Back Strength Predicts Walking Improvement in Obese, Older Adults With Chronic Low Back Pain

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Objective: To compare the effects of 4 months of isolated lumbar resistance exercise and total body resistance exercise on walking performance in obese, older adults with chronic low back pain. A secondary analysis examined whether responsiveness to training modulated walking improvement.

Design: Randomized, controlled trial.

Setting: Research laboratory affiliated with tertiary care facility.

Methods and Intervention: Participants (N = 49; 60–85 years) were randomized into a 4-month resistance exercise intervention (TOTRX), lumbar extensor exercise intervention (LEXT), or a control group (CON).

Main Outcome Measurements: Walking performance, maximal low back strength and leg strength, and average resting and low back pain severity score (from an 11-point numerical pain rating scale; NRS_{pain}) were collected at baseline and month 4.

Results: The TOTRX and LEXT improved lumbar extensor strength relative to CON, and the TOTRX ($P < .05$). NRS_{pain} scores at month 4 were lowest in the TOTRX group compared with the LEXT and CON groups, respectively (2.0 ± 1.7 points vs 3.7 ± 2.6 points and 4.6 ± 2.4 points; $P < .006$). A total of 53% and 67% of participants in the TOTRX and LEXT groups were responders who made lumbar extensor strength gains that achieved ≥20% greater than baseline values. Although the TOTRX demonstrated the greatest improvement in walking endurance among the intervention groups, this did not reach significance (10.1 ± 12.2% improvement in TOTRX vs 7.4 ± 30.0% LEXT and −1.7 ± 17.4% CON; $P = .11$). Gait speed increased most in the TOTRX (9.0 ± 13.5%) compared with the LEXT and CON groups ($P < .05$). The change in lumbar extensor strength explained 10.6% of the variance of the regression model for the change in walking endurance ($P = .024$).

Conclusions: The use of LEXT and TOTRX produced similar modest improvements in patients' walking endurance. Lumbar extensor strength gain compared with leg strength gain is a moderate but important contributor to walking endurance in obese older adults with chronic low back pain. Responders to resistance exercise programs (event those with only lumbar extension exercise) who make at least a 20% improvement in strength can expect better improvement in walking endurance than those who do not achieve this strength improvement.

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INTRODUCTION

Muscle strength is important for the maintenance of walking ability as a person ages. Weakness in the leg muscles compromises walking endurance, gait speed, crouch, stair climbing, and rising from a chair [1,2]. Emerging evidence suggests that strength deficits in persons with no current mobility disability can predict a high risk of developing future mobility impairment [3]. As degenerative joint diseases develop in the lower extremity and spine, physical activity and muscle strength may decrease. Most authors have investigated the effects of knee extensor, knee flexor, hip extensor, and ankle plantar flexor strength on patients' walking and mobility tasks [1,3,4]. The maintenance of lumbar strength is also important for physical aspects of quality of life [5] in aging, and lumbar strength deficits exist in persons with low back pain (LBP) [6]. However, lumbar muscle strength is not commonly measured in aging-related mobility research. This is unfortunate because lumbar muscles are

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involved in key mobility tasks, and these muscles are activated at approximately 30% of maximal voluntary strength values during walking [7].

Lumbar strengthening might be a key therapeutic component in treating chronic LBP and walking impairment. The region encompassing the low thoracic and lumbar spine and associated muscles is among the most prevalent sites for pain in older adults [8], and chronic LBP is related to a greater prevalence of physical disability and difficulties performing activities of daily living and self-care [9]. Excess body weight exacerbates mobility limitations in older adults with LBP compared with healthy-weight counterparts [10]. Walking impairment diminishes the quality of life and might contribute to additional weight gain. Obesity-related lumbar muscle strength deficits [11] worsen pain severity and mobility impairment. Older patients with unrelenting LBP often resort to costly medications or medical procedures [12,13]. The physical and economic burdens of excess weight coupled with chronic LBP will likely worsen as our older population grows. Cost-effective strategies that preserve mobility are vital in preventing this escalating health care burden in the obese, older population [14].

A possible approach to improve walking performance (endurance and speed) in the obese older adult with chronic LBP is to correct strength deficits such as isolated lumbar extension exercise or a total body program that incorporates lumbar extension. We previously reported that 6 months of resistance exercise (including lumbar extension) increases lumbar strength across the range of lumbar flexion motion in healthy, overweight older adults [15]. The relative contributions of exercise-induced lumbar extension strength or leg strength to improvements in walking mobility in obese, older adults with LBP are not yet clear. The purpose of this study was to compare the effects of 4 months of isolated lumbar resistance exercise and total body resistance exercise on walking performance (endurance, gait speed) in obese, older adults with chronic LBP. A secondary analysis was performed to examine whether responsiveness to training (low back strength gain of $\geq$20% from baseline) modulated walking endurance and speed in each training group.

We hypothesized that the total body exercise group would make superior improvement in walking performance than the other groups. We also hypothesized that improvements in low back and leg strength would similarly contribute to walking endurance and speed. Finally, we hypothesized that the participants who responded better to the training (by demonstrating a $\geq$20% increase in low back strength) would achieve greater improvements in walking endurance and speed compared with participants who did not respond well (did not achieve at least a 20% increase in low back extensor strength). This improvement value was chosen because it exceeds previously published improvements in leg and lower back strength after resistance training exercise in diabetic, overweight, and obese older persons [15,16].

METHODS

Participants

Individuals with chronic LBP were recruited from the Gainesville, Florida, area and surrounding regions using the UF Orthopaedics Clinics, the Clinical Trials Register, study flyers and newspaper advertisements, and a list of older adults provided by the UF Claude Pepper Aging Center.

Inclusion Criteria. Men and women who were 60-85 years, who had a waist circumference greater than 88 cm (women) and 102 cm (men), a body mass index value of $\geq$30 kg/m^2, who were suffering from LBP for $\geq$6 months [17], who had abdominal obesity [18], and who were free of abnormal cardiovascular responses during the graded maximal walk test were eligible for the study. Exclusion criteria included being wheelchair bound, having a specific LBP or acute back injury [17], having spinal stenosis with neurogenic claudication, having back surgery within the previous 2 years [17], or currently using any pharmacologic or lifestyle weight-loss interventions. This study was approved by the University of Florida Institutional Review Board. All study processes and procedures on human subjects were conducted following the Helsinki Declaration of 1975 guidelines, as revised in 1983. All participants completed an informed consent process with the study team and signed an informed consent form. The study was registered as a clinical trial (NCT01250262).

Symptoms of LBP

The severity of back pain while the patient stood at rest was self-reported with the use of an 11-point numerical pain rating scale (NRS_{pain}) with anchors of 0, indicating no pain, and 10, indicating the worst possible pain. The NRS_{pain} measure is an accepted outcome for chronic pain conditions, as described in the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials [19]. This measurement is reliable and valid [20] for assessing pain intensity.

Walking Tests and Strength

Each participant performed walking tests (endurance time, gait speed at 2 velocities) and maximal strength testing of the lumbar muscles and the lower extremity. The primary outcomes were walking endurance time and gait speed.

Graded Treadmill Walking Exercise Test. The participant's peak aerobic capacity, or rate of oxygen consumption, was measured by the use of a graded exercise test (modified incremental treadmill Naughton) [21]. All tests followed the guidelines of the American College of Sports Medicine [22], with electrocardiogram heart monitoring and periodic blood pressure measures recorded. Open-circuit spirometry was used to determine the peak rate of oxygen use and carbon dioxide production. LBP symptoms and severity were collected