Published in final edited form as:

Am J Phys Med Rehabil. 2013 May ; 92(5): 430–438. doi:10.1097/PHM.0b013e31828763a0.

Functional Pain Severity and Mobility in Overweight Older Men and Women with Chronic Low Back Pain: Part I

Heather K. Vincent, PhD¹, Amanda N. Seay, BS¹, Cindy Montero, MS¹, Bryan P. Conrad, PhD¹, Robert W. Hurley, MD, PhD², and Kevin R. Vincent, MD, PhD¹

¹Department of Orthopaedics and Rehabilitation, Interdisciplinary Center for Musculoskeletal Training and Research

²Departments of Anesthesiology, Psychiatry, Orthopaedics and Neurology, Interdisciplinary Center for Musculoskeletal Training and Research

Abstract

Objective—This study determined whether mobility and functional pain were different among older men and women with chronic low back pain (LBP) and varying body mass index (BMI) levels.

Design—This was a comparative, descriptive study of obese, older adults with LBP (N=55; 60-85 years). Participants were stratified based on BMI: overweight (25-29.9 kg/m²), obese (30-34.9 kg/m²) and severely obese (35 kg/m²). Participants completed a functional test battery (walking endurance, chair rise, stair climb, 7-day activity monitoring, gait parameters) and pain ratings with activity ('functional pain').

Results—Functional pain scores during walking and stair climb were highest in the severely obese group compared with the overweight group (p<0.05), but functional test scores were not found to be significantly different by BMI. Gait base of support was 36% greater and single/double support times were 3.1-6.1% greater in the severely obese group compared to the overweight group (p<0.05). Women had slower chair rise and stair climb times, and had slower walking velocity than men. Daily step numbers were lowest in the severely obese group compared with the obese and overweight groups (2971 vs 3511 and 4421 steps/day; p<0.05), but were not different by gender. Normalized lumbar extensor, abdominal curl and leg press strength values were lowest in the severely obese group, and women had 18-34% lower strength values than men for all three exercises (p<0.05). Lumbar strength was associated with stair climb, chair rise and walking endurance times. BMI was an independent predictor of walking endurance time, but not steps taken per day.

Conclusions—In this study, obese persons reported higher functional pain values during walking and stair climb compared to overweight participants, and had lower lumbar strength. Rehabilitation strategies that include lumbar extensor strengthening may help improve functional

Correspondence: Heather K. Vincent, PhD Department of Orthopaedics and Rehabilitation, Division of Research UF Orthopaedics and Sports Medicine Institute PO Box 112727 Gainesville, FL 32611 .

Disclosures: Financial disclosure statements have been obtained, and no conflicts of interest have been reported by the authors or by any individuals in control of the content of this article. Funding for this project was obtained from the NIH NIAMS grant RO3 AR057552-10A1 (H.Vincent, R. Hurley, K. Vincent)

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

mobility and walking duration, both of which can help with weight management in the obese, older adult with chronic LBP.

Keywords

Low Back Pain; Obesity; Walking; Physical Function; Body Mass Index

Chronic low back pain (LBP), defined as LBP lasting longer than three months, has major medical and economic impact in the US.¹ The impact of severe LBP increases with advancing age² and is a strong contributor to mobility disability. Obese persons with LBP have increased disability, higher pain severity and worse functional capacity than non-obese counterparts.³ Pain with functional activities (walking, body transfers, home duties), or functional pain creates aversion to movement. Repeated exposure to pain with movement and activities of daily living discourages such activity and facilitates mobility disability and physical deconditioning. Functional limitations and restrictions of activities of daily living are almost double in persons with joint pain compared with persons with no pain.⁴ The loss of mobility and functional capacity resulting from back pain are serious threats to public health as they are predictive of chronic disability⁵ and increased risk of mortality.⁶

We are not aware of any evidence describing whether functional pain is influenced by the magnitude of adiposity in persons who suffer from LBP. This is an important issue, as this clinical population is rapidly expanding, and prevalence of musculoskeletal complaints such as LBP will follow suit across a range of obesity levels. A clear understanding of the relationships between functional pain and BMI will provide some basis for developing tailored interventions to treat chronic LBP and improve mobility in this population based on body habitus. Hence, the purpose of this study was to determine whether mobility and functional pain were different among older men and women with LBP and varying body mass index values. We hypothesized that participants with higher BMI values would demonstrate higher levels of functional pain, less daily mobility and lower functional capacity than those with lower BMIs.

METHODS

Participants

Participants with chronic, diffuse low back pain were recruited from the Gainesville, FL and surrounding communities using flyers, patient lists provided by the UF Claude Pepper Aging Center and the Clinical Trials Register. Potential candidates were also identified from the UF Orthopaedics and Anesthesia Pain Medicine Clinics.

