

Research article

The effect of high resistance weight training on reported pain in older adults

Kathleen M. Knutzen ✉, Bethany A. Pendergrast, Billie Lindsey and Lorraine R. Brilla
Western Washington University, Bellingham, WA, USA

Abstract

The present study examined the effect of a progressive, whole-body, high resistance training program on reported pain in older adults. Ninety-eight participants (60 – 83 years) completed the McGill Pain Questionnaire prior to and after an eight week training period. Seventy-nine of the participants completed a progressive, high resistance training program of 11 different exercises on three days a week. At the end of eight weeks, the training group achieved significant strength gains ranging from 62% -119% ($p \leq 0.005$). Pain measures for the training and control groups were compared using an analysis of covariance on post-test pain measures after an adjustment by pre-test scores. ($p \leq 0.05$). The training group reported less perceived pain than the control group in four pain measures (overall pain intensity, sensory dimension, miscellaneous pain measures, number of pain descriptors selected). There were no differences reported for the affective or evaluative dimensions of perceived pain, the number of painful areas, or the present pain. Results suggest that eight weeks of progressive, whole-body weight training has a positive impact on perception of pain in older adults.

Key words: McGill Pain Questionnaire, joint pain, strength.

Introduction

With increasing age, a complex process of physiologic changes occur (American College of Sports Medicine [ACSM], 1998). Chronic musculoskeletal conditions, such as osteoarthritis (OA), fractures associated with osteoporosis, and low back disorders become more prevalent; and these chronic conditions cause a considerable amount of pain in older adults (Roche and Forman, 1994; Vuori, 2001). Chronic pain among the elderly represents a major public health concern (Brattberg et al., 1997; Crook et al., 1984; Von Korff et al., 1988). An estimated 87% of community dwelling older adults suffer from pain, while among nursing home residents, the prevalence is as high as 80% (Herr and Garand, 2001). In older adults living in rural Iowa, as high as 86% reported pain of some type with 59% reporting multiple pain complaints (Mobily et al., 1994).

In the elderly, chronic pain is mainly a result of degenerative joint and spine disease coupled with leg and foot disorders (Helme and Gibson, 2001). Chronic pain results in decreased movement and loss of strength (Marcus, 2000) and limits the ability to engage in the activities of daily living (Rucker et al., 1996). The risk of falling is higher among those with chronic pain (Marcus, 2000) and falls are one of the leading causes of injury, disability, and

premature death in the elderly. In addition to the physical risks, older adults with chronic pain experience depression, impaired cognitive function, sleep disturbance, diminished socialization, and loss of independence (Herr and Garand, 2001; Marcus, 2000; Roche and Forman, 1994; Vuori, 2001). Furthermore, they are five times more likely to use health care services than elderly without chronic pain (Marcus, 2000) and incur higher health care costs (Herr and Garand, 2001; Woolf and Pfleger, 2003). It is therefore understandable that chronic pain plays a major role in a diminished quality of life among the elderly (Crook et al., 1984).

One major cause of chronic pain in the elderly is osteoarthritis (OA), a degenerative joint disease that affects 50% of Americans 65 years of age and older (AGS, 2001) and 80% of Americans 75 years of age and older (McCarberg and Herr, 2001). OA is a commonly associated with chronic joint pain, loss of range of motion, and muscle weakness. (Kovar et al., 1992). Sarcopenia, a loss of muscle mass and strength that occurs with aging, may contribute to the disability and pain of patients with OA (Hurley and Roth, 2000; Suomi and Collier, 2003).

Strength training is thought to reduce functional instability and pain in older osteoarthritic patients by preventing sarcopenia and by improving the strength and function of the surrounding connective tissue (AGS, 2001; Hughes et al., 2004; Hurley and Roth, 2000). Several studies support that strength training can significantly reduce pain in elderly patients with OA (Baker et al., 2001; Hughes et al., 2004; O'Reilly et al., 1999; Rogind et al., 1998; Shilke et al., 1996; Suomi and Collier, 2003). Combination exercise programs (aerobic and strength) (Focht, 2006) as well as long-term exercise programs (Wildner et al., 2006) are also seen as effective for improvement of knee pain in individuals with osteoarthritis. A long term pattern of aerobic exercise has been shown to reduce reported pain values in older adults by as much as 25% (Bruce et al., 2005) and exercise in general has been shown to be an effective pain management strategy (Kemp et al., 2005).

