EFFECTS OF A HOME EXERCISE PROGRAM ON INDEX OF KYPHOSIS, HEIGHT, BALANCE, AND QUALITY OF LIFE IN POSTMENOPAUSAL WOMEN WITH LOW BONE MASS

A THESIS

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VICTORIA CLARKE CANNELLA KELLER, B.S.

DENTON, TEXAS

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To the Dean of the Graduate School:

I am submitting here with a thesis written by Victoria Clarke Cannella Keller entitled "Effects of a Home Exercise Program On Index of Kyphosis, Height, Balance, and Quality of Life in Postmenopausal Women with Low Bone Mass." I have examined this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science with a major in Physical Therapy.

Mary Thompson
Dr. Mary Thompson, Major Professor

We have read this thesis and recommend its acceptance:

Mary Thompson
Dr. Mary Thompson

Elaine Jackson
Dr. Elaine Jackson

Sue Schafer
Dr. Sue Schafer, Associate Director

Accepted:

Jennifer Martin
Dean of the Graduate School

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ABSTRACT

VICTORIA CLARKE CANNELLA KELLER

EFFECTS OF A HOME EXERCISE PROGRAM ON INDEX OF KYPHOSIS HEIGHT, BALANCE, AND QUALITY OF LIFE IN POSTMENOPAUSAL WOMEN WITH LOW BONE MASS

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The purpose of this thesis was to focus on the use of four clinic visits and a home exercise program as an intervention to reduce thoracic kyphosis, increase height, and improve balance and quality of life in women with low bone mass and a clinically apparent kyphosis. Three postmenopausal women participated in four weekly visits for instruction and progression in a home program consisting of 9 progressive trunk-strengthening exercises. During the third visit they were instructed in body mechanics during activities of daily living that avoid spinal flexion. Prior to the intervention and after 8 weeks of exercise, measurements were taken. After 8 weeks of performing the exercise program, all patients demonstrated improvement in their index of kyphosis, balance, and increase in height. Two of the 3 had improvement in their scores on the Osteoporosis Quality of Life Questionnaire. It appears the intervention is successful and should be studied further.

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CHAPTER I

INTRODUCTION

Osteoporosis affects more than 24 million Americans and is characterized by decreased bone mass and subsequent increased risk of fracture (National Osteoporosis Foundation [NOF], 2002. Many patients suffer from pain and disability associated with vertebral fractures (Osteoporosis Quality of Life Study Group [Osteoporosis Group], 1997). There are an estimated 70,000 osteoporotic vertebral compression fractures (VCFs) in the United States each year (Lieberman, Dudeney, Reinhardt, & Bell, 2000). These fractures are not benign. Linville (2002) reported that there is as much as a 15% to 30% increase in mortality rate in patients with VCFs. Milne and Lauder (1974) demonstrated a direct correlation between aging (after the age of 60) and increasing kyphosis attributed to VCFs. Twenty-eight years later, Linville reported that 33% of women greater than age 65 have vertebral fractures. Vertebral compression fractures lead to progressive sagittal spine deformity (kyphosis) and changes in spinal biomechanics, and are believed to contribute to a five-fold increase in further vertebral fractures via transmission of forces to other weakened vertebrae (Lieberman et al., 2000).

The influence of VCFs extends beyond the thoracic spine; the most common vertebral region effected. Lieberman et al. (2000) reported that two or more vertebral fractures significantly affect health, daily living, and medical costs through loss of lung capacity, loss of appetite, reduced mobility, chronic pain, and/or clinical depression.

These fractures can limit an individual's ability to perform activities of daily living, restricting function in employment as well as social and recreational settings (Lyles, Gold, Shipp, et al., 1993). Lind, Lucente, and Kohn (1996) demonstrated a correlation between increased thoracic kyphosis and the prevalence of advanced uterine prolapse, with the risk of prolapse being 1.35 times greater with each additional degree of kyphosis. Furthermore, Balzini, Vannucchi, Benvenuti et al. (2003) demonstrated that severe flexed posture is associated with slow gait and increased base of support. Balzini and associates also reported that patients with significant flexed posture had a significantly lower score on the balance and gait scores of the Performance Oriented Mobility Assessment than patients with mild flexed posture. Similarly, Cook (2002) demonstrated that there are significantly compromised balance assessment results in individuals diagnosed with osteoporosis, who display a higher degree of thoracic kyphosis, than in those individuals with osteoporosis but with a lesser degree of thoracic kyphosis. Since persons with osteoporosis are at higher risk of fracture with falling, balance impairments are especially of concern.

Balzini, Vannucchi, Benvenuti et al. (2003) confirmed the psychological impact of a flexed posture in older women. Participants with severe deformity demonstrated greater depression and lower motivation as measured by the Geriatric Depression Scale and the Multidimensional Fatigue Inventory respectively compared with older women with mildly flexed postures. Miyakoshi, Itoi, Kobayashi, and Kodama (2003) demonstrated that quality of life in patients with osteoporosis was impaired by postural deformity, especially by whole kyphosis.

Women with osteoporosis express concerns with this change in their shape such that clothes do not fit properly and they fear falling and breaking a bone (Osteoporosis Group, 1997). Anxiety often causes inactivity, and many women with osteoporosis are frozen by their anxiety into sedentary lifestyles. They fear that activity or exercise could cause fracture and do everything they can to avoid situations in which fractures are likely (Gold, 1996). Ironically, as women become more kyphotic, their back muscles and ligaments are stretched beyond the normal position. This leads to chronic back pain that tends not to respond to analgesics, heat or cold. However, these women often respond well to exercise (Gold), the very thing they fear might cause further fracture.

There is good evidence on the benefits of exercise for women with osteoporosis and kyphosis. Dalsky and associates (1988) reported that weight bearing exercise led to significant increases in bone mineral content in older, postmenopausal women. Preisinger, Alacamlioglu, Pils, Bosina, Metka, and Schneider (1996) found that regular long term therapeutic exercises were beneficial in reducing subjective back complaints and slowed loss of bone mass. Malmros, Mortensen, Jensen, and Charles' (1998) 12-week supervised exercise training program for osteoporotic patients improved balance and level of daily function and decreased the experience of pain and use of analgesics. A 24-session, supervised program of progressive trunk strengthening exercises over 8 - 12 weeks can reduce thoracic kyphosis and increase shoulder flexion, trunk muscle performance, and ADL in postmenopausal women with low bone mass (Grafa, 2003). It is unknown if other training paradigms will produce similar results.

Statement of Problem

Increased thoracic kyphosis has been demonstrated to increase pain, negatively effect balance, and have a detrimental effect on quality of life. Supervised exercise sessions in the clinic setting have been demonstrated to reduce the thoracic kyphosis width (Grafa, 2003; Malmros et al., 1998). However, today's healthcare environment limits the number of visits covered by third party payers, therefore requiring more emphasis on home exercise programs. Additionally, as kyphosis secondary to low bone mass is a continuing and progressive problem, women need to learn to manage this problem as a lifestyle change.

Purpose

The purpose of this thesis was to provide multiple case reports that focus on the use of four clinic visits for instruction in a home exercise program as an intervention to reduce thoracic kyphosis, increase height, and improve balance and quality of life in women with low bone mass and a clinically apparent kyphosis.

Definitions

The following words and terms were operationally defined for the purpose of this thesis:

Osteoporosis is defined by the World Health Organization (WHO) as having a bone mineral density (BMD) at 2.5 standard deviations or more below that of a "young normal" adult (T-score at or below -2.5). Women in this group who have already experienced one or more fractures are deemed to have severe or "established" osteoporosis (National Osteoporosis Foundation [NOF], 2003).

Osteopenia is often referred to as low bone mass. It is defined by WHO as BMD between 1 and 2.5 SD below that of a "young normal" adult (T-score between -1 and -2.5) (NOF, 2003).

Height is a participant's stature in centimeters as measured using a stadiometer.

Spinal curve measurements are kyphosis and lordosis width and length. They are measured in centimeters as elaborated in Appendix A.

Index of kyphosis (I/K) is the ratio of thoracic width to thoracic length multiplied by 100 (Chow & Harrison, 1987).

A clinically apparent kyphosis is a kyphosis where the I/K value is greater than 13 (Chow & Harrison, 1987).

Dynamic balance is the ability to maintain a position, stabilize for voluntary movements, and react to external disturbances (Berg, Maki, Williams, Holliday, & Wood-Dauphinee, 1992). In the case reports, dynamic balance was measured using the Berg Balance Scale. The scores can range from 0 to 56 with the higher score indicating better balance during functional activities.

Function is defined by the American Physical Therapy Association *Guide to Physical Therapist Practice* (further referred to as the *Guide*) (2001) as "those activities identified as essential to support physical, social, and psychological well-being and to create a personal sense of meaningful living (p. 687)." *Functional limitation* is further defined in the *Guide* as "the restriction of the ability to perform at the level of the whole person, a physical action, task, or activity in an efficient, typically expected or competent manner (p. 687)." Measurement of function and functional limitation was through the five domains in the Osteoporosis Quality of Life Questionnaire (OQLQ): symptoms, emotional function, physical function, activities of daily living, and leisure and social activities.

Physical therapy intervention in this thesis included instruction in postural exercises, posture, and body mechanics. Details appear in Appendix B.

Ten Repetition Maximum (10 RM) for this study was the method used for determining the amount of resistive weights when weights were used for exercise progression. A starting weight was selected below the participant's currently estimated maximum lifting capacity. If the participant could perform 10 repetitions with proper form, then a 2.2 kg (1 lb.) weight was added and the participant was instructed to perform 10 repetitions. When the participant could complete all but 1 or 2 of the lifts, the 10-RM value was reached. The participant was allowed to rest approximately 2 to 3 seconds between each 10 RM trial. Once the 10 RM was determined, 70% of the 10 RM value for each exercise was calculated and was used as the initial weight.

Assumptions

The assumptions made for this thesis was as follows:

1. Participants performed each test to the best of their ability.

2. Participants completed the exercise log truthfully and accurately.

3. The observed increased kyphosis was secondary to low bone mass.

Limitations

The primary limitation of this thesis included participants' potential low or non-compliance. The participants were given an exercise log to make them more accountable for exercise performance, but they could falsely report compliance. In addition, case reports do not impose the required controls to identify cause-and-effect (McEwen, 1996).

Clinical Significance

Several researchers (Dalsky et al. 1988; Grafa, 2003; Malmros, et al., 1998; Preisinger, et al., 1996) have demonstrated that exercise can be beneficial for persons with osteoporosis and low bone mass. These researchers used supervised exercises of at least 12 weeks in duration. Grafa (2003) studied the benefits of an exercise program with the exercise participants coming into the clinic three times per week for 8 - 12 weeks. Her study indicated improved I/K, trunk strengths and ADL scores post-treatment. Grafa's exercise program was used in this thesis. With today's health care environment, finding cost effective means to improve the functional abilities of people is imperative. Also since kyphosis is a progressive problem, women need to learn self-management in order to reduce the pain and disfigurement that can occur over the years. The significance of this thesis was to provide case reports that describe practice in the current health care environment that may improve quality of life and reduce impairments for women with clinically apparent kyphosis through a cost saving program utilizing a limited number of clinic visits and performance of a home exercise program.

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this thesis was to provide multiple case reports that focus on the use of four clinic visits for instruction in a home exercise program as an intervention to reduce thoracic kyphosis, increase height, and improve balance and quality of life in women with low bone mass and a clinically apparent kyphosis. Because these women have been diagnosed with low bone mass, the focus of this literature review is on why women are at risk, the benefits of exercise and other physical therapy interventions as well as research on the measurement of thoracic kyphosis, quality of life and balance.

Osteoporosis and Low Bone Mass

Osteoporosis is a disease characterized by low bone mass and structural deterioration of bone tissue that leads to a subsequent increased fragility and risk of fracture. The National Osteoporosis Foundation (NOF) estimates that osteoporosis and low bone mass are a major health threat for almost 44 million people in the U.S. age 50 and older. In the U.S. today it is estimated that 10 million individuals (80% are women) have osteoporosis. Thirty-four million Americans, or 55% of the people age 50 or older, have low bone mass that places them at risk for developing osteoporosis and related fractures (NOF, 2003).

Osteoporosis is often called the "silent disease" because bone loss occurs without any symptoms. The NOF (2003) reports that women can lose up to 20% of their bone mass in the 5 to 7 years following menopause. Often persons do not realize that they have osteoporosis until they sustain a fracture. After vertebrae collapse, the person may experience severe back pain, loss of height, or spinal deformities such as increased kyphosis. There is no cure for osteoporosis, but there are several medications available to prevent and treat it.

Certain persons are more likely to develop osteoporosis than others. The National Osteoporosis Foundation (2003) lists risk factors for this disease in Table 1.