Inclusion Criteria

Men and women meeting the following criteria were eligible for this study: 60-85 years; suffering from chronic low back pain for >6 months with >3 pain episodes per week;⁷ men with waist circumferences ≥ 102 cm and women with waist circumferences ≥ 88 cm;⁸ must be willing and able to participate in regular exercise for 14 weeks; using pain medications to control low back pain; free of abnormal cardiovascular responses during the graded maximal walk test.

Exclusion Criteria

Candidates were excluded if they have one or more of the following: unable to walk;⁹ pain symptoms are too severe to prevent strength testing or walking; specific low back pain or acute back injury (herniated disc, ankylosing spondylosis, other related neurologic disease);⁷ spinal stenosis that precludes walking one block due to neurogenic claudication; back

surgery within the past two years;⁷ current use of weight loss interventions. Based on BMI values, participants were stratified into overweight (BMI 25-29.9 kg/m²), obese (30-34.9 kg/m²) and severely obese (≥ 35 kg/m²) brackets. This study was approved by the University of Florida Institutional Review Board, and all procedures on human subjects were conducted in accordance with the Helsinki Declaration of 1975, as revised in 1983. All participants read, understood and signed an informed consent document.

Low Back Pain Symptoms

Back pain severity was self-assessed using an 11 point numerical pain rating scale (NRS_{pain}) with terminal descriptors (anchors of 0 = no pain; 10 = worst possible pain). The NRS is an accepted outcome measure for chronic pain conditions, as described in the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials.¹⁰ This measurement is reliable and valid¹¹ for assessing pain intensity.

Functional Mobility Tests

Each participant performed four functional tasks. During each test, the NRS_{pain} severity was used to capture pain during functional tasks (functional pain, or pain with movement). Functional pain provides insight on the adverse effects of movement rather than the speed of task completion alone.

Graded Treadmill Walking Exercise Test—The participant's maximal aerobic fitness, or rate of oxygen consumption (VO₂max) was determined using a walking symptom-limited graded exercise test (modified incremental treadmill Naughton).¹² All tests followed the guidelines of the American College of Sports Medicine,¹³ with electrocardiogram heart monitoring and periodic blood pressure measures. Open-circuit spirometry was used to determine VO₂ and carbon dioxide production. Back pain symptoms and severity were collected using the NRS_{pain} rating scale at rest (before exercise), every two minutes during exercise with workload change and every two minutes during recovery. Peak pain ratings are reported in the results, as these ratings corresponded with the highest treadmill workload. Walking time until voluntary exhaustion or pain limitation was recorded. Rating of perceived exertion values were collected at rest, at each exercise stage and during recovery.¹³

Chair Rise Time and Stair Climb Time—Chair rise time was measured as the time required for the participant to move from a sitting to a full standing position without using their arms. Chair rise difficulty has been shown to predict severe mobility impairment within 12 months in older women.¹⁴ The chair rise time is internally reliable (intraclass coefficient values range from 0.91-0.96).¹⁵ The time to walk up one flight of stairs was measured by having the participants walk up one flight of stairs consisting of 12 steps as quickly as possible.¹⁶ The stair climb test has clinical relevance as it can be used to detect leg power impairment, is strongly associated with gait speed and predicts standing balance.¹⁷ Both tests were performed three times and the fastest trial time was used for data analysis.

Gait Analysis—Gait analysis consisted of walking on a 26-foot long gait mat (GaitRite®; CIRSystems, Inc.; Havertown, PA). Assessments included walking at a self-selected, comfortable pace and at the fastest possible pace. The importance of capturing gait characteristics at the fastest possible pace reflects the ability to perform higher intensity exercise compared with self selected comfortable pace. Short distance walking speed of distances less than 10m is a very strong predictor of adverse health events and premature mortality.¹⁸ Measurement of the fastest walking speed has prognostic ability to predict increased incidence of persistent lower extremity physical limitations¹⁹ and functional

dependence.²⁰ This gait mat has been shown to have good within day repeatability in persons with lower extremity joint pain.²¹

Ambulatory Activity—To document the daily mobility patterns, a 7-day pedometer test was administered in which participants wore a StepWatch® step activity monitor (SAM; Cyma, Seattle, WA). It is an accurate, dual-axis accelerometer device designed to count steps in individuals with disabilities, abnormal or slow gaits, or lower-extremity prostheses, and has been validated in these populations.²² This activity measurement has been successfully used in obese patients with low back pain.²³

Muscle Strength—Assessments of strength (1 repetition maximum, 1-RM) were determined for major muscle groups relating to low back stabilization: lumbar extension, abdominal curl and leg press. After a five minute warm up of walking on the treadmill, the participant would perform five light intensity repetitions, three moderate intensity repetitions and progressively heavier repetitions separated by one minute rest period. The maximum weight that could be lifted once with appropriate form was considered the 1-RM for the exercise.