Other medical conditions such as rheumatoid arthritis (RA), back pain, and osteoporosis have also been shown to benefit from exercise programs. In a study of RA patients, a 12-week progressive high-resistance training program did not change the number of painful or swollen joints in participants; however, a significant reduction (21%) occurred in participants' self-reported pain score (Rall et al., 1996). A 10-week exercise program of balance, strength, flexibility and relaxation resulted in a significant reduction in reported pain by participants with

osteoporosis (Malmros et al., 1998). Similarly, a 12-month program of aerobic, flexibility, and strengthening exercises focusing primarily on the upper limbs, shoulder girdle, the abdomen, and the back of osteopenic women lowered back pain intensity (Bravo et al., 1996). Physical training that reconditions back muscles has also been shown to be effective therapy for low back pain (Johannsen et al., 1995; Mannion et al., 1999).

Clinical investigators have long recognized that pain has many qualities and dimensions (Melzack, 1983). In recent decades pain has come to be regarded as a multidimensional construct: sensory qualities of pain, affective reactions to pain, and pain intensity (Holroyd et al., 1996). The McGill Pain Questionnaire (MPQ), developed in 1975 by Melzack and Torgerson, is a well-known and frequently used multidimensional instrument for measuring the quality and intensity of pain in English-speaking countries. It quantifies three dimensions of the pain experience: sensory, affective, and evaluative (Chapman et al., 1985). The purpose of this study was to examine the effect of a whole-body progressive strength training program on selected pain parameters of older adults. Several indices of the MPQ were administered before and after an eight-week strength training program to measure participants' self-reported pain. The university Human Subjects Review Board approved this study.

Methods

Participants

Participants for this study were recruited through advertisements via the local hospital network, community senior centers, and retirement homes within the county. There were 97 volunteer participants, 57 women (59%) and 40 men (41%) assigned to a control ($n = 19$) and treatment group ($n = 79$). The older adults ranged in age from 60-83 (Treatment $M = 71.5 \pm 6.5$ yrs.; Control $M = 70.0 \pm 6.5$ yrs). The height of participants ranged from 102 to 184 cm (Treatment $M = 1.66 \pm 0.11$ m; Control $M = 1.68 \pm 0.08$ m) and in weight from 49 to 126 kg (Treatment $M = 76.0 \pm 14.8$ kg; Control $M = 73.1 \pm 17.1$ kg). Participants received medical clearance from their physicians before participation in the study. They were excluded if they suffered from any serious medical conditions, including uncontrolled heart or respiratory problems and dementia.

Instrument

The MPQ is a reliable and valid measure of the quality and quantity of pain that is frequently used in pain-related research (Chapman et al., 1985; Love et al., 1989; Melzack, 1975). Recognizing that pain is a multidimensional parameter, the MPQ evaluates pain affect, sensory qualities of pain, pain intensity as well as other subjective dimensions. This allows for a quantification of distinct components of the pain experience. The MPQ provides an estimate of overall pain intensity: the Pain-Rating Index Total (PRIT). The PRIT consists of a set of 78 verbal descriptors listed on one page in 20 subclasses of 2 to 6 words each. Each list is arranged in a continuum from low to high intensity. The overall PRIT score is obtained by summing all of the descriptors selected. Scores range

from 0 to 78, with 78 being the most intense. A higher score on the PRIT denotes more pain. Sub dimensions of the PRIT include measures of the PRI-sensory [0-42], the PRI-affective [0-14], the PRI-evaluative [0-5], and the PRI-miscellaneous [0-17] (Wilkie et al., 1990). Each one of these sub dimensions measures a unique component of self-reported pain. The PRI-affective dimension evaluates the emotional response to pain such as considering the pain to be tiring or sickening and is reflective of the perceived disruption engendered by the pain experience. The PRI-sensory is a measure of pain sensation and is reflective of a sensory-discriminative psychological dimension. The PRI-evaluative is representative of the cognitive response to pain and whether pain is perceived to be bearable or irritable. A final PRI-miscellaneous dimension includes four clusters of words that are descriptive of a variety of pain qualities including words such as radiating, cool, agonizing, numb, nagging, spreading, piercing and dreadful.