Table 1

Modifiable and Non-Modifiable Osteoporosis Risk Factors

Modifiable	Non-Modifiable
• Current low bone mass • Abnormal absence of menstrual periods (amenorrhea) • Anorexia nervosa • Low lifetime calcium intake • Use of certain medications, such as corticosteroids and anticonvulsants • Estrogen deficiency as a result of menopause, especially early or surgically induced • Low testosterone levels in men • An inactive lifestyle • Current cigarette smoking • Excessive use of alcohol	• History of fracture in a primary relative • Being female • Being thin and/or having a small frame • Advanced age • A family history of osteoporosis • Personal history of fracture after age 50 • Being Caucasian or Asian, although African Americans and Hispanic Americans are at significant risk as well.

Fracture Risks Associated with Osteoporosis

The definition of osteoporosis includes the fact that osteoporosis presents an increased risk of fractures. The NOF (2003) reports that osteoporosis is responsible for more than 1.5 million fractures annually including 300,000 hip fractures and 700,000 vertebral fractures. The estimated national direct expenditures (hospitals and nursing homes) for osteoporotic and associated fractures were $17 billion in 2001. The focus of this literature review was vertebral compression fractures (VCF) since these are responsible for the kyphotic posture commonly seen with osteoporosis.

Kado, Browner, Palermo, Nevitt, Genant, and Cummings (1999) stated that only about one third of vertebral fractures manifest clinically, and patients with diagnosed vertebral fractures may have more severe and symptomatic fractures than those whose fractures are undiagnosed. These fractures are often found by chance and are difficult to date which has made correlations with other health issues difficult (Lindsay et al., 2001).

Lindsay et al. (2001) studied the risk of new vertebral fracture in the year following a fracture. Women were randomly assigned to the placebo group in four large 3-year clinical trials evaluating the efficacy of risedronate for the treatment of post-menopausal osteoporosis. All subjects received calcium supplementation. Lateral spine radiographs were obtained at baseline for evaluation of prevalent vertebral fractures and annually thereafter for incidence of vertebral fractures. Over the course of the study, vertebral fractures were observed in 381 of the 2,725 women (14%). Of these, only 23% had symptomatic vertebral fractures. Risk of sustaining vertebral fractures increased with the presence of prevalent fractures. Among subjects who sustained fractures during the study, occurrence of a second incident vertebral fracture within 1 year of the initial fracture was 19.2% overall. Twenty-four percent of subjects with two or more prevalent fractures at base line had an incident vertebral fracture within 1 year of their first observed fracture. Lindsay and associates suggest that osteoporosis may actually be a quickly progressing disease once a fracture occurs.

Kado et al. (1999) prospectively studied 9,704 ambulatory women aged 65 years or older without bilateral hip replacements, including women who had vertebral fractures ascertained by routine radiographs, and assessed mortality rates during a mean of 8.3 years of follow-up. Of the 9,704 women, 9,575 had baseline lateral radiographs of the thoracic and lumbar spine that were technically acceptable. Of these women, 1,915 (20%) had one or more vertebral fractures. During the follow-up of 8.3 years, 1,679 women (17.5%) died. Compared with women who did not have a fracture, women with one or more fractures had a 1.23-fold greater age-adjusted mortality. Women with severe fractures had a 1.34-fold greater mortality. Interestingly, women with mild to severe vertebral fractures had an age-adjusted 35% to 40% increase risk of cancer death even though the study radiologist classified only five women (2.7%) as having possible pathologic, rather than osteoporotic fractures. Women with vertebral fractures were two to three times more likely to die of pulmonary causes than those without fractures. This finding could not be explained by long-term corticosteroid or tobacco use. The authors suggested that their results raise the possibility that early and aggressive treatment of pulmonary disease in women with vertebral fractures and prevention of further vertebral fractures among those with kyphosis might reduce mortality rates.

Effects of Exercise for Persons with Low Bone Mass

Preisinger et al. (1996) performed a randomized controlled trial to define the effects of therapeutic exercise on bone density and back complaints. Ninety-two sedentary postmenopausal women were prospectively divided into either an exercise or control group and then retrospectively subdivided as compliant and not fully compliant. This yielded three groups for analysis: Group 1 was the compliant exercise group, Group 2 was the noncompliant exercise group, and Group 3 was no exercise, control group. The exercise groups initially participated in 20 sessions supervised by a physiotherapist. The exercises included warm up exercise, stretching, and exercises directed towards improving faulty posture, motor control, coordination, and mechanical efficiency during daily living. Subjects were then instructed to perform the exercises three times per week and record the sessions in a diary. The subjects not performing exercise at least 60 minutes per week were placed in the noncompliant group. At entry of the study as well as after 4 years, radiographs were taken of the lumbar and thoracic spines. Bone densities were measured in the non-dominant forearm. Intensity of back pain complaints were recorded by questionnaire. After 4 years of regular exercise, no significant change in bone density was found in Group 1. There was a significant loss of bone density found in Groups 2 and 3. There were no significant differences in fractures in any location. Back complaints decreased significantly in Group 1 only, thus suggesting that exercise is beneficial in pain reduction. The lack of group differences in bone density may be related to the location of the measurement (forearm) versus the area targeted by the exercise (spine).

Dalsky et al. (1988) assessed the effects of weight bearing exercise training on lumbar bone mineral content in post-menopausal women maintained on calcium, 1500 mg per day. They placed 35 women between the ages of 55 and 70 years into groups, exercise and control, according to desire of the subject. The protocol was designed to determine the effects of short-term (9 months) and long-term (22 months) weight-bearing exercise and subsequent, reduced training (post-training, 13 months). The subjects in the exercise group participated in three sessions per week of weight bearing exercise for 50 to 60 minutes each. Sessions also included 15 to 20 minutes of nonweight-bearing activities (cycling, rowing, and weight training). The lumbar spine was scanned with dual photon absorptiometry initially, after 9 months, and at 6 to 12-month intervals thereafter. An increase of 5.2% above baseline in the short-term exercise group (17 women) was compared to a decrease in mean of 1.4 *SD* $\pm$ 0.8% in the short-term control group. The total change in lumbar bone density was +6.1% above baseline for the long-term exercise group (11 women) compared with –1.1*SD* $\pm$ 1.1%. When the training was stopped or reduced to less than 3 days per week, bone density returned toward baseline values with a loss of 4.8% when compared to the final exercise value. The authors felt that their results demonstrated that weight-bearing exercise training, of the frequency, intensity, and duration used in their study significantly increased lumbar bone mineral content above initial levels in postmenopausal women maintained on adequate calcium. The problem with this study was the subjects were not randomized but selected the group in which they wanted to participate. Therefore other unmeasured variables may have contributed to the increase in BMD. Women who wanted to exercise were maybe more likely to take other measures to improve BMD such as better diet, HRT, quit smoking.

Sinaki and Lynn (2002) performed a pilot study to assess the effect of a proprioceptive dynamic posture training program on balance in osteoporotic women with kyphotic posture. Participants were 7 women between the age 70 and 83 with osteoporosis. Their thoracic kyphosis measured on standing lateral radiography of the spine showed a Cobb angle of 50° to 65°. At baseline all subjects had assessment of their pain level, physical activity level, computerized dynamic posturography (CDP), and muscle strength via a strain gauge isometric dynamometer, hand dynamometer, and 10 repetition maximum test for the knee extensors. After random assignment to one of two groups, one group received back extensor strengthening exercises only and the other group received the same exercise program plus proprioceptive dynamic posture (PDP) training using a 2-pound weighted kypho-orthosis to be worn daily for 2 hours only during ambulatory activities. The group with the PDP training was subdivided into two groups based on their CDP scores: those that had a normal composite score at baseline and those with abnormal composite scores at baseline. The women kept a daily diary during the 4-week study to record pain levels and were monitored 2 weeks into the study to assess their level of physical activity. At the end of the 4 weeks, each participant's pain level, physical activity level, CDP, and muscle strength measurements were again evaluated. Insignificant changes were noted in the CDP scores in the first group (exercise only group who also had abnormal baseline CDP) and in the second group (exercise plus PDP training group who had normal baseline CDP). Significant improvements were achieved in the third group (exercise plus PDP training group who had abnormal baseline CDP). All of the composite sensory scores from the third group became normal. All subjects in the study regardless of the randomization reported a decrease in back pain at the end of the study. This seems to indicate that back extensor exercises are beneficial for pain relief. Although the number of subjects in this study was small, the authors felt that the PDP with the weighted kypho-orthosis may be beneficial in reducing the risk for falls and further investigation on a larger scale would be helpful.

Papaioannou et al. (2002) performed a randomized controlled trial designed to investigate the effect of a 6-month home-based exercise program versus control (usual activities) on quality of life of postmenopausal women with osteoporosis who had at least one vertebral fracture documented by radiographic findings age 60 or older (n = 74). Twelve-month assessments of outcomes were completed to determine if women would continue exercising with minimal supervision and if benefit could be sustained. They were randomized into exercise and control groups and the research assistant who collected all the data was blinded to intervention status.

Papaioannou and associates' home-based exercise program (2002) taught the participants to integrate short sessions of physical activity into the course of the daily lives. They received a 1-hour training session with supervision in their homes. The exercises included stretching, strength training, and aerobics such as walking which were described in a manual that included a description of the exercises. The specific exercises were not included in the article. The women were instructed to perform 60 minutes of exercise over the course of the day on 3 days a week with one day of rest interspersed. A log was completed after each session. An exercise therapist made a home visit monthly to each participant in the exercise group for the first 6 months to review their programs. Follow-up phone calls were conducted every 2 weeks from baseline to 12 months. Subjects in the control group were instructed to continue their usual activities. They were contacted once a month by phone for 12 months.

Outcome measurements in the Papaioannou (2003) study were obtained at baseline, 6 and 12 months. The Osteoporosis Quality of Life Questionnaire (OQLQ) and the Sickness Impact Profile (SIP) were performed to measure quality of life. Balance was measured by postural sway on a force plate and the Timed Up and Go test. Bone mineral density was evaluated by DEXA. The number of participants who completed the study was 60 out of 74 at 6 months, and 57 out of 74 at 12 months. At 6 months the exercise group demonstrated greater improvement in symptoms ($p = 0.003$), emotion ($p = 0.01$), and leisure/social ($p = 0.03$) in the OQLQ. At 12 months, benefit was shown for some components of the OQLQ; however, the extent of the benefit tended to be less. There was no significant difference in the SIP measurements over 6 or 12 months. The postural sway test demonstrated improvement for the exercise group after 6 months in range of displacement ($p = 0.01$). The results of this test remained significant at 12 months. There was no improvement after 6 or 12 months in the Timed Up and Go ($p > 0.10$). There were no significant differences in bone density at 12 months between groups. The authors concluded that a home exercise program improved quality of life in frail elderly women with vertebral fractures. The problem with this study, though, was that there was continuous follow-up with the exercise subjects, which probably influenced compliance. Unfortunately, in a clinical setting it is time prohibitive to constantly follow patients for a year.

Malmros, Mortensen, Jensen, and Charles (1998) performed a placebo-controlled, randomized, single-masked study to determine the effects of a 10-week exercise program for osteoporotic patients. Outcome measures included pain, use of analgesics, functional status, quality of life, balance, and muscle strength. Fifty-three women, age 55 to 75, with osteoporosis and at least one vertebral compression fracture and back pain within the previous 3 years were included in the study. Women were excluded if they were experiencing acute pain from a new fracture, or had diseases that would interfere with participation in the program. Blocks of 12 patients were randomly assigned to the training group or control group. The training program was conducted by one of two physiotherapists for 1 hour twice a week for 10 consecutive weeks in groups of 6 participants. The program consisted of overall balance training, muscle strength, stretching, and relaxation, in lying and standing positions to the limit of pain. The exact exercises were not included in the article. Spinal rotation was only performed in a lying position. Isometric training of extensors and flexors of the trunk were included. Balance was trained by exercises standing on one leg. The patients learned to stabilize the lumbar spine in all exercises. For the second 5 weeks, the program was extended with more demanding exercises. A home exercise program with 10 of the exercises was given to the participants after 5 weeks. The control group was instructed to continue their daily life as usual. All participants were tested before randomization (week 0) after 5 weeks and after 10 weeks. Twelve weeks after training had stopped (week 22) a questionnaire was sent to all participants by mail. Pain level was measured using an 11-point box scale of 0 to 10. A questionnaire asked about analgesics use (amount and type). The Oswestry questionnaire was modified by the authors and used to question the level of daily function. A questionnaire on quality of life was designed by the authors. Balance was tested via a Chattecx Balance System. Muscle strength of the back extensors, abdominal flexors and the quadriceps muscle was determined through the use of strain gauge dynamometers.