Statistics

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS; v.20.0). Data were managed using REDCap (Research Electronic Data Capture).²⁴ Descriptive statistics and frequencies were obtained to characterize the three BMI groups; Chi square tests were used for categorical variables. Wilcoxon rank-sum tests were used to determine whether there were group differences in joint pain symptoms and in the self-reported limitations with walking or stair climbing. As confirmed by Levene's test, the assumptions of the F tests were met for all data presented. A one way analysis of variance was used to determine if differences existed between groups for the outcome measures, with the study group as the independent variable and gait, functional task scores as the dependent variables. A Tukey post-hoc test was used to identify where differences occurred. Univariate analysis of variance were performed on select dependent variables of gait parameters and functional mobility tests and daily steps to determine whether gender influenced functional pain and mobility in these three BMI strata. BMI (overweight; obese, severely obese) and gender (men, women) were the independent variables.

Pearson correlations were performed to determine the relationships between functional pain values and daily activity, chair rise and stair time; a Bonferroni correction was used to correct for multiple correlations. To determine whether BMI predicted walking endurance or daily activity, two hierarchical regression analyses was performed. Walking endurance time and steps taken per day were the two separate dependent variables. After accounting for main patient variables in the model that might contribute to variations in walking endurance or daily steps (age, sex, race, lumbar strength, pain severity), BMI was added to the models. Significance was established at $p < 0.05$ for all statistical tests.

RESULTS

Participant Characteristics

Of the 191 candidates that responded to recruitment, 63 were screened eligible and were invited to participate. Table 1 provides the characteristics of each of the three BMI groups: non-obese, overweight and obese. A total of 55 participants completed all measurements ($n=17$, overweight; $n=26$, obese; $n=12$, severely obese). Differences were detected among the three BMI groups for waist circumference and body weight ($p < 0.05$). No other

differences were detected among the three BMI groups for demographic or physiologic characteristics or number of medications used.

Functional Pain Severity

As shown in Figure 1a, pain severity during treadmill walking and climbing stairs was highest in the severely obese group compared with the overweight and obese groups. Univariate analyses revealed that there were no significant BMI*gender interactions for functional pain severity with walking, chair rise or stair climb (Figure 1b).

Functional Mobility

Among the functional mobility tests, chair rise time and stair climb times were not found to be significantly different based on BMI group (Table 2). Although walking endurance time was 17.6% less in the severely obese group than the overweight group, this difference did not achieve significance ($p=0.156$). Differences were found among groups for select temporospatial parameters including width of the base of support, single support time and double support time. For select mobility variables (Table 3), univariate analyses revealed that there were significant main gender effects for chair rise time, stair climb time, walking velocity, and stride length. There was a significant BMI*gender interaction for the dependent variable of walking base of support.

Activity patterns were found to be different among the groups (Table 4). Compared with the overweight group, the severely obese group took 32% fewer daily steps and participated in 2.5% less of total daily time doing moderate activity and 4.7% more daily total time being inactive. There was no significant main effect or BMI*gender interaction for daily activity and time spent engaged in different intensities of daily activity.

Absolute maximal muscle strength (1-RM values) were not found to be different between groups for any exercise (Table 5). When strength was normalized to body weight, however, leg press values were lower in the severely obese group compared with the overweight group. Women had significantly lower absolute and normalized strength values for all exercises than men in each BMI stratum. For example, abdominal curl strength was 30-43% lower, leg press was 18-32% lower and lumbar extension strength was 14-42% lower in women than men in the different BMI groups.

Correlations and Regression

Partial correlations (adjusted for gender) were found between functional pain scores of stair climb time ($r = 0.304$) and of chair rise time ($r = 0.400$). Inverse partial correlations (adjusted for gender) existed between normalized back extensor strength and chair rise time, stair climb time ($r = -0.305$ and -0.456 ; both $p < 0.001$) and positive correlations existed between lumbar extensor strength and walking endurance and walking velocity ($r = 0.490$ and 0.430 ; both $p < 0.0001$). Strength values were not related to daily activity or proportions of time spent performing different levels of activity. In the two regression analyses (Table 6), BMI values were moderate but significant predictors of the variance of walking endurance time, but not for steps taken per day.