Another variable is the total number of words chosen (NWC) on the MPQ which ranges from 0-20. Present Pain Intensity (PPI) is a variable on the MPQ that is the number-word combination chosen as the indicator of overall pain intensity. The levels of the PPI scale include none, mild, discomforting, distressing, horrible, and excruciating (range 0-5) (Escalante et al., 1995). PPI is a measure of how much a person hurts and is an estimation of the magnitude of the pain. The final component of MPQ, the number of painful areas (NPA), consists of anterior and posterior line drawings of the body on which participants indicate the spatial distribution of their pain. Participants mark the location of their pain on the NPA by using the letter "E" for external pain, "I" for internal pain, or "EI" if their pain is both internal and external (Escalante et al., 1995). To score the NPA, a transparent plastic template containing the human figure divided into 36 numbered regions is overlaid on the marked pain maps. The number of painful areas (NPA) affected can be recorded as the sum of individual body areas affected with pain (Escalante et al., 1995).

Measurement technique and procedures

Upon arrival at the pre-test, participants read and signed written informed consent. To assure completion of the MPQ, research assistants administered individual assessments by providing verbal information on the selections. Participants manually completed the written form of the MPQ. All subjects in the training group were required to attend three resistance training sessions per week for eight weeks. All subjects completed the study. At the end of the eight weeks, the MPQ was re-administered to both the control and the training groups.

Participants trained in groups of 2 to 4 people. At least one trainer was present for every four participants. The training sessions began with 5 to 10 minute warm-up and stretching exercises for the legs, trunk, and arms, followed by 11 different resistance exercises on Cybex (VR2) equipment: seated leg press, chest press, lateral row, biceps curl, triceps press, hip flexion, hip extension, hip abduction, hip adduction, plantar flexion, and dorsiflexion.

Table 1. Mean (\pm SD) of predicted 1-RM evaluated over an 8 week weight training program.

Exercises	Pretest	Posttest	%Change	P value	Effect Size
Leg Press (kg)	31.1 (17.2)	58.2 (25.4)	+87.3	.000	1.25
Biceps Curl (kg)	16.5 (10.6)	25.6 (13.9)	+54.0	.000	.73
Triceps Press (kg)	33.1 (16.8)	53.7 (23.4)	+62.0	.000	1.01
Lateral Row (kg)	27.1 (12.8)	42.7 (25.3)	+57.0	.000	1.11
Bench Press (kg)	23.0 (10.4)	34.2 (14.8)	+50.0	.000	.88
Hip Flexion (kg)	28.2 (16.2)	59.1 (25.5)	+104.0	.000	1.42
Hip Extension (kg)	32.3 (19.6)	70.3 (47.9)	+118.0	.000	1.04
Hip Abduction (kg)	25.8 (15.1)	53.6 (53.6)	+107.0	.000	1.46
Hip Adduction (kg)	28.6 (15.1)	53.6 (22.2)	+107.0	.000	1.21
Plantarflexion (kg)	13.1 (4.9)	27.6 (16.2)	+119.0	.000	1.21
Dorsiflexion (kg)	7.2 (4.5)	13.1 (10.3)	+110.0	.000	.743

To gain familiarity with the equipment, practice proper technique, and avoid injury, participants completed one set of 15-20 repetitions with light weight (4.5 to 13.5 kg) during the first week of training. At the end of the first week, trainers assisted participants in determining a one-repetition maximum on each of the resistance exercises. Maximal capacity was determined using a predicted one-repetition maximum (Pred-1RM) utilizing the equation developed by Brzycki (1993): $\text{Pred-1RM} = \text{weight lifted} / 1.0278 - (0.0278 * \text{number of repetitions})$. Participants were instructed to select a weight they could successfully lift 7 to 10 times without fatiguing. The validity of using this prediction equation with older adults has been previously established (Knutzen et al., 1999). Weekly training weights were based on a percentage of the predicted 1RM beginning with 50% of the Pred-1RM in the second week of training, and progressively increasing the intensity until it reached 80% in the fifth week, which was held at 80% for the remainder of the eight weeks. The Pred-1RM was reassessed every two weeks. Participants performed 1 to 3 sets of 7 to 10 repetitions for each of the 11 exercises.