Malmros et al. reported that the training group demonstrated reduced pain levels at week 10 as well as week 22. The pain scores in the control group was nearly unchanged during the study. The use of analgesics demonstrated a similar response. In level of daily function, the training group demonstrated a shift towards higher-scoring subgroups during the active training period. With a maximum score of 100 on the modified Oswestry, the proportion scoring 0-74 was reduced from 50% to around 15%. When the active training stopped there was a small drop-back for some patients, but the authors reported in general the score was higher than baseline. The control group showed no major changes during the study. There was a continuous improvement in quality of life scores in the training group while there was no improvement found in the values of the control group. Balance improved by 19.6% during the 10 weeks for the training group compared with an improvement of only 6.9% in the control group. At week 10, a non-significant improvement of extensor muscle strength was found in the training group compared with the controls. In summary, the exercise program involving training of balance, muscle strength, stretching, and relaxation appeared to be beneficial for reducing pain, improvement in balance, and level of daily function.

Itoi and Sinaki (1994) conducted a prospective study to determine the effect of therapeutic back strengthening exercise on the posture of healthy estrogen-deficient women. In their study, 60 subjects were randomly assigned to either an exercise group or control group. The exercise group was asked to perform a back strengthening exercise in which they lifted a weighted backpack (which contained a weight equivalent to 30% of the maximal isometric back extensor strength) 10 times in the prone position. They did this once per day 5 days a week for 2 years. The back extensor strength for both groups was tested every 4 weeks for 2 years. Roentgenograms were obtained at baseline and at the end of the 2 year study for measuring thoracic kyphosis, lumbar lordosis and sacral inclination.

When looking at the statistics from this study, Itoi and Sinaki (1994) discovered that both the exercise and control groups demonstrated an increase in back extensor strength and there was no statistical difference between the two groups in change of thoracic kyphosis. The researchers then regrouped the subjects on the basis of the increase in back extensor strength. They again found no significant difference in the change in the thoracic kyphosis. Then Itoi and Sinaki categorized the subjects as either hyperkyphotic (34.1° or more) or less kyphotic (less than 34.1°). In the hyperkyphotic group, the subjects with a significant increase in back extensor strength demonstrated a significant decrease in thoracic kyphosis, whereas those with a small increase in strength demonstrated an increase in thoracic kyphosis. They concluded that the decrease in thoracic kyphosis in the hyperkyphotic group was due to the increase in back extensor strength even though it was not directly related to the exercise.

Sinaki and Mikkelsen (1984) performed a study on 59 women with postmenopausal spinal osteoporosis as documented by roentgenogram. They divided the women into four groups according to the type of exercise prescribed: spinal extension, spinal flexion, both extension and flexion, and neither flexion nor extension. All patients were instructed to avoid lifting objects weighing more than 10 pounds and to use flexion of the knees rather than the spine for bending activities. At the end of the study, the subjects had additional spinal roentgenograms and these were compared with the initial ones for further wedging and compression fractures. Additional fractures occurred as follows: Extension-only group, 16%, Flexion-only group, 89%, Extension and Flexion group, 53%, and No-exercise group, 67%. The authors concluded that if a therapeutic exercise program is used, extension or isometric back and abdominal strengthening exercises seem more appropriate than flexion exercises.

Sinaki, Wollan, Scott, and Gelczer (1996) performed a correlational study to determine the influence of back extensor strength on vertebral fractures in 36 women with osteoporosis. Back extensor strength was measured by using a strain-gauge dynamometer (BID-2000). Roentgenograms of the thoracolumbar spine were obtained to determine the number and site of vertebral fracture and to assess posture by measuring thoracic kyphosis, lumbar lordosis, and sacral inclination. They found a significant negative correlation of kyphosis with the number of vertebral fractures and kyphosis with back extensor strength. The number of vertebral fractures was negatively correlated with back extensor strength.

Grafa (2003) performed a study to determine the effect of trunk and scapular strengthening exercises on I/K, trunk and lower trapezius muscle performance, shoulder flexion range of motion, and self-perceived functional disability in post-menopausal women with low bone mass. Thirty-three postmenopausal women with low bone mass and a clinically apparent kyphosis (I/K $\geq$ 13) were randomly assigned to one of two groups. The control group continued their regular routine while the experimental group received a supervised program of 9 progressive trunk-strengthening exercises 3 times a week (24 sessions) within 12 weeks. Flexicurve measurements were used to calculate I/K. Trunk extensor and lower trapezius muscle performances were measured in gravity-minimized positions using a hand-held dynamometer. Shoulder flexion was measured with a goniometer. Functional disability was measured using the activities of daily living component score from the Osteoporosis Functional Disability Questionnaire (OFDQ). The overall MANCOVA ($F_{(4, 25)} = 3/84$, $P = 0.014$; $\eta^2 = .38$) demonstrated a difference between groups and follow-up analysis revealed significant increases in shoulder flexion and muscle performances while decreasing the I/K in the experimental group. The exercise program described by Grafa's study was used in this thesis for the physical therapy intervention.

In summary, exercise has been demonstrated in numerous studies to be beneficial for women with osteoporosis in reducing pain, improving function and improving balance along with the decrease in thoracic kyphosis and increase in back extensor strength. This thesis focused on applying this information in a useable manner for clinicians and the population in general.

Measuring Thoracic Kyphosis, Quality of Life, Height, and Balance

Index of Kyphosis Measures

One of the measuring tools used in this study was the flexicurve ruler. The flexicurve ruler is a strip of lead covered in plastic, which can be bent in one plane only and retains the shape into which it is bent. Milne and Lauder (1974) described the method of its use for the measurement of thoracic kyphosis and lumbar lordosis. The flexicurve was placed on the participant's back with one end at the seventh cervical vertebra, and closely applied to the midline of the back, with the subject being asked to stand as erect as possible. The level of the lumbosacral joint was marked on the flexicurve with a grease pencil, after which the instrument was laid on a piece of paper and the spinal curve copied by running a pencil along the flexicurve. A straight line was then drawn from the ends of the curve. Chow and Harrison (1987) named the parts of the drawing that tend to be used in current literature. The dimension "I" is the vertical distance of a point on the curve farthest from the straight line (see Appendix A). Dimension "K" is the part of the straight line from C7 to the point where the curve intersects the straight line. Milne and Lauder determined that the ratio I/K was least dependent on spinal length compared to other calculations with the measurements. Milne and Williamson (1983) multiplied the index of kyphosis (I/K) by 100 to simplify the description of changes that occurred in their study. Chow and Harrison observed that an individual with I/K values greater than 13 has a clinically apparent kyphosis. Additional parameters to establish an I/K greater than 13 as a clinically apparent kyphosis was not presented.

Lundon, Li, and Bibershtein (1998) performed a reliability study to demonstrate interrater and intrarater reliability in the measurement of kyphosis using three tools: DeBrunner's kyphometer, the flexicurve ruler, and roentgenographs. Twenty-six postmenopausal women with known bone mineral density and a diagnosis of osteoporosis were measured three times each with the Debrunner's kyphometer and the flexicurve ruler by three trained therapists. The patients also received a roentgenograph from the lateral view of the thoracolumbar spine in the standing position. The DeBrunner's kyphometer provided angle of kyphosis via the protractor scale on the instrument. The angle of kyphosis was calculated from the roentgenograph and the flexicurve via the Cobb technique. The DeBrunner's kyphometer showed slightly higher but not significantly different intra- and interrater reliability compared with the flexicurve ruler and roentgenograph. The authors felt that these three tools could be used interchangeably, although the data presented were not entirely supportive of their conclusions.

Other studies have been performed to test the reliability of the flexicurve. Hinman (2003/2004) measured the interrater reliability of flexicurve postural measures among novice users. She demonstrated Intraclass Correlation Coefficients (ICCs) of .94 and .93 in the 3 testers calculating the I/K in relaxed and erect postures. This indicated highly reproducible measurements among testers. Milne and Lauder (1974) performed a reliability substudy to determine the intrarater reliability of measuring spinal curves with the flexicurve. Using the *F* test they determined the ratio of mean square for persons to mean square for error was significant at the 1% level for thoracic length and width and at the 5% level for the index of kyphosis. Their study demonstrated an increase in kyphosis with age in older men and women. The benefits of using the flexicurve clinically in this thesis were two–fold: it is cost effective and reliable, as indicated by these studies.

Quality of Life Measures

Throughout the years numerous tools have been developed to measure the quality of life of individuals, both generic in nature and disease specific. There have also been numerous tools specifically for the use of individuals with osteoporosis, some adapted to different languages and cultures. The Osteoporosis Quality of Life Study Group (1997) designed a tool specifically for postmenopausal women suffering chronic back pain due to osteoporosis. The Osteoporosis Quality of Life Questionnaire (OQLQ) consists of 30 items distributed across five domains: Symptoms, Physical Function, Activities of Daily Living, Emotional Function, and Leisure. The group tested the OQLQ on 226 women suffering from osteoporosis and back pain in the United States and Canada. They also administered the Sickness Impact Profile (SIP), the 36-item short form of the Medical Outcomes Survey instrument (MOS SF-36), and the Brief Pain Inventory (BPI). With reliability coefficients between baseline and 2-week follow-up varying from 0.80 to 0.89 for the five domains, the OQLQ proved to be as powerful as or more powerful than alternative instruments for detecting improvement or deterioration in patients whose status changed.

Height Measures

Watt, Pickering and Wales (1998) compared an ultrasonic height measuring device (Gulliver) with mechanical stadiometry and the classic "book and tape measure" method. When measuring children and a rigid metal box, the stadiometer demonstrated greater inter- and intra-rater reliability than either of the other two methods. They concluded that the stadiometer is precise and reproducible, and can detect true changes in height over one month periods in mid-childhood.

Stothart and McGill (2000) compared the reproducibility of 2 measurement techniques for repeated measures of spine height using stadiometry following five experimental activity conditions. Six subjects were repeatedly measured while they stepped in and out of the stadiometer for each pair of measures and when they remained in place in the stadiometer for all of the measures. They found much greater variability in the repeated measures of height for the in and out method with the standard deviation for the 10 measures of each subject ranging from 0.84 to 1.30 compared to 0.42 to 0.66 for the in place condition. The authors recommended leaving the subject in the stadiometer during repeated measures.

Balance Measures

The Berg Balance Scale was chosen to assess balance due to its ease of use and that it does not require sophisticated equipment. It only takes approximately 20 minutes to perform and covers functional activities. Berg, Maki, Williams, Holliday, and Wood-Dauphinee (1992) compared the Berg Balance Scale to the Balance Subscale of the Mobility Index developed by Tinetti and the Timed Up and Go. They also measured postural sway in the following sequence: (a) quiet unperturbed stance; (b) anterior-posterior (A-P) pseudorandom perturbations; and (c) medial-lateral (M-L) pseudorandom perturbations. The perturbations were performed as the subjects stood on a moving platform. Berg et al. found the ICCs for both intra and inter-rater reliability for performing the Berg test to be .98. The Berg Balance Scale and the Balance Subscale developed by Tinetti demonstrated a strong correlation ($r = .91$). Higher Balance Scale scores were associated with faster performance on the Timed Up and Go ($r = -.76$) and less aid required for ambulation ($r = -.75$). The relationships between the Berg Balance Scale and the platform tests were moderately strong.

Bogle Thorbahn and Newton (1996) performed a study to determine whether the Berg balance test could be used to predict an elderly person's risk for falls. They tested 66 subjects, 16 men and 50 women with a mean age of 79.2 years. They sent a questionnaire to each subject after 6 months to assess the predictive validity of the balance assessment. Questionnaire return rate was 85% at the 6 month follow-up. When the scores achieved on the Berg balance test were applied to the 6 month follow-up fall frequency, the sensitivity was 53% (8/15) and the specificity was 92% (36/39). Bogle Thorbahn and Newton noted, though, that the greater number of falls occurred in persons that scored closer to the 45 cutoff score than did in persons with much lower scores. They felt that this was due to persons with extremely poor balance who were more likely to depend on assistive devices or companions and less likely to put themselves in situations that they could fall.

Chiu, Au-yeung, and Lo (2003) performed a study aimed to compare the sensitivity and specificity of four functional tests: the Berg Balance Scale, Tinetti Mobility Score, Elderly Mobility Scale and Timed Up and Go test. They also wanted to determine their optimal cut-off scores, and identify the one with the highest power to discriminate fallers from non-fallers in older people. Subjects met the following criteria: aged 65 years or older, had history of non-syncope associated fall within the previous 6 months, and were ambulating independently with or without the need for walking aids.

They were classified into single fallers or multiple fallers. The subjects were matched with healthy people as the controls. The results for the Berg, Tinetti, and Elderly Mobility Scale demonstrated the highest scores for the controls, followed by single fallers and multiple fallers. The magnitudes of the Timed Up and Go were in reverse order, with multiple fallers taking the longest time to complete the task. Receiver operating characteristic curve analysis demonstrated the best discriminatory power with the Berg for fallers in sensitivity and specificity. The authors felt that the cut-off score of 47 on the Berg for discriminating single fallers from the controls. The 2 items on the Berg that were most significant in discriminating single faller from the controls was picking up an object from the floor and standing on one leg. In discriminating single fallers from multiple fallers, picking up an object from the floor and placing alternate feet on a stool were the 2 significant items identified. Chiu et al. concluded that the Berg Balance Scale was the most powerful of the four commonly used functional tests in discriminating fallers from non-fallers.