Summary

Overall, obese and severely obese participants reported higher NRS pain values during loading bearing tasks such as walking and stair climb. Gait in severely obese participants was characterized by wider base of support and longer double support time to enhance stability. Daily steps taken and percent of daily time spent doing moderate activity was lowest in the severely obese group. Normalized strength for all exercises was lower in severely obese persons compared to overweight persons, and in lower in women than men.

Pain was related with stair and chair function, and lumbar extensor strength was related to overall functional test performance, but neither pain nor strength were associated with daily activity patterns. BMI was an independent predictor for walking endurance time, but not daily activity (steps/day).

DISCUSSION

We examined the relationships between mobility and functional pain in overweight, older men and women with LBP. Obese participants ($BMI > 30 \text{ kg/m}^2$) demonstrated higher functional pain values during walking and stair climb than overweight participants, and less daily ambulation and less favorable gait parameters. Stair climb was most challenging for the severely obese participants, with highest pain scores among the three BMI groups during this activity. BMI was a significant predictor of walking endurance time in our regression analysis.

Musculoskeletal pain has been identified as a culprit underlying low walking endurance in morbidly obese persons.²⁵ In the present study, the walking endurance times in the obese and severely obese persons were 15-18% less than those of the overweight group, although these differences did not achieve significance. We did find that despite the lower endurance, functional pain values (rated during walking and stair climb) were higher in severely obese participants than in overweight participants. Normalized lumbar extensor strength values were related to all functional test scores but not patterns of daily activity. Functional low back pain values for the different tasks were not different between men and women in this study, however. These findings reflect an elevated LBP pain burden in severely obese persons during daily mobility tasks. The fact that we did not detect any performance differences among BMI groups during the chair rise task may be due to the adoption of movement strategies to offload the lumbar spine in obese persons. Specifically, obese individuals have reduced trunk flexion and have a posterior movement of the feet compared to non-obese individuals.²⁶ This biomechanical shift significantly reduces the torque on the lumbar spine, and likely suppresses pain symptoms while shifting loading and pain to the knees.

We anticipated that greater functional pain ratings might translate to fewer daily steps taken and less time engaged in physical activity. While our activity monitoring found progressively lower daily steps and time spent in moderate activity with higher BMI, the back pain values during walking did not correlate with steps or activity time and BMI was not a significant predictor of daily steps taken in our regression analyses. However, the correlations between pain severity and time to complete other tasks such as stair climb or chair rise were significant. The inconsistency between pain and daily activity levels was similar to that reported by Huijnen et al²⁷ in middle-aged participants; these authors postulated that pain ratings and actual physical function levels are modulated in part by participant methods of perceiving and coping with pain during different activities. Persons with persistent traits (to keep moving despite pain) compared to avoidance traits (stop doing activity when it hurts) might have lasting higher pain values even when they are not exercising because they push themselves to complete painful activity.²⁷ In the present study, we did not measure these characteristics, but we believe that some of the lack of strong relationship between functional pain and daily steps may be due to these varying personality traits in our heavier participants.

Lumbar extensor muscle strength was inversely associated with chair rise and stair climb time, but not with daily steps or time spent doing different intensities of activity. An interpretation is that variation in participant perception and tolerance to pain during movement results in achievement of long walking times in some persons compared with

others irrespective of pain or lumbar strength. Female gender and elevated BMI negatively predict walking distance.²⁸ Thus, the lower prevalence of women in our severely obese group may have reduced the ability to detect significant differences in walking endurance (Table 3). What may complicate the relationships between these study variables is that there are adaptive muscle activation strategies in LBP, such as guarding and activation of different muscles compared to persons without back pain.²⁹ Also, obese persons likely have other joint pains that might impede walking endurance independent of back pain (foot, ankle, knee), and discomforts such as respiratory difficulty and skin friction and vein varicosity.²⁵ Very few comparative data exist on the effects of low back strength on daily activities and activity patterns in this population. However, some data suggest that low back pain itself does not necessarily decrease daily activity patterns, and some individuals may be more likely to reduce activity than others.³⁰ For example, a higher prevalence of middle-aged persons with the onset of chronic LBP and a decrease of physical activity were characterized by greater fear of movement due to pain (kinesiophobia) and pain catastrophizing.³⁰

Considerations for Future Directions

A strength of the present study is that we assessed several understudied factors in a unique population with LBP. Both objective and subjective validated measurements were used to examine the relationships between the study variables. These findings will help refine potential targets for interventions in obese, older persons with LBP, and have generated new questions for further inquiry. Compared to our cross sectional study design, a larger, long term prospective study design would: 1) permit identification of factors that predict severe mobility disability over time, and 2) generate statistical power necessary to stratify analyses by gender and age. Additional information about the characteristics of the back extensor muscles such as the multifidus muscle (fat and connective tissue content, fiber angulation and fiber typing) relative to functional pain and mobility in this clinical population would prove very insightful. Radiographic imaging of the degree of lumbar spine degeneration and inflammatory cytokine levels would help create a comprehensive profile of other factors that modify functional pain and mobility in the obese older adult with chronic LBP. Finally, testing the efficacy of different interventions to improve low back strength may make daily functional tasks easier and may promote longer walking durations, both of which would help with weight and pain symptom management in the obese older adult.