Data analysis

Overall pain intensity was assessed using the MPQ. Analysis of covariance (ANCOVA) was used to analyze the post test group differences in reported pain when adjusted for by pretest self-reported pain (SPSS software-version 13.0). The dependent variables measured included pain rating index total (PRIT), pain rating index sensory (PRIS), pain rating index affective (PRIA), pain rating index evaluative (PRIE), pain rating index miscellaneous (PRIM), number of words chosen (NWC), present pain intensity (PPI), and number of painful areas (NPA). A paired samples t-test was applied to analyze the differences between pre- and post-training strength measures for the training group. A Bonferroni adjustment was made to

control for the experiment-wise alpha for the strength measurements and the significance level was set at $p \leq 0.005$.

Results

The results of the high resistance weight training program are presented in Table 1. To assess the size of the training effect, Cohen's d (Cohen, 1988) was calculated with .20, .50, and .80 scores representing small, medium and large effects, respectively. The high resistance training intervention demonstrated significant strength improvement for all of the exercises ($p \leq 0.005$) with predominantly large effect sizes. The greatest improvements in strength were seen in exercises involving the hip and ankle joints ($> 100\%$) while the lowest level of strength gain was seen in the shoulder and elbow joint exercises. None of the participants experienced any injuries or reported any muscle soreness associated with the training.

Analysis of covariance revealed significant differences between the control and training groups in self-reported pain measures when adjusted for by pretest pain values (Table 2). The training group reported less perceived pain in four of the eight pain measures, including overall intensity of the perceive pain (PRIT), sensory aspects of pain (PRIS), assessment of various pain qualities (PRIM), and the number of words chosen to qualitatively assess pain (NWC). The number of painful areas (NPA), the present pain intensity (PPI), the affective aspects of pain qualities (PRIA) and the cognitive perceptions of pain qualities (PRIE) did not differ between the two groups.

Discussion

The present study sought to evaluate the effect of an eight week progressive whole-body strength training program

Table 2. Mean (\pm SD) of the McGill Pain Questionnaire.

Variables	CONTROL GROUP (n = 19)			TRAINING GROUP (n = 79)			ANCOVA RESULTS	
	Pretest	Posttest	%Change	Pretest	Posttest	%Change	P value	Effect Size
Pain Rating Index Total	6.44 (7.0)	6.72 (6.5)	+4.3	5.99 (7.84)	2.99 (4.6)	-50.0	.002	.76
PRI Sensory	4.72 (4.8)	4.94 (5.0)	+4.7	4.35 (6.3)	2.23 (3.6)	-48.7	.006	.69
PRI Affective	.22 (.73)	.22 (.73)	0	.25 (.65)	.10 (.34)	-60.0	.285	.27
PRI Evaluative	.89 (1.13)	.61 (.70)	-31.5	.66 (.99)	.33 (.76)	-50.0	.234	.37
PRI Miscellaneous	.78 (1.12)	.94 (1.5)	+20.5	.72 (1.43)	.24 (.8)	-66.7	.005	.72
Number of Words Chosen	3.11 (3.4)	3.00 (2.95)	-3.5	2.61 (3.3)	1.34 (1.97)	-48.7	.004	.75
Present Pain Intensity	.5 (.99)	.67 (.97)	+34.0	.38 (.65)	.39 (.74)	+2.6	.248	.35
Number of Painful Areas	2.28 (3.06)	1.83 (1.54)	-19.7	2.2 (2.93)	1.44 (2.17)	-34.5	.412	.19