Summary

Major concerns of women with low bone mass are their changing shape, fear of falling and fear of fracture. Vertebral compression fractures contribute to the kyphotic posture commonly seen with osteoporosis, often resulting in pain, reduced lung capacity, and increased depression. It has been shown that exercise is beneficial to women with thoracic kyphosis and low bone mass. Weight bearing exercise has been shown to increase lumbar bone density (Dalsky et al., 1988). Preisinger et al. (1996), Sinaki and

Lynn (2002), Malmros et al. (1998) demonstrated the benefit of pain reduction on back pain with exercise. Itoi and Sinaki (1994) and Grafa (2003) recorded improvement in thoracic kyphosis with their exercise programs. Unfortunately, though, the previous studies provided more visits and/or supervision of the exercise participants than is feasible in today's health care environment. Third party payers are more restrictive in the number of visits allowed with a physical therapist. In addition, the specific exercise protocol is rarely described for clinical use. The question, then, is whether women will benefit from performing the exercises at home with a limited number of visits to the physical therapist for correction of technique and progression of the exercises. The case reports in this thesis attempts to provide insight into possible answers to this question that will assist the clinician in directing an individual patient's care.

CHAPTER III

METHODS

The purpose of this thesis was to provide multiple case reports that focus on the use of four clinic visits for instruction in a home exercise program as an intervention to reduce thoracic kyphosis, increase height, and improve balance and quality of life in women with low bone mass and a clinically apparent kyphosis. This chapter provides a detailed description of the tester, instruments, and the procedures.

Participants

Participants for this study were recruited using convenience sampling from the bone density center at Baylor Medical Center at Irving. The facility provided the researcher with a list of potential subjects with low bone mass or osteoporosis and visually apparent kyphosis who had agreed to be contacted (Appendix C). Once a potential subject was identified and consented to participate in the study, written consent from each subject's physician was obtained (see Appendix D). After receipt of the physician's consent, a testing time was scheduled with the subject. Signed informed consent (Appendix E) was required of all participants in accordance with the Institutional Review Boards (IRB) at the data collection site (Baylor Medical Center at Irving) and Texas Woman's University (TWU).

Participants were postmenopausal women diagnosed with low bone mass or osteoporosis (T score of -1.0 or less from the averaged measurements taken from L_1 through L_4) within 3 months, using bone densiometry measures from the Lunar DEXA at Baylor Medical Center at Irving. Additional inclusion criteria for this thesis was that they have a visually apparent thoracic kyphosis, and that they were ambulatory either with or without an assistive device. Because teaching and learning is an important component to effective home programs, subjects were excluded in this study if they had a diagnosis of dementia or any other disorder that would prohibit them from accurately answering the medical questionnaire, quality of life questionnaire, or participating in the exercise program. Persons were excluded if the measured I/K was < 13 as defined by Chow and Harrison (1987). Women who were currently experiencing extreme acute back pain and/or acute compression fractures were also excluded. Participants had to be able to speak and understand English because the Berg Balance Scale and Osteoporosis Quality of Life have only been tested reliable in English.

The Tester

The tester was a physical therapist with 23 years of clinical experience and was a senior member of the osteoporosis team at Baylor Medical Center at Irving. The physical therapist performed all the pre and post-test measures and provided instructions in the exercise intervention. A trained research assistant read the height measurements on the stadiometer, traced the flexicurve onto the graph paper, and assisted with the hopper drawings.

Instruments

A medical questionnaire was completed by each subject in order to gather demographic information. It was also used to determine whether a participant was cognitively able to answer questions appropriately and follow directions in order to participate in the study. See Appendix F for further details. In addition, documentation of compliance with the home exercise program was conducted through the use of an *Exercise Log* (see Appendix G). The log was checked with each clinic visit and at the end of the study.

The outcome measures were height (cm), index of kyphosis (%), Berg Balance Score (sum score), and Osteoporosis Quality of Life Questionnaire (5 sub-scores), each described as follows. Height was measured using a wall mounted *stadiometer* (Perspective Enterprises, Kalamazoo, MI) and recorded in cm. The stadiometer is a board mounted on the wall that has measurements in both centimeters and inches running the length of the board. A moveable caliper is attached to the board and is able to slide up and down for the measurement of height. The height of the board was calibrated to insure proper height measurements. Watt, Pickering and Wales (1998) compared an ultrasonic height measuring device (Gulliver) with mechanical stadiometry and the classic "book and tape measure" method. When measuring children and a rigid metal box, the stadiometer demonstrated greater inter- and intra-rater reliability than either of the other two methods. The ultrasonic height measuring device and the "book and tape measure" method produced three times less reliable estimations than the stadiometer.

For the measurement of index of kyphosis, a *surveyor's flexicurve, graph paper, and grease pencil* were used. The flexicurve is a strip of lead covered with plastic which can be bent in one plane only. This device was used to mold to the shape of the spine so that the shape could be traced onto graph paper. The graph paper is divided in one inch blocks that is further divided in $1/10^{th}$ inch blocks. The grease pencil was used to mark C_7 and the L_5S_1 junction on the flexicurve. Hinman (2003/2004) measured the interrater reliability of flexicurve postural measures among novice users. She demonstrated Intraclass Correlation Coefficients (ICCs) of .94 and .93 in the 3 testers calculating the I/K in relaxed and erect postures. This indicated highly reproducible measurements among testers. In her study, Grafa (2003) demonstrated ICC of .98 in the intrarater reliability of calculating I/K.

Dynamic balance was assessed by using the sum score from the *Berg Balance Scale.* This tool rates a subject's performance on 14 items common in everyday life and rates each item on a scale of 0 (worst performance) to 4 (best performance). Each item is rated by the tester. The highest achievable score is 56/56. A person scoring less than 45/56 is considered at high risk for falls (Bogle Thorbahn, and Newton, (1996). Further details can be seen in Appendix H.

Berg, Maki, Williams, Holliday, and Wood-Dauphinee (1992) and Bogle Thorbahn & Newton investigated the measurement properties of the Berg. Berg et al. (1992) compared the Berg Balance Scale to the Balance Subscale of the Mobility Index developed by Tinetti and the Timed Up and Go. They also measured postural sway in the following sequence: (a) quiet unperturbed stance; (b) anterior-posterior (A-P) pseudorandom perturbations; and (c) medial-lateral (M-L) pseudorandom perturbations. The perturbations were performed as the subjects stood on a moving platform. Berg et al. found the ICCs for both intra and inter-rater reliability for performing the Berg test to be .98. The Berg Balance Scale and the Balance Subscale developed by Tinetti demonstrated a strong correlation ($r = .91$). Higher Balance Scale scores were associated with faster performance on the Timed Up and Go ($r = -.76$) and less aid required for ambulation ($r = -.75$). The relationships between the Berg Balance Scale and the platform tests were moderately strong. Four years later Bogle Thorbahn and Newton performed a study to determine whether the Berg balance test could be used to predict an elderly person's risk for falls. They found in their study the sensitivity to be 53% (8/15) and the specificity to be 92% (36/39).

For the purposes of this thesis, perceived function and functional limitations was defined through the five sub-scores on the *Osteoporosis Quality of Life Questionnaire (OQLQ)* - (see Appendix I). This is a therapist administered questionnaire that consists of 30 items distributed across five domains: Symptoms, Physical Function, Activities of Daily Living, Emotional Function, and Leisure and Social Activities. Each item has a seven-point scale; a rating of 1 represents worst possible function and a 7 representing the best possible function. A summary score for each domain was calculated by adding the score of each item then dividing by the number of items in the domain. It is recommended that each domain be scored and interpreted separately. Previous work with other disease-specific instruments using a 7-point scale has suggested that changes of score of approximately 0.5 on each domain represent small but important differences (Papaioannou, et al., 2003). This tool was chosen because it is disease specific and is as much or more powerful than other general quality of life tools (Osteoporosis Group, 1997).

Procedures

Procedures for the study are detailed below. There are five subsections: screening procedures to assess potential subjects for eligibility, baseline measurement procedures, reliability test procedures, intervention procedures, and post-intervention measurement procedures.

Screening Procedures

Potential participants completed the medical questionnaire to obtain their baseline information. Their index of kyphosis was measured and calculated to determine whether the I/K was greater than or equal to 13, thus making the participant eligible to participate in the study. Spinal curve measurements were made by the physical therapist with the use of a surveyor's flexicurve and graph paper in the manner described by Milne and Lauder (1974). The patient was asked to wear a patient gown open in the back. The bra was unfastened and any clothing was pushed down to the hips. The patient was asked to remove her shoes and stand with the feet even and hip width apart on a piece of paper. The research assistant traced around the feet on the paper. The C_7 spinal process was identified by having the patient flex and extend her neck several times to differentiate the mobility between the C_7 and T_1 and marked with the grease pencil. The L_5S_1 junction was identified and marked by palpation of the iliac crests to locate the L_{4-5} interspace then moving down one level. The flexicurve was placed on the patient's back, with one end on the seventh cervical spine, and closely applied to the midline of the back, with the patient being asked to stand as erect as possible with head erect and eyes focused directly ahead. The level of the lumbosacral junction was marked with a grease pencil on the flexicurve. Once the flexicurve had been carefully molded to the shape of the patient's spine, it was carefully removed in a manner to not alter the shape in any way. The instrument was laid on the graph paper making sure that C_7 and L_5S_1 marks were aligned on the same vertical line. The research assistant traced the spinal curve onto the graph paper and attached the patient's personal identification number (PIN) to the graph. A straight line was then drawn down the length of the curve from the C_7 mark to the L_5S_1 junction mark. Measurement of the thoracic curve was made from the peak of the curve to the straight line, with "I" being the distance measured. The thoracic length, "K", is the length of the straight line from C_7 to the point where the curve intersects the straight line. Index of kyphosis is the ratio of I:K multiplied by 100 (Chow & Harrison, 1987). If the I/K was 13 or greater the potential patient could participate. See Appendix A for a description of the graph and the calculations.

Baseline Measurement Procedures

All participants received four baseline measurements. The index of kyphosis determined eligibility as described in the previous section. The three remaining measurements were height, balance, and functional status performed in that order. All testing was performed by the physical therapist.

Height was assessed using a wall mounted stadiometer. For this thesis the method described by Siminoski et al. (2004) was used to measure the height of the participants. The stadiometer was mounted on the wall and calibrated. Each participant was measured without shoes. They were asked to stand with their heels 1 inch from the wall with their buttocks and back against the board of the stadiometer. Adjustments were made to insure that the greater trochanter was slightly anterior to the malleoli. The participant's head was facing forward with the back of the head not necessarily touching the vertical board. The participant was instructed to take a deep breath, hold it and stand straight. At that moment, the observer applied bilateral pressure to the mastoid processes of the patient to hold the head in position. The patient was then asked to relax and exhale. The caliper was slid down to the patient's head and the height was recorded to the closest millimeter. This process was performed three times for each participant. The average of the three measurements was used as the height for the participant. The physical therapist positioned the participant and slid down the caliper but was blinded to the measurement by an opaque card placed over the readout. The measurements were read and transcribed by the physical therapy technician.

The Berg Balance Scale was administered by the physical therapist. The test was administered using two straight back chairs, one with arms and one without, as well as a stopwatch, ruler, and 6" wooden box. The specific tasks are described in Appendix H. The total score was used to determine the intervention outcome.

The Osteoporosis Quality of Life Questionnaire was also administered by the physical therapist. The participant and physical therapist sat facing each other with a table in between them. The questions were read by the investigator and the appropriate answer card was placed in front of the participant (see Appendix I for the questions and the answer cards). The physical therapist recorded the participant's answers on the answer sheet (also in Appendix I) and calculated the sub-scores at the end of the test.

Intervention Procedures

All the participants were instructed in general postural exercises (Grafa, 2003) and body mechanics (see Appendix B) to be performed daily for 8 weeks. At the initial intervention session, which was scheduled for a date later than the assessment session, participants were instructed in the exercise program by the physical therapist through the use of demonstration and monitored practice with emphasis on correct technique. They were given printed descriptions of the exercises, the appropriate weights, and instructions to perform the exercises daily, documenting the exercise session on the exercise log.

The progressive strengthening exercise program (detailed in Appendix B) consisted of the following:

1. Lower abdominal progression
2. Bridging progression
3. Military press (shoulder abduction progression)

4. Wall slide progression (supported shoulder abduction while standing and facing a wall)
5. Overhead arm lowering
6. Bent over row
7. Reverse flies
8. Shoulder scaption (with external rotation)
9. Trunk extension (with lower trapezius progression)

The program was designed for most of the exercises to start in a gravity-minimized position and to progress to an against-gravity position. Once progressed to the against gravity position, weights were added and increased as progression continued.

