoulos T, Montero C, Vincent HK. Eccentric and concentric resistance exercise comparison for knee osteoarthritis. Med Sci Sports Exerc. 2019;51(10):1977–86.

Knee osteoarthritis (OA) is a leading cause of pain and disability globally (1), with 23% of Americans (2) and 9.3% of Australians (3) at risk of developing this condition after age 60. Chronic pain inhibits neural pathways to surrounding musculature of a joint resulting in a deficit of activation and reduction of muscle mass and function associated with the joint (4). Knee pain is associated with a reduction in physical function, loss of knee extensor/flexor muscle mass and strength, poor quality of life, physical deconditioning, and reduced health status (5). There is no cure for knee OA (1). Management of the condition focuses on pain reduction and improvement of knee extensor/flexor strength (1).

Machine-based resistance training, with an emphasis on concentric contraction, is the most often used method to improve knee extensor/flexor strength in persons with knee OA. This type of training may assist with pain reduction (6). What is unknown are the benefits of eccentric-based resistance training as a method of managing knee pain and muscle strength. Research in young men suggests that eccentric resistance training increases muscular strength and mass and improves neural activation deficit at a lower metabolic and cardiovascular cost compared to concentric contractions. Eccentric resistance exercise may be better suited for the health-related deficits associated with knee OA management (6).

MANUSCRIPT REVIEW

The purpose of this 4-month randomized controlled study was to compare the efficacy of eccentric-based versus concentric-based resistance training on the management of knee OA pain and strength. The authors hypothesized that eccentric training would have superior outcomes for knee pain, perceived function, and leg maximal strength. Inclusion criteria were (1) men and women (60 to 85 years), (2) diagnosed with knee OA ≥6 months (7), (3) experiencing tibiofemoral, not patellofemoral, knee pain, (4) grade 2 or 3 Kellgren and Lawrence knee OA, confirmed by radiograph (8), and (5) able to participate free of injury/disease that would preclude resistance training. The Kellgren and Lawrence system is a common method of classifying knee OA severity measuring joint space of the tibiofemoral joint and assigning it with a grade of 1 to 5 (mild to severe) (8). All participants were required to attend 3 laboratory visits in addition to 4 months of resistance training. Visit 1 included consent, completion of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) to assess pain, stiffness, and function (9), air plethysmography body composition testing, and treadmill-based graded exercise test with expired air metabolic assessment. Visit 2 included 1-repetition maximum (1RM) testing for several major muscle groups to assist with resistance training programming. Visit 3 took place at the conclusion of the 4-month training program, and all measures except the graded exercise test were repeated.

A total of 88 participants were randomized to 3 groups: (1) concentric-based resistance training (CON-RT), (2) eccentric-based resistance training (ECC-RT), and (3) control group (CT). The CON-RT group was assigned 1 set of 12 repetitions at 60% 1RM, and the ECC-RT group was assigned 1 set of 8 repetitions at 60% of the concentric 1RM during eccentrically loaded movements. All participants provided a rating of perceived effort between 17 and 18 on the 6 through 20 Borg scale. As participants adapted to intensity of resistance training, weight was titrated to maintain a 17 to 18 rating on the Borg scale. Both groups performed resistance training twice weekly for the leg press, knee extension, knee flexion, calf press, chest press, seated row, overhead press, and biceps curl (for more detail on each exercise: http://links.lww.com/MSS/B592; last accessed March 29, 2020). The CT group was instructed to continue to participate in normal activities.

A total of 34 participants dropped with only 54 participants completing the study (CON-RT=17; ECC-RT=19; CT=17, for analysis). The reason for drop-out included personal/health reasons (CON-RT=5; ECC-RT=5; CT=7), and discontinuation of the intervention (CON-RT=5; ECC-RT=2; CT=5). At baseline there were no significant differences between groups for body composition, medications, WOMAC scores, or duration of disease. The CON-RT and ECC-RT groups completed 94.8% and 96.4% of all sessions, respectively, without any adverse events. There were no

changes in body composition and WOMAC from pretraining to posttraining for total scores, knee stiffness, and function across the 3 groups. There was a trend toward significance for improved WOMAC pain scores for both the CON-RT and ECC-RT groups who completed the training. Further regression analysis to determine a relationship between muscular strength and WOMAC pain scores indicated that baseline knee flexion 1RM is a predictor of knee pain and improvement in leg press 1 RM had the best relationship in reduction of WOMAC pain scores.