on pain qualities as self-reported by older adults. Improved strength in the training group was associated with lower pain values as compared to the controls in four MPQ measures. Of all variables measured, PRIT may be the most significant because it includes all dimensions of pain and gives the greatest indication of overall perceived pain (Kim et al., 1995). The lower PRIT in the training group suggests that progressive resistance training of all major muscle groups, when performed three times per week for eight weeks, had a positive impact on perception of overall pain. In a meta-analysis of 51 studies who administered the MPQ, Wilkie et al. (1990) report PRIT values in the range of 5.4 to 44.4 with highest values recorded by individuals with low back pain. Our values averaged 3.6, with a range of 2 to 22, indicating similar levels of perceived pain compared to previous studies. Consistent with the results of the present study, Chok et al. (1999) reported a beneficial effect of an endurance training program that reduced the PRIT score from 12.8 to 4.5 over a 6 week period. The overall perceived pain level in the present study was reduced by 50% after strength training.

The PRI-sensory subclass measures the sensory experience of pain in terms of temporal, spatial, pressure, and thermal properties. This dimension ranges from 3.6 to 26.0 in fifty one studies (Wilkie et al., 1990) with subjects with low back or labor pain reporting the highest pain intensity in terms of the sensory experience and dental pain reporting the lowest PRI-sensory scores. Subjects' pain perception from a sensory perspective was reduced in individuals with low back pain after a 6 week exercise program (pre = 7.1; post = 2.14) (Chok et al., 1999). This was also confirmed in the present study, where the sensory qualities of pain were reported as being more favorable in the training group. The self-reported sensory aspects of pain were reduced by 49% after high resistance weight training.

The training group also reported more favorable pain measures for the miscellaneous pain dimension (PRI-misc). A variety of pain qualities are represented in this category, including words such as cool, nagging, spreading, piercing and dreadful. PRI-misc scores ranged from 0 to 9.7 across fifty one studies using the MPQ (Wilkie, 1990) with highest scores in subjects in an acute post-operation setting. The results of the present study confirm the role of strength gain on the individual report of miscellaneous pain measures. The training group utilized fewer words to describe their pain and overall, the number of words chosen in both groups was lower than seen in other studies (Wilkie et al., 1990).

The affective (PRI-affective) dimensions of pain and the evaluative (PRI-evaluative) dimensions of pain were not significantly different between the training and control groups. The scores in the present study were lower than the range of scores presented in other studies (Wilkie et al., 1990). The affective qualities of pain are represented by tension and fear and measure emotional and psychological reactions to pain. The evaluative qualities of pain are represented by a cognitive, subjective interpretation of pain. The characteristics of both the training and the control groups indicated they did not report many pain

qualities that were affective or evaluative. It also may be that even if physical symptoms of pain are diminished in the training group, psychological and emotional aspects may not change and participants may continue to harbor a fear of pain. Additionally, the pain intensity and the number of painful areas did not significantly vary between the training and control groups and this is most likely reflective of ongoing medical conditions which generate what is perceived to be a similar level of pain intensity (mild) and is generally located in the same areas (approximately two areas).

The findings of this study are consistent with similar studies that have evaluated the effect of exercise on pain in older adults. Mannion et al. (1999) found chronic back pain was reduced after a three-month period of strength training. Baker et al. (2001) observed that strength training substantially reduced pain and improved physical function and quality of life in patients with knee OA. Schilke and colleagues (1996) found a significant decrease in pain and an increase in mobility among those with knee OA. Furthermore, Hughes and colleagues (2004) and Suomi and Collier (2003) found significant decreases in pain ratings among participants after eight weeks of exercise training.

We note several limitations of this study. First, the MPQ is a self-report instrument of pain and therefore subject to participant's perception. Second, we did not measure whether participants were involved in other physical activities beyond the program that may have affected their pain perception, however, the inclusion of a small control group also fell under this same limitation and we saw no change in their pain perception. Last, improved social interaction through the work-out group and individual instruction and support may have had a positive effect on overall well being, therefore reducing perception of pain.