CONCLUSIONS

In this study, severely obese persons reported higher functional pain values during walking and stair climb, and did not participate in as much daily movement compared to overweight participants. BMI was a significant predictor of walking endurance. Rehabilitation strategies that address the lumbar strength deficits in obesity may improve functional mobility and may promote longer walking durations, both of which can help with weight management in the obese, older adult with chronic low back pain.

Acknowledgments

This publication was made possible by Grant Number RO3 AR057552-10A1 from NIAMS/NIH. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the NIAMS or NIH. Study data were collected and managed using REDCap electronic data capture tools hosted at the University of Florida (CTSA grant UL1 TR000064).

REFERENCES

1. Chapman JR, Norvell DC, Hermsmeyer JT, et al. Evaluating common outcomes for measuring treatment success for chronic low back pain. *Spine (Philadelphia PA)*. 2011; 36(21 Suppl):S54–S68.

2. Macfarlane GJ, Beasley M, Jones EA, et al. The prevalence and management of low back pain across adulthood: results from a population-based cross-sectional study (the MUSICIAN study). *Pain*. 2012; 153(1):27–32. [PubMed: 21978663]
3. Fanuele JC, Abdu WA, Hanscom B, Weinstein JN. Association between obesity and functional status in patients with spine disease. *Spine*. 2002; 27(3):306–312. [PubMed: 11805697]
4. Covinsky KE, Lindquist K, Dunlop DD, Yelin E. Pain, functional limitations, and aging. *Journal of the American Geriatrics Society*. 2010; 57(9):1556–1561. [PubMed: 19682122]
5. Rejeski WJ, Ip EH, Marsh AP, Zhang Q, Miller ME. Obesity influences transitional states of disability in older adults with knee pain. *Archives of Physical Medicine and Rehabilitation*. 2008; 89(11):2102–2107. [PubMed: 18996238]
6. Nocera J, Buford TW, Manini TM, et al. The impact of behavioral intervention on obesity mediated declines in mobility function: implications for longevity. *Journal of Aging Research*. 2011; 2011:392510. [PubMed: 22013527]
7. Helmhout PH, Harts CC, Staal JB, Candel MJ, de Bie RA. Comparison of a high-intensity and a low-intensity lumbar extensor training program as minimal intervention treatment in low back pain: a randomized trial. *European Spine Journal*. 2004; 13(6):537–547. [PubMed: 15095072]
8. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection EaToHBCiA. *Journal of the American Medical Association*. 2001; 285:2486–2497. [PubMed: 11368702]
9. Izquierdo-Porrera AM, Gardner AW, Powell CC, Katzell LI. Effects of exercise rehabilitation on cardiovascular risk factors in older patients with peripheral arterial occlusive disease. *Journal of Vascular Surgery*. 2000; 31(4):670–677. [PubMed: 10753274]
10. Dworkin RH, Turk DC, Wyrwich KW, et al. Interpreting the clinical importance of treatment outcomes in chronic pain clinical trials: IMMPACT recommendations. *Journal of Pain*. 2008; 9(2): 105–121. [PubMed: 18055266]
11. Von Korff M, Jensen MP, Karoly P. Assessing global pain severity by self-report in clinical and health services research. *Spine*. 2000; 25(24):3140–3151. [PubMed: 11124730]
12. Vincent KR, Braith RW, Feldman RA, Kallas HE, Lowenthal DT. Improved cardiorespiratory endurance following 6 months of resistance exercise in elderly men and women. *Archives of Internal Medicine*. 2002; 162(6):673–678. [PubMed: 11911721]
13. American, College, of, Sports, Medicine. ACSM's Guidelines for Exercise Testing and Prescription. 6 ed. 6 ed. Lippincott Williams and Wilkins; Philadelphia: 2000.
14. Rivera JA, Fried LP, Weiss CO, Simonsick EM. At the tipping point: predicting severe mobility difficulty in vulnerable older women. *Journal of the American Geriatrics Society*. 2008; 56(8): 1417–1423. [PubMed: 18808598]
15. Smeets RJ, Hjdra HJ, Kester AD, Hitters MW, Knottnerus JA. The usability of six physical performance tasks in a rehabilitation population with chronic low back pain. *Clinical Rehabilitation*. 2006; 20(11):989–997. [PubMed: 17065542]
16. Vincent KR, Braith RW, Feldman RA, et al. Resistance exercise and physical performance in adults aged 60 to 83. *Journal of the American Geriatrics Society*. 2002; 50(6):1100–1107. [PubMed: 12110072]
17. Bean JF, Kiely DK, LaRose S, Alian J, Frontera WR. Is stair climb power a clinically relevant measure of leg power impairments in at-risk older adults? *Archives of Physical Medicine and Rehabilitation*. 2007; 88(5):604–609. [PubMed: 17466729]
18. Cesari M, Pahor M, Lauretani F, et al. Skeletal muscle and mortality results from the InCHIANTI Study. *Journal of Gerontology A Biological Sciences and Medical Science*. 2009; 64(3):377–384.
19. Cesari M, Kritchevsky SB, Penninx BW, et al. Prognostic value of usual gait speed in well-functioning older people--results from the Health, Aging and Body Composition Study. *Journal of the American Geriatrics Society*. 2005; 53(10):1675–1680. [PubMed: 16181165]
20. Rantanen T, Guralnik JM, Ferrucci L, et al. Coimpairments as predictors of severe walking disability in older women. *Journal of the American Geriatrics Society*. 2001; 49(1):21–27. [PubMed: 11207838]
21. Rome K, Hanchard NC. Within-day reliability of temporal-spatial gait parameters associated with rheumatoid arthritic feet. *Musculoskeletal Care*. 2005; 3(1):17–23. [PubMed: 17041990]