In keeping with Grafa's protocol, the ten-repetition maximum (10 RM) method was used to determine the amount of resistive weights when weights were used for the progression. A starting weight was selected below the participant's estimated maximum lifting capacity. If the participant could perform 10 repetitions with proper form, then a 2.2 kg (1 lb.) weight was added and the participant was instructed to perform 10 repetitions. When the participant could complete all but 1 or 2 of the lifts, the 10-RM value was reached. The participant was allowed to rest approximately 2 to 3 seconds between each 10 RM trial. Once the 10 RM was determined, 70% of the 10 RM value for each exercise was calculated and was used as the initial weight. Two sets of 10 repetitions of each exercise were performed with about a 10-second rest between each set. Participant's exercises were progressed when fatigue no longer occurred at 10 repetitions (Grafa, 2003).

The exercise participants were given verbal and written instructions in body mechanics during activities of daily living with emphasis on avoidance of spinal flexion. This was completed during the third visit to avoid overwhelming the participant with too much new information in one day. All participants returned to the clinic once a week for 4 weeks so that the physical therapist could inspect/correct technique and progress the exercises as needed. They were given an exercise log to record the performance of their home exercise program beginning with the initial intervention session and continuing daily until the day of the post-intervention measurements.

Post Intervention Procedures

At the end of eight weeks the physical therapist remeasured all the participants on the outcome measures: index of kyphosis, height, dynamic balance and functional status. The physical therapist was blinded to the initial scores at the time of the assessment.

Data Analysis

Participants' characteristics and outcomes were described. Percent compliance was calculated from the exercise logs.

CHAPTER IV

RESULTS

The purpose of this thesis was to provide multiple case reports that focus on the use of four clinic visits for instruction in a home exercise program as an intervention to reduce thoracic kyphosis, increase height, and improve balance and quality of life in women with low bone mass and a clinically apparent kyphosis.

Three women participants were instructed in a home exercise program designed to target the trunk muscles. The women participated in 4 consecutive weekly visits then continued the exercise on their own for a total of 8 weeks of exercise. They were given weights in order to perform the exercise with appropriate resistance. They were reassessed after 8 weeks of exercise.

The results, presented in this chapter, describe the participant characteristics, the outcome measures, reliability measures, and compliance data.

Participant Characteristics

Nine participants with low bone mass and increased thoracic kyphosis were recruited for this study using convenience sampling from the bone density center at Baylor Medical Center at Irving. Two women did not receive the intervention. Three were excluded because their index of kyphosis was less than 13. Four of the participants qualified for the study and received the intervention. One of the participants that initially qualified and was participating in the intervention dropped from the study for unrelated medical reasons. Therefore the results for 3 participants are presented. A summary of characteristics of participants who completed the intervention is found in Table 2. Note that all of the participants were diagnosed with osteopenia when using the WHO criteria for classification.

Table 2

Description of Participants' Age, Height, Years Postmenopausal, Index of Kyphosis, and Lumbar Bone Density (BMD)

Participant PIN	Age (Years)	Height (cm)	Postmenopausal (Years)	Index of Kyphosis (%)	Lumbar BMD (T score)
6	63	161.20	26	13.76	-1.30
7	78	157.96	20	15.50	-1.40
9	84	153.37	44	14.40	-1.80

Note: PIN indicates personal identification number; BMD indicates bone mineral density.

Description of Outcome Measures

Table 3 shows the pre- and post-intervention scores for I/K, height, and score on the Berg Balance Scale.

Table 3

Pre- and Post-Treatment Scores for Index of Kyphosis, Height, and Berg Balance Scale

Participant PIN	Index of Kyphosis (%)		Height (cm)		Berg Balance Scale (score)	
	Pre	Post	Pre	Post	Pre	Post
6	13.76	13.08	161.20	161.80	52	56
7	15.50	11.29	157.96	158.90	54	55
9	14.40	13.33	153.37	153.80	45	49

Note: PIN indicates personal identification number; Pre, pre-treatment values; Post, post-treatment values.

Self-perception of function was assessed using the Osteoporosis Quality of Life Questionnaire. This is a therapist administered questionnaire that consists of 30 items distributed across five domains: Symptoms, Physical Function, Activities of Daily Living, Emotional Function, and Leisure and Social Activities. Each item has a 7-point scale; a rating of 1 represents worst possible function. A summary score for each domain was calculated by adding the score of each item then dividing by the number of items in the domain. It is recommended that each domain be scored and interpreted separately. Previous work with other disease-specific instruments using a 7-point scale has suggested that changes of score of approximately 0.5 on each domain represent small but important differences (Papaioannou, et al., 2003). Table 4 shows the pre and post scores of each domain on the OQLQ.

Table 4

Pre- and Post-Treatment Scores on the 5 Domains of the Osteoporosis Quality of Life Questionnaire

Participant PIN	OQLQ Domain	Pre-Treatment (score)	Post-Treatment (score)
6	Symptoms	7.00	6.44
	Emotional Function	6.25	6.25
	Physical Function	7.40	7.00
	Activities of Daily Living	7.22	7.00
	Leisure and Social	7.33	7.00
7	Symptoms	2.11	5.22
	Emotional Function	2.75	5.50
	Physical Function	1.80	5.40
	Activities of Daily Living	2.22	5.67
	Leisure and Social	3.00	7.00
9	Symptoms	3.11	4.44
	Emotional Function	5.50	4.50
	Physical Function	3.40	3.80
	Activities of Daily Living	3.56	5.70
	Leisure and Social	2.67	3.33

Note: PIN indicates personal identification number; OQLQ, Osteoporosis Quality of Life Questionnaire.

Compliance Data

Participants in the exercise group were asked to perform the exercises every day. With the realization that distractions occur in life, a compliance rate of 5 to 7 times per week was considered excellent. Compliance was thus calculated by taking the number of days exercised divided by the number of weeks the exercise took place times five. Table 5 indicates the compliance of the participants during the study.

Table 5

Compliance of Exercise Performance During the Intervention

Participant PIN	Compliance (%)
6	97.5
7	100
9	48.78

Summary

Three post-menopausal women with low bone mass and a clinically apparent thoracic kyphosis completed the intervention. One of the participants recruited and qualified had to drop out for unrelated medical reasons. Two of the women who completed the intervention had excellent compliance. The third began the exercise period with fair compliance but ended the last few weeks with poor compliance.

CHAPTER V

DISCUSSION

Women with kyphosis are referred to physical therapy for a number of reasons such as pain, reduced mobility, and balance disorders. Balzini, Vannucchi, Benvenuti et al. (2003) demonstrated that severe flexed posture is associated with slow gait and increased base of support. Balzini and associates also reported that patients with significant flexed posture had a significantly lower score on the balance and gait scores of the Performance Oriented Mobility Assessment than patients with mild flexed posture. Similarly, Cook (2002) demonstrated that there are significantly compromised balance assessment results in individuals diagnosed with osteoporosis who display a higher degree of thoracic kyphosis, than in those individuals with osteoporosis but with a lesser degree of thoracic kyphosis. Since persons with osteoporosis are at higher risk of fracture with falling, balance impairments are especially of concern. In addition, Lind, Lucente, and Kohn (1996) demonstrated a correlation between increased thoracic kyphosis and the prevalence of advanced uterine prolapse, with the risk of prolapse being 1.35 times greater with each additional degree of kyphosis.

Balzini, Vannucchi, Benvenuti et al. (2003) confirmed the psychological impact of a flexed posture in older women. Participants with severe deformity demonstrated greater depression and lower motivation as measured by the Geriatric Depression Scale and the Multidimensional Fatigue Inventory respectively compared with older women with mildly flexed postures. Miyakoshi, Itoi, Kobayashi, and Kodama (2003) demonstrated that quality of life in patients with osteoporosis was impaired by postural deformity, especially by whole kyphosis.

Thoracic kyphosis is associated with osteopenia and osteoporosis, and may result in vertebral compression fractures. Milne and Lauder (1974) demonstrated a direct correlation between aging (after the age of 60) and increasing kyphosis attributed to vertebral compression fractures (VCFs). Linville reported that 33% of women greater than age 65 have vertebral fractures. Vertebral compression fractures lead to progressive sagittal spine deformity (kyphosis) and changes in spinal biomechanics, and are believed to contribute to a five-fold increase in further vertebral fractures via transmission of forces to other weakened vertebrae (Lieberman et al., 2000).

The influence of VCFs extends beyond the thoracic spine, the most common vertebral region affected. Lieberman et al. (2000) reported that two or more vertebral fractures significantly affect health, daily living, and medical costs through loss of lung capacity, loss of appetite, reduced mobility, chronic pain, and/or clinical depression. These fractures can limit an individual's ability to perform activities of daily living, restricting function in employment as well as social and recreational settings (Lyles, Gold, Shipp, et al., 1993). Women with osteoporosis express concerns with this change in their shape such that clothes do not fit properly and they fear falling and breaking a bone (Osteoporosis Group, 1997). Anxiety often causes inactivity, and many women with osteoporosis are frozen by their anxiety into sedentary lifestyles. They fear that activity or exercise could cause fracture and do everything they can to avoid situations in which fractures are likely (Gold, 1996). Ironically, as women become more kyphotic, their back muscles and ligaments are stretched beyond the normal position. This leads to a chronic back pain that tends not respond to analgesics, heat or cold. However, these women often respond well to exercise (Gold), the very thing they fear might cause further fracture.

There is good evidence on the benefits of exercise for women with osteoporosis and kyphosis. Dalsky and associates (1988) reported that weight bearing exercise led to significant increases in bone mineral content in older, postmenopausal women. Preisinger, Alacamlioglu, Pils, Bosina, Metka, and Schneider (1996) found that regular long term therapeutic exercises were beneficial in reducing subjective back complaints and slowed loss of bone mass. Malmros, Mortensen, Jensen, and Charles' (1998) 12-week supervised exercise training program for osteoporotic patients improved balance and level of daily function and decreased the experience of pain and use of analgesics. A 24-session, supervised program of progressive trunk strengthening exercises over 8 - 12 weeks can reduce thoracic kyphosis and increase shoulder flexion, trunk muscle performance, and ADL in postmenopausal women with low bone mass (Grafa, 2003). It is unknown if other training paradigms will produce similar results.

Increased thoracic kyphosis has been demonstrated to increase pain, negatively effect balance, and have a detrimental effect on quality of life. Supervised exercise sessions in the clinic setting have been demonstrated to reduce the thoracic kyphosis width (Grafa, 2003). However, today's healthcare environment limits the number of visits covered by third party payers, therefore requiring more emphasis on home exercise programs. Additionally, as kyphosis secondary to low bone mass is a continuing and progressive problem, women need to learn to manage this problem as a lifestyle change.

The purpose of this thesis was to provide multiple case reports that focus on the use of four clinic visits for instruction in a home exercise program as an intervention to reduce thoracic kyphosis, increase height, and improve balance and quality of life in women with low bone mass. The present data are intended as a pilot study for an ongoing study.

Case Descriptions

Recruitment

Participants were recruited using convenience sampling from the bone density center at Baylor Medical Center at Irving. The facility provided the researcher with a list of potential participants with low bone mass or osteoporosis and visually apparent kyphosis who had agreed to be contacted. Once a potential participant was identified and consented to participate in the intervention, written consent from each woman's physician was obtained. Signed informed consent was required of all participants in accordance with the Institutional Review Boards (IRB) at the data collection site (Baylor Medical Center at Irving) and Texas Woman's University (TWU).

Four postmenopausal women diagnosed with low bone mass or osteoporosis (T score of -1.0 or less from the averaged measurements taken from L_1 through L_4) within 3 months, using bone densiometry measures from the Lunar DEXA at Baylor Medical Center at Irving were recruited for this study. They each had a clinically apparent thoracic kyphosis ($I/K \geq 13$) as defined by Chow and Harrison (1987), and that they were ambulatory either with or without an assistive device. Because teaching and learning is an important component to effective home programs, patients were excluded from this intervention if they had a diagnosis of dementia or any other disorder that would prohibit them from accurately answering the medical questionnaire, quality of life questionnaire, or participating in the exercise program. Patients currently experiencing extreme acute back pain and/or acute compression fractures were also excluded since the intervention targets chronic, subacute problems associated with thoracic kyphosis. All the women spoke and understood English because the Berg Balance Scale and Osteoporosis Quality of Life have only been tested reliable in English. One of the patients had to drop out due to unrelated medical problems. This case report will discuss the three patients to complete the intervention.

Examination

The physical therapist performed four baseline measurements including the index of kyphosis also used to determine eligibility. The three remaining measurements were height, balance, and functional status performed in that order.

The physical therapist measured the spinal curves with the use of a surveyor's flexicurve and graph paper in the manner described by Milne & Lauder (1974). This measure was chosen because Milne and Lauder (1974) and Grafa (2003) found that measuring spinal curves with the flexicurve was reliable. It is also clinically useful in that it is simple and inexpensive.