We also note several strengths of our study. First, the evaluation of the effects of a high resistance weight training program on self-reported pain parameters has not been specifically evaluated as it relates to general overall pain. There have been reported effects of subject strength on pain in specific joints and for patients with osteoarthritis. Second, we used a multi-dimensional measurement of pain perception which enhanced our understanding of pain qualities for an older population. The MPQ has also been shown to be an effective tool to measure changes in subjective pain and provides multiple perspectives of the pain experience not evaluated in other studies. Lastly, we included whole-body resistance training, which went beyond the emphasis suggested by Singh (2002): to train muscles of the lower body to particularly influence mobility and independence, both of which are negatively affected by chronic pain.

Conclusion

There is a growing national initiative to increase physical activity among older adults. Likewise, there is a need to identify the most efficient and effective strength training recommendations for older adults (Seguin and Nelson, 2003). As it stands, the American College of Sports Medi-

Medicine recommends two to three days per week of strength training (ACSM, 1998). Benefits of strength training include increased muscle and bone mass, muscle strength, balance, flexibility, self-confidence and self-esteem. Strength training also reduces many of the symptoms of chronic diseases, and when combined with balance training, falls. Due to the affect of pain on people's willingness to participate in any physical activity, the importance of reducing pain or pain perception among older adults should not be underestimated.

Our study supports that participants in an eight-week progressive, whole -body high resistance training program reported reduced pain qualities as compared to an untrained group of controls. Whether or not reduced pain perception would occur with a low intensity training regimen is a question for further research. All resistance work should be performed at sufficient intensity, however, to confer the many benefits associated with strength training. With this improved capacity, older adults can expect to live more productive, active, and independent lives.