22. Storti KL, Pettee KK, Brach JS, Talkowski JB, Richardson CR, Kriska AM. Gait speed and step-count monitor accuracy in community-dwelling older adults. *Medicine & Science in Sports & Exercise*. 2008; 40(1):59–64. [PubMed: 18091020]
23. Yamakawa K, Tsai CK, Haig AJ, Miner JA, Harris MJ. Relationship between ambulation and obesity in older persons with and without low back pain. *International Journal of Obesity*. 2004; 28(1):137–143. [PubMed: 14557828]
24. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research Electronic Data Capture [REDCap] – A metadriven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*. 2009; 42(2):377–381. [PubMed: 18929686]
25. Hulens M, Vansant G, Claessens AL, Lysens R, Muls E. Predictors of 6-minute walk test results in lean, obese and morbidly obese women. *Scandinavian Journal of Medicine and Science in Sports*. 2003; 13(2):98–105.
26. Sibella F, Galli M, Romei M, Montesano A, Crivellini M. Biomechanical analysis of sit-to-stand movement in normal and obese subjects. *Clinical Biomechanics (Bristol, Avon)*. 2003; 18(8):745–750.
27. Huijnen IP, Verbunt JA, Peters ML, et al. Differences in activity-related behaviour among patients with chronic low back pain. *European Journal of Pain*. 2011; 15(7):748–755. [PubMed: 21195646]
28. Tomkins-Lane CC, Holz SC, Yamakawa KS, et al. Predictors of walking performance and walking capacity in people with lumbar spinal stenosis, low back pain, and asymptomatic controls. *Archives of Physical Medicine and Rehabilitation*. Feb.2012 22 (epub ahead of print).
29. van der Hulst M, Vollenbroek-Hutten MM, Rietman JS, Schaake L, Groothuis-Oudshoorn KG, Hermens HJ. Back muscle activation patterns in chronic low back pain during walking: a “guarding” hypothesis. *Clinical Journal of Pain*. 2010; 26(1):30–37. [PubMed: 20026950]
30. Bousema EJ, Verbunt JA, Seelen HA, Vlaeyen JW, Knottnerus JA. Disuse and physical deconditioning in the first year after the onset of back pain. *Pain*. 2007; 130(3):279–286. [PubMed: 17467902]

Figure 1.
a. Functional pain severity ratings during a walking endurance test, a chair rise test and a stair climb test in overweight, obese and severely obese participants with chronic LBP. Values are means $\pm$ SD. **b.** Functional pain severity ratings during functional tests by BMI group and gender. Values are means $\pm$ SD.

Table 1Participant characteristics. Values are means $\pm$ SD or % of the group.