The flexicurve is a strip of lead covered with plastic which can be bent in one plane only. This device was used to mold to the shape of the spine so that the shape could be traced onto the graph paper. The graph paper was divided in one inch blocks that was further divided in 1/10th inch blocks. A grease pencil was used to mark C_7 and the L_5S_1 junction on the flexicurve.

Each patient was asked to wear a patient gown open in the back. The bra was unfastened and any clothing was pushed down to the hips. The patient was asked to remove her shoes and stand with the feet even and hip width apart on a piece of paper. The physical therapy technician traced around the feet on the paper. The C_7 spinal process was identified by having the patient flex and extend her neck several times to differentiate the mobility between the C_7 and T_1 and marked with the grease pencil. The L_5S_1 junction was identified by palpation of the iliac crests to locate the $L_{4\text{-}5}$ interspace then moving down one level. This was also marked. The flexicurve was placed on the patient's back, with one end on the seventh cervical spine, and closely applied to the midline of the back, with the patient being asked to stand as erect as possible with head erect and eyes focused directly ahead. The level of the lumbosacral junction was marked with a grease pencil on the flexicurve. Once the flexicurve had been carefully molded to the shape of the patient's spine, it was carefully removed in a manner to not alter the shape in any way. The instrument was laid on the graph paper making sure that C_7 and L_5S_1 marks were aligned on the same vertical line. The physical therapy tech traced the spinal curve onto the graph paper and attached the patient's PIN (personal identification number) to the graph. A straight line was then drawn down the length of the curve from the C_7 mark to the L_5S_1 junction mark. Measurement of the thoracic curve was made from the peak of the curve to the straight line, with "I" being the distance measured. The thoracic length, "K", is the length of the straight line from C_7 to the point where the curve intersects the straight line. Index of kyphosis is the ratio of I:K multiplied by 100 (Chow & Harrison, 1987).

Height was assessed with a wall mounted stadiometer. The method described by Siminoski, et al. (2004) was used to measure the height of the patients. The stadiometer was mounted on the wall and calibrated. Each patient was measured without shoes. They were asked to stand with their heels 1 inch from the wall with their buttocks and back against the board of the stadiometer. Adjustments were made to insure that the greater trochanter was slightly anterior to the malleoli. The patient's head was facing forward with the back of the head not necessarily touching the vertical board. The patient was instructed to take a deep breath, hold it and stand straight. At that moment, the observer applied bilateral pressure to the mastoid processes of the patient to hold the head in position. The patient was then asked to relax and exhale. The caliper was slid down to the patient's head and the height was recorded to the closest millimeter (see Figure 1). This process was performed three times for each patient. The average of the three measurements was used as the height for the patient. The physical therapist positioned the subject and slid down the caliper but for this case report was blinded to the measurement by an opaque card placed over the readout. The measurement was read and transcribed by the physical therapy technician.

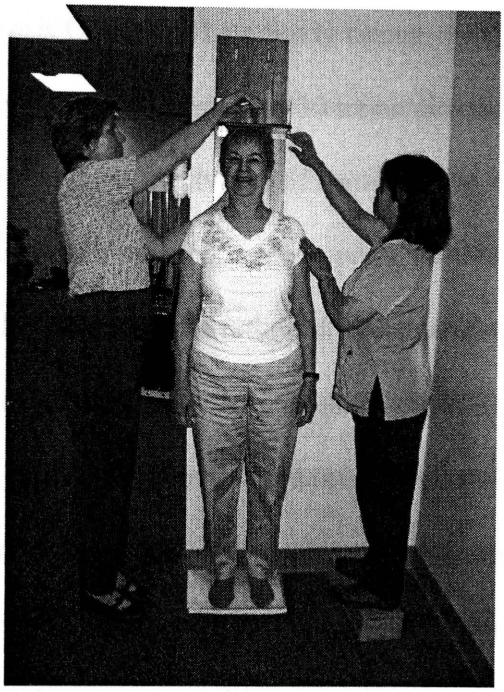

Figure 1: Measurement of height with the stadiometer

The physical therapist measured dynamic balance by the sum score from the Berg Balance Scale. It was chosen due to its ease of use, does not need sophisticated equipment, takes approximately 20 minutes to perform, covers functional activities, and its ability to predict fall risk (Bogle Thorbahn and Newton, 1996). This tool evaluates a patient's performance on 14 items common in everyday life and rates each item on a scale of 0 (worst performance) to 4 (best performance). In order to perform the Berg Balance Scale a stop watch was used to time the various activities, a ruler was used to measure reach, and a six inch box was be used for the alternating step test.

Perceived function and functional limitations were measured using the five sub-scores on the Osteoporosis Quality of Life Questionnaire (OQLQ). This tool was chosen because it is disease specific and is as much as or more powerful than other general quality of life tools (Osteoporosis Quality of Life Study Group, 1997). The OQLQ is a therapist administered questionnaire that consists of 30 items distributed across five domains: Symptoms, Physical Function, Activities of Daily Living, Emotional Function, and Leisure & Social Activities. Each item has a seven-point scale with a rating of 1 representing the worst possible function and a rating of 7 representing the best possible function. A summary score for each domain was calculated by adding the score of each item then dividing by the number of items in the domain. It is recommended that each domain be scored and interpreted separately. Previous work with other disease-specific instruments using a 7-point scale has suggested that score changes of approximately 0.5 on each domain represent small but important differences (Papaioannou, et al., 2003).

The Osteoporosis Quality of Life Questionnaire was administered by the physical therapist. The patient and therapist sat facing each other with a table in between them. The questions were read by the therapist and the appropriate answer card was placed in front of the patient. The therapist recorded the patient's answers on the answer sheet and calculated the sub-scores at the end of the test.

Evaluation

Patient 6 was a 63 year old white female. She was 26 years postmenopausal due to a hysterectomy at age 37. This is early for menses to stop, with the average age for menopause being 51 (eMedicine, 2006). Her initial measured height was 161.20 cm and her Lumbar BMD T score from L_{1-4} was -1.30, which is osteopenia when using the WHO criteria for classification. Her initial Berg score was 52/56, which indicates a low risk for falls (Bogle Thorbahn and Newton, 1996). This patient was never on hormone replacement but she did take calcium supplements. She had no comordities and she was not taking bone building medication. Patient 6 was employed in an office position and had to commute in Dallas traffic to reach her place of employment, both of which are not conducive to good posture.

Patient 7 was a 78 year old white female who was 20 years postmenopausal. This is a little later than average for menopause. Her initial measured height was 157.96 cm and her lumbar BMD T score was -1.40, which is osteopenia when using the WHO criteria for classification. Her initial Berg score was 54/56, which indicates a lower risk of falling. This patient had taken hormones for about a year in the 1970s when her menopause began and was currently taking calcium supplementation. She reported not ever taken steroids but had a history of COPD. She had a history of compression fracture in the lumbar spine. The patient was not on any bone building medications. Patient 7 was an artist who traveled frequently to show her paintings. She moved her paintings herself, loading them in and out of the vehicle and setting them up for display.

Patient 9 was an 84 year old white female who was 44 years postmenopausal. Her initial measured height was 153.37 cm and her lumbar BMD T score was -1.80, which is osteopenia when using the WHO criteria for classification. Her initial Berg score was 45/56. This score indicates a high risk for falls. The patient had a history of falls and used a cane to ambulate long distances. Patient 9 reported taking hormones in the past for short periods but she currently was taking only calcium supplementation. She had a history of steroid use and had a history of compression fractures. She also had a history of cardiac and respiratory problems. She was currently taking the bone building medication Evista (Raloxifen).

Intervention

The intervention began several days after the initial examinations. All the patients were instructed in general postural exercises (Grafa, 2003) and body mechanics (see Appendix I) to be performed daily for 8 weeks. At the initial intervention session the physical therapist taught each woman individually through demonstration and monitored practice with the emphasis on correct technique. They were given printed descriptions of the exercises, the appropriate weights, and instructed to perform the exercises daily, documenting the exercise session on the exercise log.

The progressive strengthening exercise program (detailed in Appendix I) consisted of the following:

1. Lower abdominal progression
2. Bridging progression
3. Military press (shoulder abduction progression)
4. Wall slide progression (supported shoulder abduction while standing and facing a wall)
5. Overhead arm lowering
6. Bent over row
7. Reverse flies
8. Shoulder scaption (with external rotation)
9. Trunk extension (with lower trapezius progression)

The program was designed for most of the exercises to start in a gravity-minimized position and progress to an against-gravity position. Weights were added and increased as a progression for the against gravity position.

In keeping with Grafa's protocol, the ten – repetition maximum (10 RM) method was used to determine the amount of resistive weights when weights were used for the progression. A starting weight was selected below the subject's currently estimated maximum lifting capacity. If the subject could perform 10 repetitions with proper form, then a 2.2 kg (1 lb.) weight was added and the subject was instructed to perform 10 repetitions. Ten RM was reached when the subject could complete all but 1 or 2 of the lifts. The subject was allowed to rest approximately 2 to 3 seconds between each 10 RM trial. Once the 10 RM was determined, 70% of the 10 RM value for each exercise was calculated and was used as the initial weight. Two sets of 10 repetitions of each exercise were performed with about a 10-second rest between each set. Patient's weights or exercises were progressed when fatigue no longer occurred at 10 repetitions (Grafa, 2003).

The patients were given verbal and written instructions in body mechanics during activities of daily living with emphasis on avoidance of spinal flexion. This was done during the third exercise visit to avoid overwhelming the subject with too much new information in one day. All patients returned to the clinic once a week for 4 weeks so that the physical therapist could inspect/correct technique and progress the exercises as needed. These were four visits totally separate from the pre- and post- assessments. They were given an exercise log to record the performance of their home exercise program beginning with the initial intervention session and continuing daily until the day of the post-intervention measurements, 8 weeks from the first intervention visit.

Outcomes

At the end of eight weeks from the first exercise appointment the physical therapist remeasured index of kyphosis, height, dynamic balance and functional status for all the patients. The physical therapist was blinded to the initial scores at the time of the assessment. The outcomes of all clinical measures are summarized in Tables 6 and 7. Compliance data are presented in Table 8.

Table 6

Pre- and Post-Treatment Scores for Index of Kyphosis, Height, and Berg Balance Scale

Participant PIN	Index of Kyphosis (%)		Height (cm)		Berg Balance Scale (score)	
	Pre	Post	Pre	Post	Pre	Post
6	13.76	13.08	161.20	161.80	52	56
7	15.50	11.29	157.96	158.90	54	55
9	14.40	13.33	153.37	153.80	45	49

Note: PIN indicates personal identification number; Pre, pre-treatment values; Post, post-treatment values. For index of kyphosis a lower number is better, while with height and the Berg a higher number is better.

Table 7

Pre- and Post-Treatment Scores on the 5 Domains of the Osteoporosis Quality of Life Questionnaire

Participant PIN	OQLQ Domain	Pre-Treatment (score)	Post-Treatment (score)
6	Symptoms	7.00	6.44
	Emotional Function	6.25	6.25
	Physical Function	7.40	7.00
	Activities of Daily Living	7.22	7.00
	Leisure and Social	7.33	7.00
7	Symptoms	2.11	5.22
	Emotional Function	2.75	5.50
	Physical Function	1.80	5.40
	Activities of Daily Living	2.22	5.67
	Leisure and Social	3.00	7.00
9	Symptoms	3.11	4.44
	Emotional Function	5.50	4.50
	Physical Function	3.40	3.80
	Activities of Daily Living	3.56	5.70
	Leisure and Social	2.67	3.33

Note: PIN indicates personal identification number; OQLQ, Osteoporosis Quality of Life Questionnaire.

Table 8

Compliance of Exercise Performance During the Intervention

Participant PIN	Compliance (%)
6	97.5
7	100
9	48.78

Patient 6 demonstrated a slight improvement in her I/K and height and a 4 point improvement on the Berg. Items of improvement on the Berg were as follows. She initially required the use of her hands to go from sit to stand, was unable to tandem stand, and was unable to stand on one leg more than 3 seconds. During the final visit she was able to stand without the use of her hands, was able to tandem stand 30 seconds, and stand on one leg for 10 seconds. She reported feeling much stronger and overall better about herself but her OQLQ scores were the same or slightly worse. As mentioned previously, a 0.50 change in a domain on the OQLQ is considered significant. She demonstrated 0.56 decrease in the Symptom domain. She reported on the day of the final testing that she had done yard work recently which made her sore. Thus she reported having more pain and difficulty with some activities in the previous 2 weeks but this was attributed to the increased activity.

Patient 7 was quite enthusiastic during and after the intervention. She demonstrated a marked improvement in her I/K from 15.50 to 11.29. Her height improved almost a centimeter. In the Berg she initially was unable to stand on one leg for greater than 3 seconds which she was able to do during the final visit so there was a 1 point improvement in her Berg score. The patient had difficulty with looking over one shoulder at the final visit, which she didn't have during the initial evaluation. On the OQLQ, she had significant improvement (over 0.5) in all domains. At the final visit the patient reported that overall she was feeling much better, she was having less pain, and had greater ability to do her daily activities that included moving her paintings to different locations.