References

- American College of Sports Medicine. (1998) Exercise and physical activity for older adults. *Medicine and Science in Sports and Exercise* **30**, 992-1008.
- American Geriatrics Society Panel on Exercise and Osteoarthritis. (2001) Exercise prescription for older adults with osteoarthritis pain: consensus practice recommendations. *Journal of the American Geriatrics Society* **49**, 808-823.
- Baker, K.R., Nelson, M.E., Felson, D.T., Layne, J.E., Sarno, R. and Roubenoff, R. (2001) The efficacy of home based progressive strength training in older adults with knee osteoarthritis: a randomized controlled trial. *Journal of Rheumatology* **28**, 1655-1665.
- Brattberg, G., Parker, M.G. and Thorslund, M. (1997) A longitudinal study of pain: reported pain from middle age to old age. *Clinical Journal of Pain* **13**, 144-149.
- Bravo, G., Gauthier, P., Roy, P., Payette, H., Gaulin, P., Harvey, M., Peloquin, L. and Dubois, M. (1996) Impact of a 12-month exercise program on the physical and psychological health of osteopenic women. *Journal of the American Geriatric Society* **44**, 756-762.
- Bruce, B., Fries, J.F., and Lubeck, D.P. (2005). Aerobic exercise and its impact on musculoskeletal pain in older adults: a 14 year prospective, longitudinal study. *Arthritis Research and Therapy*, **7**, 1263-1270.
- Brzycki, M. (1993) Strength testing – predicting a one-rep max from reps-to fatigue. *Journal of Health, Physical Education, Recreation, and Dance* **64**, 88-90.
- Chapman, C. R., Casey, K. L., Dubner, R., Foley, K. M., Gracely, R. H. and Reading, A. E. (1985) Pain measurement: an overview. *Pain* **22**, 1-31.
- Chok, B., Lee, R., Latimer, J., and Tam, S.B. (1999) Endurance training of the trunk extensor muscles in people with sub acute low back pain. *Physical Therapy* **79**, 1032-1042.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. 2nd edition. Hillsdale, NJ: Lawrence Earlbaum Associates.
- Crook, J., Rideout, E. and Browne, G. (1984) The prevalence of pain complaints in a general population. *Pain* **18**, 299-314.
- Escalante, A., Lichtenstein, M.J., White, K., Rios, N. and Hazuda, H.P. (1995) A method for scoring the pain map of the McGill pain questionnaire for use in epidemiologic studies. *Aging: Clinical and Experimental Research* **7**, 358-366.
- Ferrell, B.A., Josephson, K.R., Pollan, A.M., Loy, S. and Ferrell, B.R. (1997) A randomized trial of walking versus physical methods for chronic pain management. *Aging* **9**, 99-105.
- Focht, B.C. (2006) Effectiveness of exercise interventions in reducing pain symptoms among older adults with knee osteoarthritis: a review. *Journal of Aging and Physical Activity* **14**, 212-235.
- Helme, R.D. and Gibson, S.J. (2001) The epidemiology of pain in elderly people. *Clinics in Geriatric Medicine* **17**, 417-431.
- Herr, K.A. and Garand, L. (2001) Assessment and measurement of pain in older adults. *Clinics in Geriatric Medicine* **17**, 457-478.
- Holroyd, K.A., Talbot, F., Holm, J.E., Pingel, J.D., Lake, A.E. and Saper, J.R. (1996) Assessing the dimensions of pain: a multi-trait-multimethod evaluation of seven measures. *Pain* **67**, 259-265.
- Hurley, B.F. and Roth, S.M. (2000) Strength training in the elderly. *Sports Medicine* **30**, 249-268.
- Hughes, S.L., Seymour, R.B., Campbell, R., Pollack, N., Huber, G. and Sharma, L. (2004) Impact of the fit and strong intervention on older adults with osteoarthritis. *The Gerontologist* **44**, 217-228.
- Johannsen, F., Remvig, L., Kryger, P., Beck, P., Warming, S., Lybeck, K., Dreyer, V. and Larsen, L.H. (1995) Exercises for chronic low back pain: a clinical trial. *Journal of Orthopedic and Sports Physical Therapy* **22**, 52-59.
- Kemp, C.A., Ersek, M., and Turner, J. (2005) A descriptive study of older adults with persistent pain: Use and perceived effectiveness of pain management strategies. *BMC Geriatrics*, **5**, 5-12.
- Kim, H.S., Schwartz-Barcott, D., Holter, I.M. and Lorensen, M. (1995) Developing a translation of the McGill pain questionnaire for cross-cultural comparison: an example from Norway. *Journal of Advanced Nursing* **21**, 421-426.
- Knutzen, K.M., Brilla, L.R. and Caine, D. (1999) Validity of 1RM prediction equations for older adults. *Journal of Strength and Conditioning Research* **13**, 242-246.
- Kovar, P.A., Allegrante, J.P., MacKenzie, C.R., Peterson, B.G., Gutin, B. and Charlson, M.E. (1992) Supervised fitness walking in patients with osteoarthritis of the knee. *Annals of Internal Medicine* **116**, 529-534.
- Love, A., Loeboeuf, D.C. and Crisp, T.C. (1989) Chiropractic chronic low back pain sufferers and self-report assessment methods. Part 1. A reliability study of the Visual Analogue Scale, the pain drawing and the McGill Pain Questionnaire. *Journal of Manipulative and Physiological Therapeutics* **12**, 21-25.
- Malmros, B., Mortensen, L., Jensen, M.B. and Charles, P. (1998) Positive effects of physiotherapy on chronic pain and performance in osteoporosis. *Osteoporosis International* **8**, 215-221.
- Mannion, A.F., Muntener, M., Taimela, S. and Dvorak, J. (1999) A randomized clinical trial of three active therapies for chronic low back pain. *Spine* **24**, 2435-2448.
- Marcus, D.A. (2000) Treatment of nonmalignant chronic pain. *American Family Physician* **61**, 1331-1338.
- McCarberg, B.H. and Herr, K.A. (2001) Osteoarthritis: how to manage pain and improve patient function. *Geriatrics* **56**, 14-24.
- Melzack, R. (1975) The McGill Pain Questionnaire: major properties and scoring methods. *Pain* **1**, 277-299.
- Melzack, R. (1983) The McGill Pain Questionnaire. In *Pain Measurement and Assessment*. Ed: Melzack, R. New York: Raven Press. 41-47.
- Mobily, P.R., Herr, K.A., Clark, M.K., and Wallace, R.B. (1994). An epidemiologic analysis of pain in the elderly. *Journal of Aging and Health* **6**, 139-154.
- O'Reilly, S.C., Muir, K.R. and Doherty, M. (1999) Effectiveness of home exercise on pain and disability from osteoarthritis of the knee: a randomised controlled trial. *Annals of the Rheumatic Diseases* **58**, 15-19.
- Rall, L.C., Meydani, S.N., Kehayias, J.J., Dawson-Hughes, B. and Roubenoff, R. (1996) The effect of progressive resistance training in rheumatoid arthritis: Increased strength without changes in energy balance or body composition. *Arthritis and Rheumatism* **39**, 415-426.
- Roche, R.J. and Forman, W.B. (1994) Pain management for the geriatric patient. *Clinics in Podiatric Medicine and Surgery* **11**, 41-53.
- Rogind, H., Bibow-Nielsen, B., Jensen, B., Moller, H.C., Fridmott-Moller, H. and Bliddal, H. (1998) The effects of a physical training program on patients with osteoarthritis of the knees. *Archives of Physical Medicine and Rehabilitation* **79**, 1421-1427.
- Rucker, K.S., Metzler, H.M. and Kregel, J.K. (1996) Standardization of chronic pain assessment: a multiperspective approach. *Clinical Journal of Pain* **12**, 94-110.
- Schilke, J.M., Johnson, G.O., Housh, T.J. and O'Dell, J.R. (1996) Effects of muscle-strength training on the functional status of patients with osteoarthritis of the knee joint. *Nursing Research* **45**, 68-72.