	Overweight	Moderately Obese	Severely Obese	p (sig)
Age (yr)	70.0 $\pm$ 6.6	67.7 $\pm$ 6.9	65.7 $\pm$ 6.4	0.43
Women (% , #)	73.7, 13	61.3, 16	58.8, 7	0.56 [^]
Caucasian (%)	100	83.9	88.2	0.18 [^]
Weight (kg)	76.9 $\pm$ 13.2	92.5 $\pm$ 13.5 *	107.5 $\pm$ 14.9 **	0.0001
Waist (cm)	98.0 $\pm$ 5.6	104.8 $\pm$ 9.7 *	114.7 $\pm$ 7.9 **	0.0001
BMI (kg/m ²)	27.6 $\pm$ 2.1	32.3 $\pm$ 1.4 *	38.6 $\pm$ 3.1 **	0.0001
Widowed	26.3	11.3	17.6	0.50 [^]
Employment status (%)				
Retired	63.2	67.7	52.9	
Employed	21.1	19.4	23.5	
Disabled	5.3	9.7	11.8	
Not working	10.5	3.2	11.8	0.63 [^]
Living alone (%)	26.3	32.3	23.5	0.72 [^]
Total medications (#)	5.9 $\pm$ 4.0	6.1 $\pm$ 2.9	7.6 $\pm$ 4.3	0.83
Pain medications (#)	1.8 $\pm$ 1.2	1.4 $\pm$.0.7	1.6 $\pm$ 1.0	0.44

* different than overweight group

** different than remaining groups at p<0.05.

[^] group differences tested using a Chi square test.

Table 2

Functional mobility tests and gait in overweight older adults with chronic low back pain Values are means $\pm$ SD or % of the group. * $p < 0.05$; different from the overweight group

(sig)	Overweight	Moderately	Severely	p
		Obese	Obese	
Walking endurance (min)	14.2 $\pm$ 4.5	12.0 $\pm$ 4.3	11.7 $\pm$ 4.2	0.16
Chair rise time (sec)	1.1 $\pm$ 0.5	1.1 $\pm$ 0.5	0.9 $\pm$ 0.4	0.65
Stair climb time (sec)	5.3 $\pm$ 1.4	5.7 $\pm$ 1.8	6.0 $\pm$ 3.2	0.80
Gait parameters				
Walking velocity (cm/sec)	117 $\pm$ 15	115 $\pm$ 26	104 $\pm$ 18	0.18
Cadence (steps/min)	109 $\pm$ 8.8	109 $\pm$ 13	104 $\pm$ 6	0.33
Stride length (cm)	130 $\pm$ 18	120 $\pm$ 29	120 $\pm$ 1	0.41
Base of support (cm)	8.4 $\pm$ 3.1	10.3 $\pm$ 3.9	13.1 $\pm$ 5.1	* 0.01
Single support time (%)	35.6 $\pm$ 1.5	34.4 $\pm$ 2.1	32.5 $\pm$ 2.3	* 0.0001
Double support time (%)	28.8 $\pm$ 2.9	31.5 $\pm$ 4.0	34.9 $\pm$ 4.0	* 0.0001
Toe out angle, left ($^{\circ}$)	5.3 $\pm$ 5.2	6.1 $\pm$ 5.7	6.4 $\pm$ 5.4	0.25
Toe out angle, right ($^{\circ}$)	8.2 $\pm$ 5.2	9.4 $\pm$ 5.5	6.9 $\pm$ 6.1	0.25
Fastest walking velocity (cm/sec)	163 $\pm$ 23	155 $\pm$ 24	155 $\pm$ 31	0.59

Table 3

Select functional mobility tests and gait variables based on BMI stratum and gender. Values are means $\pm$ SD

	Overweight		Moderately Obese		Severely Obese		Sig
	Men	Women	Men	Women	Men	Women	
Walking endurance (min)	14.3 $\pm$ 3.3	14.2 $\pm$ 4.9	12.6 $\pm$ 4.2	11.6 $\pm$ 4.3	13.3 $\pm$ 4.9	9.9 $\pm$ 2.7	
Chair rise time (sec)	0.8 $\pm$ 0.1	1.3 $\pm$ 0.5	0.8 $\pm$ 0.3	1.2 $\pm$ 0.5	1.0 $\pm$ 0.4	1.0 $\pm$ 0.3	b
Stair climb time (sec)	4.7 $\pm$ 0.7	5.8 $\pm$ 1.4	4.7 $\pm$ 1.1	6.3 $\pm$ 1.9	4.5 $\pm$ 0.7	7.3 $\pm$ 3.7	b
Walking velocity (cm/sec)	123 $\pm$ 11	116 $\pm$ 16	127 $\pm$ 30	109 $\pm$ 21	113 $\pm$ 17	97 $\pm$ 14	b
Stride length (cm)	140 $\pm$ 16	127 $\pm$ 18	125 $\pm$ 45	119 $\pm$ 15	132 $\pm$ 16	109 $\pm$ 17	b
Base of support (cm)	8.2 $\pm$ 3.5	8.5 $\pm$ 3.1	8.6 $\pm$ 3.7	11.1 $\pm$ 3.8	15.3 $\pm$ 4.8	11.0 $\pm$ 4.3	a, c
Double support time (% of cycle)	28.4 $\pm$ 2.2	28.9 $\pm$ 3.2	30.2 $\pm$ 3.3	32.2 $\pm$ 4.3	33.5 $\pm$ 1.9	36.8 $\pm$ 4.7	a, b