Both the CON-RT and ECC-RT groups improved leg press, knee extension, and knee flexion 1RM testing values following the intervention, whereas the CT group had no change. There were no differences in posttraining 1RM values between the CONT-RT and ECC-RT groups. There were significant interactions between the main effects of age and sex on 1RM strength measures. Older individuals and females had lower 1RM measures at baseline and posttesting when compared to younger individuals and males. When analyzing weekly strength gains, the CON-RT group had greater weekly gains as compared the ECC-RT group for the leg press and knee flexion exercises, where the ECC-RT group demonstrated a greater weekly gain in the knee extension exercise.

CLINICAL IMPLICATIONS

This is the first study to investigate the effectiveness of eccentric versus concentric resistance training in persons with grade 2 or 3 knee OA regarding strength gains and pain reduction. Findings of this study suggest that resistance training is a safe mode of exercise for persons with knee OA. Both eccentric and concentric resistance training can help to improve lower limb strength and may be effective in reductions in knee pain. The clinical exercise physiologist should consider both types of resistance training when working with patients who are managing knee OA. The type of resistance exercise should be determined based on the patient's preference, training goals, and tolerance to exercise. Eccentric resistance training may result in greater discomfort associated with Delayed Onset Muscle Soreness (DOMS), and clients must be informed by the clinical exercise physiologist of the associated discomfort and duration of DOMS.

Results should be interpreted with caution. There was a large dropout rate associated with this study that may have impacted the statistical analysis. Furthermore, it is possible that performing only 1 set was not enough total exercise volume to elicit maximal gains over the 4-month duration. Future studies should consider the use of multiple sets as a higher volume of resistance may provide additional benefits with muscle mass and strength gains.

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Pulmonary Rehabilitation and Exercise Intensity in Moderate to Severe COPD

He GX, Li N, Ren L, Shen HH, Liao N, Wen JJ, Xu YM, Wang J, Li QY. Benefits of different intensities of pulmonary rehabilitation for patients with moderate-to-severe COPD according to the GOLD stage: a prospective, multicenter, single-blinded, randomized controlled trial. Int J Chron Obstruct Pulmon Dis. 2019;14:2291–34.

Chronic Obstructive Pulmonary Disease (COPD) is an inflammatory lung disease causing obstruction of air flow during expiration. The leading cause of COPD for most individuals is tobacco smoke, air pollutants, and genetic predisposition (1). Regardless of cause, COPD is a debilitating disease resulting in a higher risk of lung infection, frailty, reduced physical function, and quality of life (1). It is estimated that 15 million Americans (1) and over 1 million Australians (2) are living with COPD. In addition to medical treatment, pulmonary rehabilitation (PR) has been shown to be an effective treatment for persons with COPD to manage their condition (3). Typical components of PR include exercise, counseling, breathing techniques, and behavior modification (3).

Despite the benefits of PR, it is underused worldwide (3). A large-scale study demonstrated that only 9.3% of 68,900 individuals with COPD who met eligibility for PR were referred in 2017 (4). Although PR is considered an important part of COPD management (5), there is very limited research assessing exercise recommendations for intensity and duration in aerobic exercise (which is the typically the mode of exercise most used in PR) (5). To increase the efficacy of PR to better manage COPD, research focusing on different intensity and durations is required.

MANUSCRIPT REVIEW

The aim of this multicenter, single-blinded, randomized controlled investigation was to determine appropriate intensity of aerobic exercise as part of PR in patients with moderate-to-severe COPD. Stages of COPD were determined by the Global Initiative for Chronic Obstructive Lung Disease [GOLD] staging (Table 1) (6). Men and women who met the inclusion criteria were recruited from 5 medical centers in Shanghai, China. Inclusion criteria were (1) age ≥40, (2) diagnosed as COPD-GOLD stage 2 or 3, (3) no history of asthma, and (4) stable COPD without hospitalization in the past 3 months. Participants were excluded if they had current lung infection or cancer, mental illness preventing participation, cardiovascular/neuromuscular/orthopedic disease, lack of medical records, or participation in a PR or cardiac rehabilitation program within the past year.

TABLE 1. Global Initiative for Chronic Obstructive Lung Disease (GOLD) Stages (6).