- Seguin, R. and Nelson, M.E. (2003) The benefits of strength training for older adults. *American Journal of Preventive Medicine* **25** (Suppl. 2), 141-149.
- Suomi, R. and Collier, D. (2003) Effects of arthritis exercise programs on functional fitness and perceived activities of daily living measures in older adults with arthritis. *Archives of Physical Medicine and Rehabilitation* **84**, 1589-1594.
- Von Korff, M., Dworkin, S.F., Le Resche, L. and Kruger, A. (1988) An epidemiologic comparison of pain complaints. *Pain* **32**, 173-183.
- Vuori, I. (2001) Dose-response of physical activity and low back pain, osteoarthritis, and osteoporosis. *Medicine and Science in Sports and Exercise* **33**(Suppl.), S551-S586.
- Wilder, F.V., Barrett, J.P. and Farina, E.J. (2006) Exercise and osteoarthritis: are we stopping too early? Findings from the Clearwater Exercise Study. *Journal of Aging and Physical Activity* **14**, 169-180.
- Wilkie, D.J., Savedra, M.C., Holzemer, W.L., Tesler, M.D. and Paul, S.M. (1990) Use of the McGill Pain Questionnaire to measure pain: a meta-analysis. *Nursing Research* **39**, 36-41.
- Woolf, A.D. and Pfleger, B. (2003) Burden of major musculoskeletal conditions. *Bulletin of the World Health Organization* **81**, 646-656.

Key points

- Improved strength in older adults had a positive effect on the perception of pain.
- The number of painful areas identified and self-reported pain qualities were diminished following high resistance weight training.
- The McGill Pain Questionnaire was an effective tool for measuring changes in pain perception as a result of training.

AUTHORS BIOGRAPHY

Kathleen KNUTZEN

Employment

Professor, Department of Physical Education, Health, and Recreation, Western Washington University

Degree

PhD

Research interests

Biomechanics, older adult function.

E-mail: Kathy.Knutzen@wwu.edu

Beth PENDERGRAST

Employment

Lecturer, Skagit Valley Community College.

Degree

MSc

Research interests

Older adults.

E-mail: frazierbeth@hotmail.com

Billie LINDSEY

Employment

Associate Professor, Department of Physical Education, Health, and Recreation, Western Washington University.

Degree

PhD

Research interests

Community health, health risks.

E-mail: Billie.Lindsey@wwu.edu

Lorraine BRILLA

Employment

Professor, Department of Physical Education, Health, and Recreation, Western Washington University.

Degree

PhD

Research interests

Exercise physiology; nutritional effects on performance.

E-mail: brilla@cc.wwu.edu

✉ Dr. Kathy Knutzen

Western Washington University, 516 High Street, Bellingham, WA 98225-9067, USA