Significance values: a = BMI effect; b = gender effect; c = interaction of BMI*gender at $p < 0.0$

Table 4

Ambulatory activity in overweight, older adults with chronic low back pain. Values are means $\pm$ SD or % of the group

	Overweight	Moderately Obese	Severely Obese	p (sig)
Daily activity (steps/day)	4421 $\pm$ 1633	3511 $\pm$ 1870	2971 $\pm$ 1053 *	0.02
Time spent doing:				
High activity (% of day)	1.1 $\pm$ 0.8	1.0 $\pm$ 0.9	0.7 $\pm$ 0.6	0.50
Moderate activity (% of day)	6.8 $\pm$ 2.7	5.5 $\pm$ 2.9	4.3 $\pm$ 1.4 *	0.02
Low activity (% of day)	14.2 $\pm$ 3.8	11.8 $\pm$ 4.1	13.2 $\pm$ 3.3	0.15
No activity (% of day)	77.8 $\pm$ 6.4	81.3 $\pm$ 6.6	82.5 $\pm$ 4.9 *	0.02

% of day = during a 24 hour period

High activity = > than 30 steps/min; Moderate activity = 15-30 steps/min; Low activity = 1 to 14 steps/min

* p<0.05; different from the Overweight group

Table 5

Muscle strength in overweight older adults with chronic low back pain. Values are expressed as a 1-repetition maximum values and by normalized values (divided by body mass). Values are means $\pm$ SD

	Overweight	Moderately Obese	Severely Obese	p (sig)
<i>Absolute values</i>				
Lumbar extension (Nm)	176 $\pm$ 107	217 $\pm$ 119	203 $\pm$ 73	0.49
Abdominal curl (Nm)	51 $\pm$ 26	62 $\pm$ 35	70 $\pm$ 42	0.39
Leg press (Nm)	409 $\pm$ 151	480 $\pm$ 176	433 $\pm$ 178	0.40
<i>Normalized values</i>				
Lumbar extension (Nm/kg)	1.6 $\pm$ 0.7	1.7 $\pm$ 0.8	1.3 $\pm$ 0.5	0.45
Abdominal curl (Nm/kg)	0.5 $\pm$ 0.2	0.5 $\pm$ 0.2	0.4 $\pm$ 0.3	0.89
Leg press (Nm/kg)	3.9 $\pm$ 1.1	3.8 $\pm$ 1.1	2.9 $\pm$ 1.1	0.05 *

*
p<0.05 across the three groups

Table 6

Hierarchical regression analyses for walking endurance (A) and steps taken per day (B)

A. Walking Endurance	R	R ²	R ² Change	Significance of <i>F</i> Change	B (CI)
Block 1 Age					
Sex					
Race	0.573	0.329	0.329	7.972 (p=0.0001)	-1.723 (-4.631 to 1.185)
Block 2 Back extensor strength	0.696	0.485	0.157	14.624 (p=0.0001)	3.221 (1.527 to 4.194)
Block 3 Pain severity	0.696	0.485	0.000	0.001 (p=0.982)	.005 (-.426 to .436)
Block 4 BMI	0.727	0.528	0.043	4.226 (p=0.046)	-.219 (-.433 to -.005)

Each block includes the listed variables and the addition of each previous block, and represents a separate regression equation. B (CI) = unstandardized B coefficient and confidence interval

B. Steps Taken Per Day	R	R ²	R ² Change	Significance of <i>F</i> Change	B (CI)
Block 1 Age					
Sex					
Race	0.389	0.151	0.151	2.791 (p=0.051)	-678.8 (-2007.6 to 649.9)
Block 2 Back extensor strength	0.398	0.159	0.007	0.047 (p=0.526)	284.6 (-612.8 to 1182.1)
Block 3 Pain severity	0.405	0.164	0.005	0.291 (p=0.592)	61.9 (-169.4 to 293.2)
Block 4 BMI	0.444	0.197	0.033	1.796 (p=0.187)	-76.6 (-191.7 to 38.6)

Each block includes the listed variables and the addition of each previous block, and represents a separate regression equation.

B (CI) = unstandardized B coefficient and confidence interval

Sex coded = 0 male, 1 female; Race coded 1 = Caucasian, 2 = African American, 3 = Hispanic, 4 = Asian