Patient 9 was more debilitated than the other 2 patients. She was also the least compliant (see Table 9). She reported that at one point during the intervention period she injured her arm in a manner not related to exercise, but it limited her ability to perform the exercises. She also had several days that she felt ill and unable to do much of anything. Despite the lower compliance rate she also demonstrated improvement in I/K, height, balance, and most OQLQ domains. Initially on the Berg she was unable to stand, sit, or transfer without the use of her hands. She also had difficulty turning to look over her shoulder and turning 360° in a speedy manner. Patient was unable to tandem stand and could not stand on one leg for 3 seconds. At discharge she continued to use her hands when standing up, sitting down, and transferring. She demonstrated improvement in her ability to look over her shoulder, she was able to tandem stand for 30 seconds, and was able to stand on one leg at least 3 seconds. She demonstrated clinically significant improvement in 3 of the 5 OQLQ domains – symptoms, ADL, and Leisure & Social. Overall the patient reported that her back was not hurting as much and she arrived for one of her exercise appointments without her cane.

Discussion

Women with low bone mass frequently experience increased kyphosis, which affects not only their self image but can also affect their balance, quality of life, and other physical and emotional aspects of their lives (Osteoporosis Group, 1997; Cook, 2002; Lieberman et al., 2000; Balzini, Vannucchi, Benvenuti et al., 2003; Miyakoshi, Itoi, Kobayashi, and Kodama, 2003). Exercise is beneficial for these women, from relief of pain and symptoms (Preisinger, Alacamlioglu, Pils, Bosina, Metka, and Schneider, 1996; Malmros, Mortensen, Jensen, and Charles, 1998; Grafa, 2003) to promoting increased bone density (Dalsky, et. al., 1988).

Grafa (2003) demonstrated that women who participated in her exercise program for 24 visits in an 8-12 week time span had decreased I/K, increased shoulder ROM and increased muscle strength. Grafa's exercise program focused on strengthening and stability in the trunk with emphasis on proper technique. In her study, the women were closely supervised by the physical therapist during the sessions. Unfortunately today's health care environment finds third party payers resistant to funding 24 clinic visits. The purpose of this case report was to present the use of Grafa's exercise program in 4 clinic visits for instruction as a home exercise program.

In this case report, 3 women with low bone mass and clinically apparent kyphosis participated in an 8-week home exercise program. They were seen once a week for 4 weeks initially for instruction in proper performance of the exercises as well as demonstration of how and when to progress the exercise program. Then they continued on their own with an unsupervised home exercise program. The frequency and duration of treatment as well as level of supervision is consistent with current physical therapy practice. The one element of this intervention that was unusual was that the patients were given the weights to properly perform the exercises at home. This is not a usual occurrence in the clinic but did appear to be quite beneficial. It was actually surprising when testing the 10 RM how much weight the women were actually able to lift, which indicates that it is easy to underestimate the abilities of the elderly, even when the therapist has many years of experience working with older women.

The patients ranged in age from 63 to 84. The youngest was still employed and felt that many of the questions on the OQLQ were rather silly and did not pertain to her.

It was interesting, though, that the tool was able to pick up the fact that on the final visit she was not feeling quite as well as initially due to performing yard work. The OQLQ was more appropriate for the other 2 patients because they had more problems and had both experienced compression fractures.

All of the patients had improvement in their I/K. This was consistent with the findings of Grafa (2003). While, due to the nature of her study, Grafa had 100% compliance from all of her subjects, the patients in this case report had compliance ranging from 100% to 48.78%. Even patient 9, with the least compliance, demonstrated improvement in I/K. This leads to questions of whether the benefits could all be attributed to the exercise or whether some benefits were gained from postural awareness. These questions would benefit from further investigation in a randomized controlled study.

Cook (2002) reported a relationship between increased thoracic kyphosis and compromised balance. The results in this case report confirm this relationship in that as I/K improved so did balance. All of the patients demonstrated an improvement in both I/K and on the Berg after the intervention. However cause and effect can not be determined outside of a randomized controlled study, therefore these outcomes need to be confirmed by further research.

The 2 older patients reported significant improvements on all domains of the OQLQ except for the physical domain for patient 9. Both of these women had significant medical problems, though quite different attitudes. Patient 8 was enthusiastic about the exercise while patient 9 had difficulty getting motivated to even do them. Much of this may have been related to their lifestyles, as patient 8 traveled frequently to sell her paintings and patient 9 tended to be less active and stay home.

After participating in an 8-week home exercise program that focused on trunk strengthening and stability, 3 patients demonstrated improvement in their I/K, balance, and an increase in height. Two of the 3 had significant improvement in their scores on the OQLQ. Initially the OQLQ did not appear to be appropriate for patient 6, who was relatively healthy, but it appeared sensitive when she was sore for doing yard work. Preventative healthcare for this patient population is of great importance for quality of life and exercise programs such as the one presented provides the opportunity for physical therapists to be involved in this vital role.

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APPENDIX A

Spinal Curve Measurements

Spinal Curve Measurements

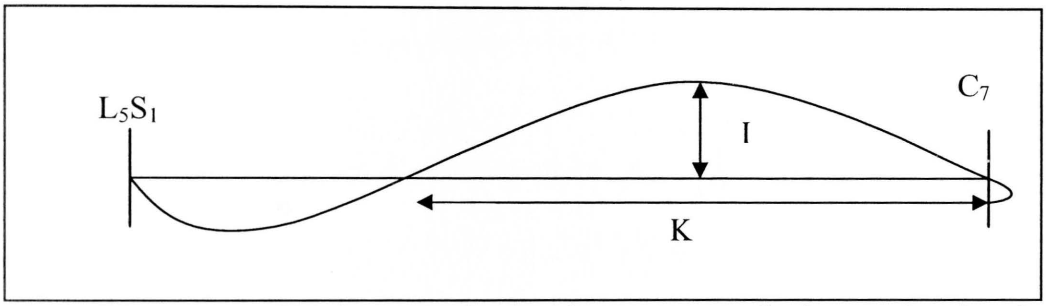


Figure 2. Tracing of kyphosis obtained with a surveyor's flexicurve showing the dimensions used in calculating index of kyphosis.

Spinal curve measurements are kyphosis and lordosis width and length. They are measured in centimeters after a surveyor's flexicurve is molded along the spine of the subjects, marked at the C_7 spinous process and at the L_5S_1 joint, and the curves traced on graph paper. A straight line is drawn from C_7 to L_5S_1 on the graph paper. 'I' is the vertical distance of a point on the curve farthest from the straight line. 'K' is the length of the straight line from C_7 to the point where the curve intersects the straight line. Index of kyphosis is the ratio of I:K multiplied by 100 (Chow & Harrison, 1987).

APPENDIX B

Exercises and Body Mechanics

Good Bones ™ Exercise Program

Colleen S. Grafa, PT, DSc

Ability Studios

220 E Evergreen

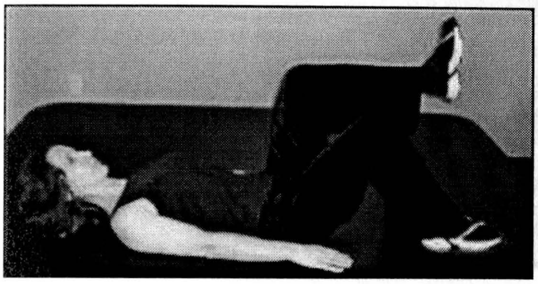
Sherman, TX 75090

903 891-8222 phone

903 891-8422 fax

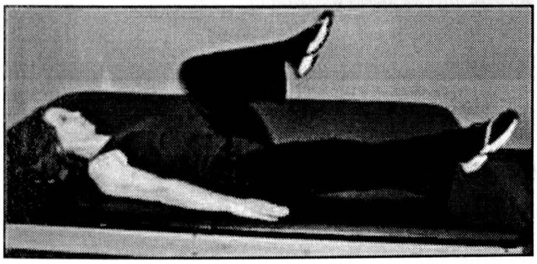
csgrafa@cableone.net

Exercise #1 ABDOMINAL PROGRESSION



Level 1: Tighten abdominals and slowly raise right leg until hip/knee are at 90°. Hold 2 seconds. Return to foot flat position. Repeat with left leg.

Level 2: Progress by bringing both knees (one at a time) 90°. Keep trunk rigid as you slowly lower one leg at a time back to the bent knee position.

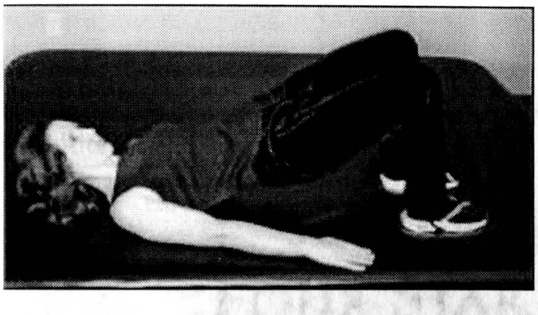


Level 3: Progress by tightening abdominals and slowly slide one foot out until legs are nearly straight, or until back begins to arch. Return to bent knee position. Repeat with other leg.

Level 4: Progress by bringing both knees to 90° then slowly straighten right leg. Hold 2 seconds. Return to 90° position. Repeat with left leg. Keep abdominals tight. Do 2 sets per session.

Progress each level when you can repeat 10 times per set. Do 2 sets per session.

Exercise #2 BRIDGE PROGRESSION



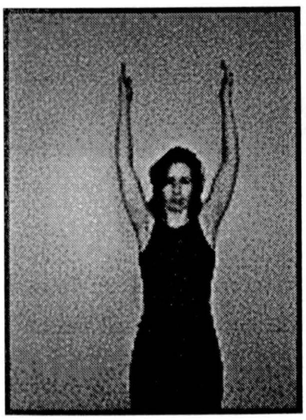
Level 1: Tighten the abdominals and slowly raise buttocks from floor.

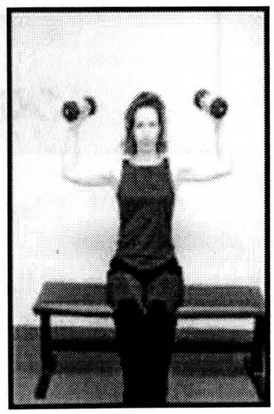
Level 2: Progress by slowly extending the right leg, keeping abdominals tight. Hold for 2 seconds then return to foot flat position. Repeat with the left leg.

Progress each level when you can repeat 10 times per set. Do 2 sets per session.

Exercise # 3 MILITARY PRESS PROGRESSION

Level 1: On back, upper arms at shoulder level, elbows bent to 90 °. Tighten abdominals as you reach arms overhead. Keep arms against the floor as much as possible without shoulder pain.





Level 2: Progress by standing with your back against a wall and repeat sliding your arms up the wall.
Level 3/4: Progress to sitting and then to standing with weights.

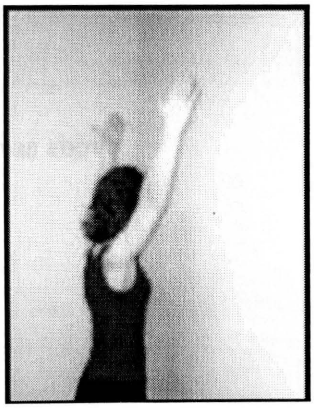
Progress each level when you can repeat 10 times per set. Do 2 sets per session.

Exercise # 4 WALL SLIDE PROGRESSION

Stand close to & face the wall with elbows bent and little finger side of the hand against the wall. Arms should be out to the side with the elbows closer to the body than the hands.

Level 1: Slide your hands up the wall to the overhead position, slightly out to the side (rather than straight up close to the head).

Level 1

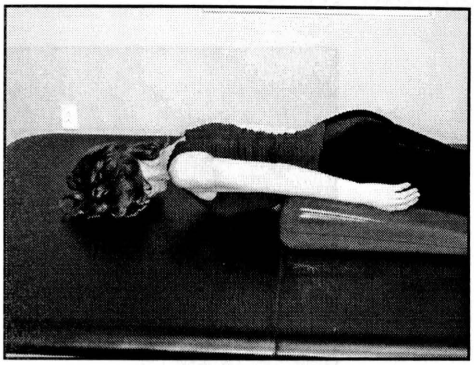


Level 2

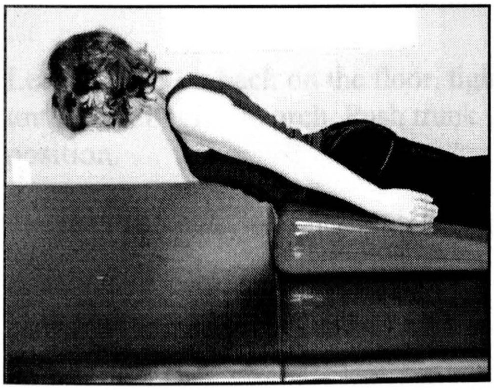
Level 2: When your hands are overhead, lift them off the wall by pulling your shoulder blades toward your spine and down. Hold 5 seconds. Return your hands to the wall and slide them back to the starting position.

