Cochrane Review: Improving Physical Function and Performance With Progressive Resistance Strength Training in Older Adults

Kathleen Kline Mangione, Amy H. Miller, Irene V. Naughton

<LEAP> highlights the findings and application of Cochrane reviews and other evidence pertinent to the practice of physical therapy. The Cochrane Library is a respected source of reliable evidence related to health care. Cochrane systematic reviews explore the evidence for and against the effectiveness and appropriateness of interventions—medications, surgery, education, nutrition, exercise—and the evidence for and against the use of diagnostic tests for specific conditions. Cochrane reviews are designed to facilitate the decisions of clinicians, patients, and others in health care by providing a careful review and interpretation of research studies published in the scientific literature.[1] Each article in this PTJ series summarizes a Cochrane review or other scientific evidence on a single topic and presents clinical scenarios based on real patients or programs to illustrate how the results of the review can be used to directly inform clinical decisions. This article focuses on an older patient with sarcopenia and multiple comorbidities who is receiving home care. Can progressive resistance training help her regain function so that she can function independently in the community again?

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Age-related muscle loss, also known as sarcopenia, is a common problem among older adults. Physical therapists are concerned about muscle loss because it is associated with loss of muscle strength and muscle quality.[2] Muscle strength—the amount of force a muscle can produce—is highly associated with functional activities.[3–4] Loss of strength is associated with slow gait speed, poor endurance, inability to rise from a chair, falls risk, incident disability, and frailty.[5–7] Men and women demonstrate differing trajectories in muscle loss, with men's loss being more gradual and women showing a more dramatic decrease after menopause.[3] The muscle loss of sarcopenia is a problem for both older men and women and increases with increasing age. Prevalence estimates from the National Health and Nutrition Examination Survey (NHANES) data suggest that 35% of the older adults had moderate sarcopenia, whereas 10% had severe sarcopenia.[8] Among a sample of community-dwelling volunteers, sarcopenia occurred in 22.6% of women and 26.8% of men. In the subgroup of women and men who were 80 years and older, prevalence rates of sarcopenia were 31.0% and 52.9%, respectively.[9]

Resistance training is used to counteract the effects of muscle loss. It is a form of exercise in which the muscle contracts against an external load.[10] Some of the equipment commonly used to perform resistance training includes free weights, exercise machines, body weight, and elastic bands. Progressive resistance training (PRT), in which the load is systematically increased as the person is able to work against a heavier load, has been shown to produce large increases in strength and moderate increases in bone mineral density, lean body mass, insulin sensitivity, and submaximal and maximal endurance.[10] Although an initial Cochrane review showed that PRT produced large effects in improving muscle strength,[11] many new trials have been added to the literature. The authors note that uncertainty remains about the effectiveness of PRT on physical disability outcomes, on more pragmatic home or hospital-based programs, on older adults who have multiple health problems, and on the comparative benefits of PRT versus other exercise programs.[12] The purpose of the review by Liu and Latham[12] was to determine the effects of PRT on physical function in older adults. The primary outcome was a measure of activity and participation (activities of daily living and the physical function component of health-related quality of life scores). The secondary outcomes were measures of body structure and function (muscle strength, aerobic capacity) and measures of activity (balance, gait speed, Timed "Up & Go" [TUG] test times, and chair rise speed). Additional outcomes were adverse events, hospital admissions, and death.

Take-Home Message

The Cochrane review by Liu and Latham included 121 trials with

Table.
Progressive Resistance Training (PRT) for Improving Physical Function in Older Adults: Cochrane Review Results