Stage	Classification	Based on Bronchodilator FEV_1
1	Mild	≥80% predicted
2	Moderate	50% <80% predicted
3	Severe	30% <50% predicted
4	Highly Severe	<30% predicted

All participants had 2 visits (premeasurement and postmeasurement) and 20 weeks of PR. Outcome measures included the comparison of exercise intensities (low, moderate, and high) to the BODE index, assessment of acute exacerbations, and anxiety/depression assessment. The BODE index is a multidimensional scale designed to predict the risk of death specifically in those with COPD (7). BODE measures include: B=Body Mass Index, O=obstruction (FEV_1), D=dyspnea (via questionnaire), and E=exercise (6-min walk test). Any acute exacerbations of COPD were defined as worsening of respiratory symptoms resulting in additional therapy and was divided into 3 stages (mild=treatment with short-acting bronchodilators [SABDs]; moderate=SABDs/antibiotics/corticosteroids; and severe=hospitalization and/or respiratory failure). Anxiety and depression were measured via the Hamilton Anxiety Scale and Hamilton Rating Scale for Depression, respectively. Blood pressure, oxygen saturation, respiratory rate, pulmonary function, BODE index measures, frequency of exacerbations, and anxiety/depression questionnaires were collected at baseline (visit 1) and repeated at the conclusion of the 20-week exercise program (visit 2). Visit 1 also included cardiopulmonary testing via indirect spirometry to assist with programing exercise intensities based on oxygen uptake.

A total of 217 participants (89 GOLD 2 and 128 GOLD 3) were randomized to 3 exercise intensity groups: low (<50% VO_2 [$ml \cdot kg^{-1} \cdot min^{-1}$]), moderate (50% to 70% VO_2), and high (>70% VO_2), and stratified by GOLD stage. PR for all groups consisted of 10 educational sessions that covered topics such as medical care, respiratory therapy, nutrition/psychological counseling, and exercise. Exercise sessions occurred 5 d per week for 40 min each session. Sessions included a 10-min warm up, 20 min of interval training (upper/lower/combo cycling and functional strength exercises), and 10 min of relaxation (walking, stretching, and meditation). Intensity was increased by 10 Watts whenever adaptation and tolerance to exercise was determined.

There were 14 who dropped out of the study (2 participants died because of acute exacerbations and 12 participants dropped because of noncompliance of PR), leaving 203 participants for analysis. There were no differences in BODE, FEV_1, anxiety/depression, and comorbidities

between intensity and COPD severity groups at baseline. Following 20 weeks of PR, all groups improved their 6-min walk test distance, BODE index, frequency of acute exacerbations, and depression scores. Only the moderate-intensity and high-intensity groups had a reduced measure of anxiety. For the moderate severity (GOLD 2) group, high-intensity exercise resulted in improvements of all outcome measures between pretesting and posttesting. The GOLD 2 group improved for each measure except FEV_1 and anxiety. Only 6-min walk test distance and frequency of acute exacerbations improved for the GOLD 2 low-intensity group. The severe (GOLD 3) high-intensity group improved all measures and had the greatest change in FEV_1 and 6-min walk test distance. The GOLD 3 moderate-intensity group improved in all outcomes except for body mass index. Except for body mass index and anxiety scores, the GOLD 3 low-intensity group showed improvement in all outcome measures at the lowest magnitude of change when compared to moderate-intensity and high-intensity GOLD 3 groups.

CLINICAL IMPLICATIONS

The findings of this study suggest that both severe (GOLD 3) and moderate (GOLD 2) COPD patients will benefit from PR, with the greatest improvements occurring with moderate and high aerobic intensity levels. Furthermore, the higher severity patients had the greatest improvement during the high-intensity exercise as compared to lower intensities and COPD patients who are classified as GOLD 2. The clinical exercise physiologist should consider inserting higher intensities of exercise for patients with moderate to severe COPD. Decisions based on exercise programming should be made with consultation of the medical care team and based on tolerance of exercise and goals of the patient. A concern is negatively affecting patient adherence to exercise participation.

Findings of this study are do not apply to GOLD 4 (highly severe COPD) and or the use of resistance training in COPD management. Functional resistance exercises were included in the exercise programming of this study; however, there was no detail on the type or volume of resistance exercise or how this impacted the results of the study.

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