• This review included 121 trials with 6,700 participants at entry.	
• Most studies were small, with less than 40 total participants, but 14 studies had 100 or more participants.	
• The participants in 59 trials were community-dwelling, healthy older adults; the remaining 62 trials included participants who had health problems or functional limitations or who were considered frail. Thirty-two of these trials included older people with a specific medical condition such as osteoarthritis or diabetes. In 9 trials, participants resided in nursing homes, and 2 studies were conducted in hospitals.	
• Most studies included both men and women (10 included only men, 22 included only women).	
• In 49 studies, average age was between 60 and 69 years; in 57 studies, average age was between 70 and 79 years; in 20 studies, average age was 80 years or older.	
• Most training programs took place in gym or clinic settings with all sessions fully supervised. Ten studies were entirely home based, whereas 12 were a combination of home and clinic sessions.	
• Eighty-three trials involved high-intensity training. Most of these trials used specialized exercise machines for training. Thirty-six trials used low-intensity to moderate-intensity training, with most using elastic tubing or bands. Frequency of training was consistent—2 or 3 times a week in almost all trials. Two exceptions to this were the 2 trials conducted in hospitals, which carried out the exercises on a daily basis. The duration for the majority of trials (n=71) was 8–12 weeks. In 54 trials, the exercise program was longer than 12 weeks. The number of exercises performed also varied, from 1 to more than 14.	
Six-minute walk distance (m)	Across 11 studies with 325 participants, PRT improved six-minute walk distance by 52.37 meters on average compared with a control group. Fifty meters has been reported to be a substantial change in older adults.[12]
Gait speed (m/s)	Across 24 studies with 1,179 participants, PRT improved gait speed by 0.08 m/s compared with a control group. Small meaningful change has been reported to be 0.05 m/s, and a substantial change has been reported to be 0.1 m/s in older adults.[13]
Timed "Up & Go" (TUG) (s)	Across 12 studies with 691 participants, PRT improved TUG time by 0.69 seconds compared with a control group. Although this change was considered statistically significant, it is questionable whether this change is clinically meaningful. The minimal detectable change in TUG times for people with hip and knee osteoarthritis have been reported to be 2.5 seconds; for frail African American older adults, 4 seconds.[14,15] Thus the reported change of less than 1 second (0.69 s) is less than detectable change and thus of questionable clinical value.
Strength grouped by exercise intensity	Across 54 studies with 2,026 participants, high-intensity PRT showed improved strength (standardized mean difference [SMD]=0.60; 95% confidence interval [CI]=0.51, 0.70) compared with a control group. Across 19 trials with 1,026 participants, comparing low- to moderate-intensity PRT with a control group, PRT also showed improved strength, but the effect was not as strong (SMD=0.39; 95% CI=0.26, 0.51).
Strength grouped by health status	Across 46 studies with 1,502 healthy participants, PRT improved strength (SMD=0.77; 95% CI=0.66, 0.88) compared with a control group. Across 19 studies with 926 older adults with specific health problems, comparing PRT with a control group, PRT also showed improved strength, but the effect was not as strong (SMD=0.37; 95% CI=0.24, 0.51).
Strength grouped by functional limitations	Across 41 studies with 1,349 participants with no functional limitations, PRT improved strength (SMD=0.81; 95% CI=0.69, 0.93) compared with a control group. Across 13 studies with 784 older adults with functional limitation, comparing PRT with a control group, PRT also showed improved strength, but the effect was not as strong (SMD=0.30; 95% CI=0.16, 0.44).

more than 6,700 older adults. The results are presented as standardized mean difference (SMD), a unitless measure that represents effect size. It has been reported that effect sizes <0.2 are small, effects >0.2 to <0.8 are moderate, and effects >0.8 are large. When comparing PRT to a control group, Lin and Lantham found a small but significant effect for PRT for improving physical disability (SMD=0.14; 95% confidence interval [CI]=0.05, 0.22). A moderate to large benefit was found for PRT for improving strength (SMD=0.84; 95% CI=0.67, 1.00). Progressive resistance training improved aerobic capacity (SMD=0.31; 95% CI=0.09, 0.53). Progressive resistance training had a small positive effect on balance but the value was not significant (SMD=0.12; 95% CI=0.00, 0.25). Chair rise speed showed a large effect (speeds became faster) after PRT (SMD=−0.94; 95% CI=−1.49, −0.38). Six-minute walk distance, gait speed, TUG test values after PRT are reported in the actual units in the Table.

Because of the number of studies, the variability in characteristics of the participants, the design of the PRT program, and the outcomes assessed, the authors conducted multiple subanalyses of the data. The Table highlights the subanalyses that might be most relevant to physical therapist practice. As the authors indicate, caution has to be applied when interpreting the subanalyses because the results are based on fewer studies.

The take-home message regarding progressive resistance training is clear: strength training performed 2 to 3 times per week reduces physical disability and improves some functional abilities, such as gait speed and chair rise time. Progressive resistance training has its largest effect in improving strength. There was no subgroup or analysis that showed that strength training was detrimental to older adults. Adverse events typically were not reported, but when they *were* reported, joint and muscle pain were the most common adverse events. The authors conclude that PRT is an appropriate intervention for older adults who want to improve performance of simple physical tasks.

<LEAP> Case #4: Applying Evidence to a Patient With Muscle Weakness

Can progressive resistive training help this patient?

Mrs. Smith is an 86-year-old woman who was living alone in a farmhouse when she fell on the floor and remained there for 2 days. Her admitting diagnoses to the hospital were dehydration, hypertension, and ambulatory dysfunction because of the fall. Her history also included left shoulder rotator cuff impairment, cardiomegaly, bilateral osteoarthritis, spinal stenosis, and anemia. She was referred for home health physical therapy and was discharged to her son's home with the goal of living independently in a nearby apartment. To achieve this goal, improvements needed to be made in her physical and functional abilities. Upon initial examination, Mrs. Smith appeared cognitively intact (alert and oriented to time, place, and person). Her vital signs were as follows: heart rate, 88 beats per minute; blood pressure, 122/82 mm Hg; respiration rate, 20. Her lungs were clear. Her impairments and functional limitations included decreased lower-extremity strength, impaired balance, slow gait speed, assistance needed in activities of daily living (ADLs), and fall risk. The TUG test took 53 seconds (>30 seconds suggests dependence in ADLs),[16] and she required close supervision to stand from the chair. She also required supervision when climbing steps and required contact guarding when stepping over a tub. Her gait speed was 0.28 m/s (normal speed is 1.0 m/s[17]), and she needed contact guarding with a wheeled walker. Her Outcome and Assessment Information Set (OASIS-mandated tool by the Centers for Medicare & Medicaid Services) Falls Risk Assessment score was 14 (scores >10 suggest high risk for falls[18]).

How did the results of the Cochrane systematic review apply to Mrs. Smith?

Mrs. Smith was similar to the community-dwelling older adults addressed in the systematic review (Table). Even though most studies included in the review took place in a gym or clinic setting, the physical therapist and Mrs. Smith decided she would be a candidate for home-based progressive resistance training. Consistent with the frequency of training reported in the review, visits were planned for 2 times per week. The physical therapist had an adjustable cuff weight, and, because the patient was ambulatory, the therapist decided to try to use 10 lb to assess Mrs. Smith's strength. Mrs. Smith could lift 10-lb cuff weights on each leg for an 8-repetition maximum before fatigue. Thus, her 8-repetition maximum was 10 lb. The PRT dose began with 10 lb and she increased the load on subsequent visits so that Mrs. Smith would always fatigue between 6 and 10 repetitions. She performed 2 sets of the knee extension exercises with repetitions to fatigue (varied from 6 to 10 repetitions) for each set. At the second session, Mrs. Smith complained of increased quadriceps soreness and was unsure whether she should

continue with PRT or not. The physical therapist explained to Mrs. Smith that muscle soreness was to be expected but would dissipate with continued PRT. Mrs. Smith agreed to continue with training.

Other interventions included in the home physical therapy visits were gait training indoors and outdoors, progressing from a wheeled walker to a standard cane indoors, stair climbing indoors and outdoors, transfer training, and standing weight shifting to improve her balance. Her home exercise program consisted of daily active range of motion exercises for the upper and lower extremities in both sitting and standing positions, along with tandem and sideways ambulation with single upper-extremity support.

How well do the outcomes of intervention provided to Mrs. Smith match those suggested by the systematic review?

Mrs. Smith received 7 home visits over the 3.5 week episode of care. The episode was shorter than anticipated because she moved out of the area. Her outcomes were consistent or greater than changes reported in the systematic review. She could lift a 20-lb weight 8 times before fatigue, indicating a strength gain of 100%. Mrs. Smith's measured strength gains exceeded those reported in the review regardless of health status or functional grouping. Her TUG score decreased by 27 seconds, now requiring 26 seconds to complete the test. This change is well over reported minimal detectable changes reported for the TUG (Table), and far more substantial than the change reported in the Cochrane review (0.69 seconds). The change in TUG time may be related more to the functional training activities that were part of Mrs. Smith's program than solely to the PRT. Mrs. Smith's gait speed increased to 0.38 m/s, a 0.1 m/s improvement that is consistent with the systematic review, which reported a 0.08 m/s improvement in gait speed following progressive resistance training. Mrs. Smith had progressed to independent indoor ambulation with a standard cane. Her transfers were now independent, which showed as a gain in the OASIS transfer measure (M1850). Mrs. Smith achieved her goal of returning to independent living in a smaller space without relying on her children for performance of ADLs. Progressive resistance training contributed to her independence in ADLs, which was the primary outcome of the Cochrane review.

Can you apply the results of the systematic review to your own patients?

The findings of this Cochrane review apply well to Mrs. Smith. The age of the participants in the studies ranged from 60 to more than 80 years. The review included studies with both healthy participants and older adults with specific health problems, as well as participants with and without functional limitations. Trials also examined older adults residing in the community or within institutions. Mrs. Smith was well represented in the review.

This Cochrane Review has some limitations, one of which is that it excluded studies that included balance, aerobic, or other training as part of the exercise intervention. In addition, only quadriceps force measures were included in the calculation of effect sizes. Only 2 studies were conducted in hospitals, which may limit application to patients in the acute hospital setting.

The common features of training noted in the systematic review were that the programs included a supervised progression of the resisted exercise programs and that the exercise was performed 2 or 3 times a week. Studies utilized a variety of modes; therefore, regardless of the equipment available, Mrs. Smith's physical therapist should be able to effect similar changes in her impairment at the body structure and function level, as well as her activity and participation levels, utilizing supervised PRT.

What can be advised based on the results of this systematic review?

Older adult patients, such as Mrs. Smith, are likely to benefit from supervised PRT regardless of the setting or mode of training. Based on the results of the Cochrane review, patients who participate in PRT are likely to show meaningful strength gains, along with decreases in physical disability. Substantial improvements in key functional activities including ADLs, gait speed, and the ability to get out of a chair should be expected. Larger changes in strength should be expected with higher intensities of PRT and in individuals without health problems or functional limitations.

K.K. Mangione, PT, PhD, GCS, is Professor, Department of Physical Therapy, Arcadia University, Glenside, Pennsylvania.

A.H. Miller, PT, DPT, is Assistant Professor of Physical Therapy and Curricular Coordinator of the Entry-Level DPT Program, Department of Physical Therapy, Arcadia University, Glenside, Pennsylvania.

I.V. Naughton, PT, MS, is Team Clinical Coordinator of Physical Therapy, Abington Memorial Hospital, Home Health Care Services, Abington, Pennsylvania.

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