Progress each level when you can repeat 10 times per set. Do 2 sets per session.

Exercise # 5 TRUNK EXTENSION PROGRESSION



Lie on stomach over a pillow with arms to your side as above.



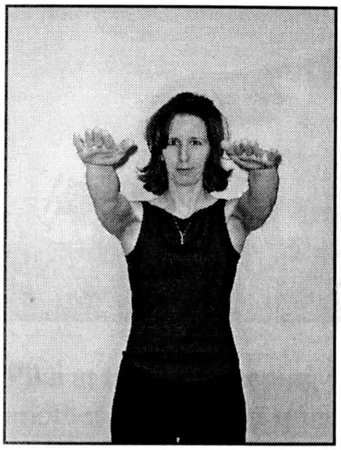
Level 1: Lift arms and trunk off of floor. Hold 5 seconds.

Level 2: Progress with arms in "T" at shoulder level.

Level 3: Progress with arms in "V" position overhead, shoulder blades together toward your spine and down.
Hold 5 seconds. Return hands and trunk to floor.

Progress each level when you can repeat 10 times per set. Do 2 sets per session.

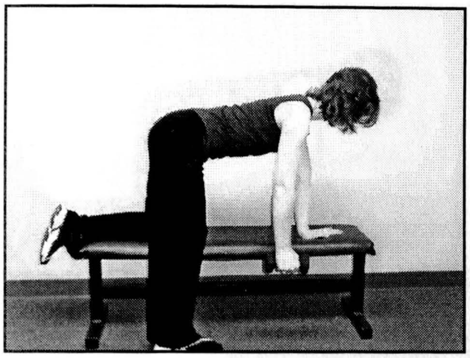
Exercise # 6 OVERHEAD ARM LOWERING

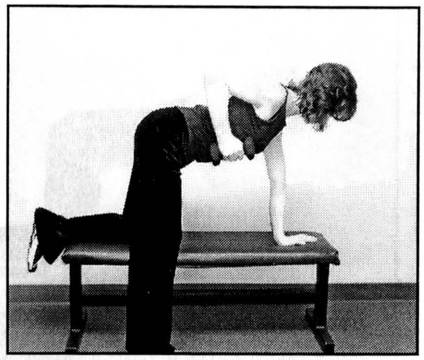


Level 1: Lie on back on the floor, tighten abdominals and raise arms slowly overhead until back begins to arch. Push trunk into floor as your return your arms to starting position.

Level 2: Progress exercise with back to the wall.

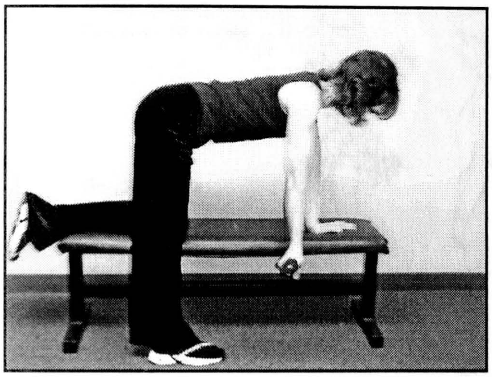
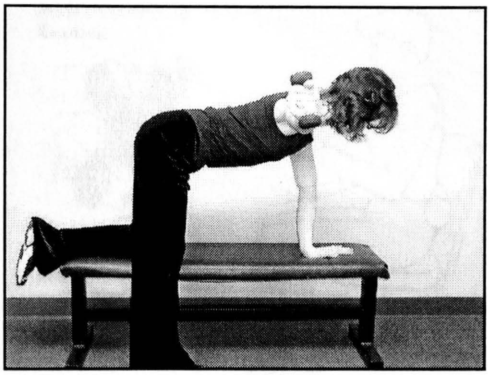
Exercise # 7 BENT OVER ROW





Pike at the hips keeping your back flat, place one knee on a chair and same side hand on another chair. Keep spine neutral. With prescribed weight, reach down towards the floor and then pull arm back, pinching shoulder blades together. Repeat 10 times then switch sides. Two sets.

Exercise # 8 REVERSE FLIES

In starting position of bent over row, hold weight in one hand. Externally rotate arm. Pinch shoulder blades together as you "hitch-hike" thumbs towards ceiling. Keep elbow straight. Repeat 10 times per set. Do 2 sets per session.

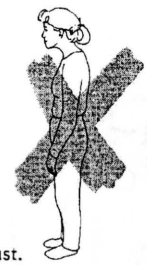
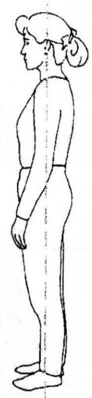
Exercise # 9 SCAPTION

(no picture)

Stand with a neutral spine and arms raised above shoulders in a "hitch-hike" position. Exhale as you raise your arms in the same axis as high as you can. Inhale as your return your arms to 90°. Add weights as prescribed. Repeat 10 times per set. Do 2 sets per session.

POSITIONING - 4

Posture - Standing

Good posture
is important.
Avoid slouching
and forward head thrust.
Maintain curve in low back
and align ears over shoulders,
hips over ankles.

POSITIONING - 8

Reading


When reading,
hold material
in tilted position
and maintain good
sitting posture.

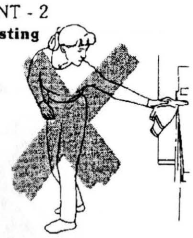
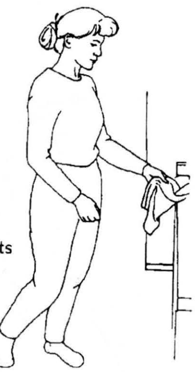
LIFTING - 11

Lifting Principles

- Maintain proper posture and head alignment.
- Slide object to be lifted as close as possible.
- Move obstacles out of the way.
- Test before lifting, ask for help if too heavy.
- Tighten stomach muscles without holding your breath.
- Use smooth movements, do not jerk.
- Use legs to do the work and pivot with your feet.
- Distribute the workload symmetrically and close to the center of trunk.
- Push instead of pull whenever possible.

MOVEMENT - 2

Avoid Twisting

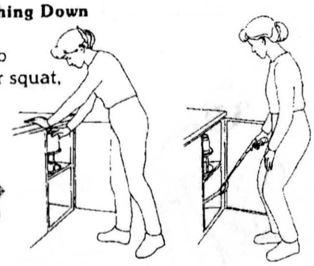



Avoid twisting or bending back.
Pivot around using feet movements
and bend at knees if needed
when reaching for articles.

ADL - 9

Housework - Reaching Down

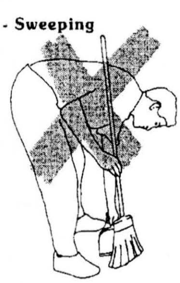
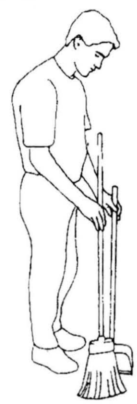
If you are unable to
bend your knees or squat,
use a lazy susan
to keep items
within easy reach.




*Store only light unbreakable
items on the lowest shelves
and use a reacher to pick up.*

ADL - 17

Housework - Sweeping

Use long-handled equipment
to avoid stooping.

ADL - 11

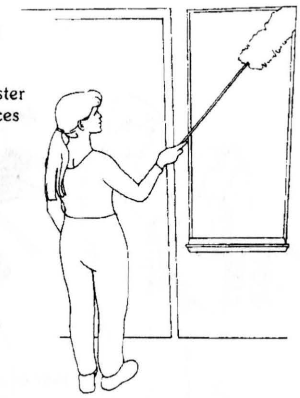
Housework - Bed

Use light bedding
such as a down comforter.
Place one knee up on bed
to reach when making bed.
Use extra depth fitted sheets and
squat down when tucking corners.

ADL - 21

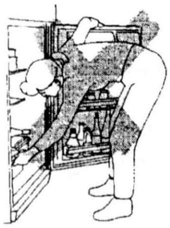
Housework - Dusting

Use long-handled duster
for hard to reach places
to avoid straining.



ADL - 6

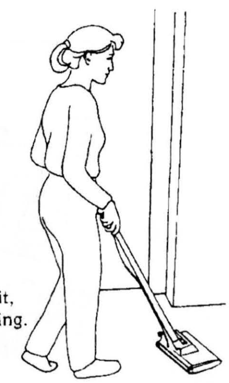
Refrigerator



Squat with knees apart
to reach lower shelves and drawers.

ADL - 19

Housework - Vacuuming

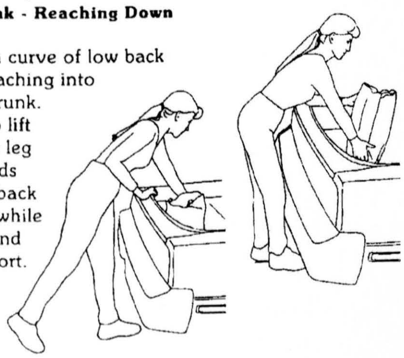


Hold the vacuum
with arm held at side.
Step back and forth to move it,
keeping head up. Avoid twisting.

LIFTING - 8

Car Trunk - Reaching Down

Maintain curve of low back
when reaching into
a deep trunk.
Can also lift
opposite leg
backwards
to keep back
straight while
using hand
for support.



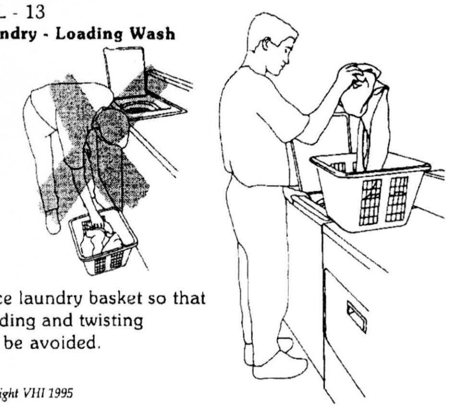
ADL - 15

Laundry Basket

Squat down and hold basket close to stand. Use leg muscles to do the work.

ADL - 13

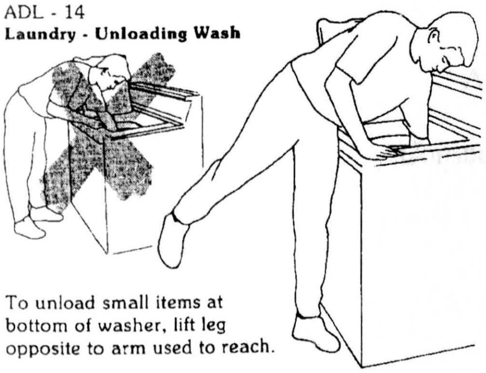
Laundry - Loading Wash



Place laundry basket so that bending and twisting can be avoided.

ADL - 14

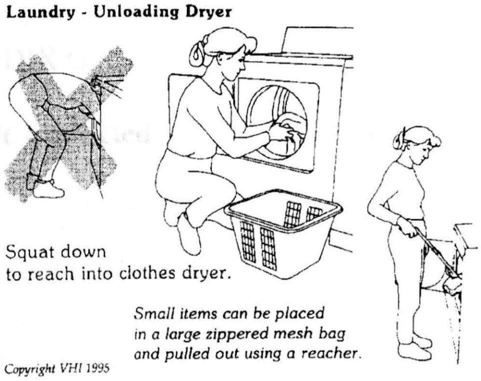
Laundry - Unloading Wash



To unload small items at bottom of washer, lift leg opposite to arm used to reach.

ADL - 16

Laundry - Unloading Dryer



Squat down to reach into clothes dryer.

Small items can be placed in a large zippered mesh bag and pulled out using a reacher.

APPENDIX C

Consent to Be Contacted

Consent to be Contacted

I, ________________________________, give permission to be contacted about a study in exercise and low bone mass by Vickie Cannella, PT from Baylor Medical Center at Irving Physical Medicine Department. I also give permission for my bone density results to be released to her.

Name: ___________________________

Phone Number: ____________________

Signature: ___________________________

Date: ________________

APPENDIX D

Physician Written Consent for Patient to Participate

PHYSICIAN'S PERMISSION FOR PATIENT TO PARTICIPATE IN RESEARCH STUDY

_________________________________ has permission to participate in the Baylor Medical Center at Irving Department of Physical Therapy study on osteoporosis and thoracic kyphosis. This patient has been diagnosed with osteoporosis or osteopenia and is currently being medically treated for this condition.

___________________________________ ___________________

Physician's signature Date

____

Physician's name (printed)

____

Physician phone number

APPENDIX E

Informed Consent

BAYLOR RESEARCH INSTITUTE
BAYLOR MEDICAL CENTER AT IRVING
IRVING, TEXAS

PARTICIPATION EXPLANATION AND CONSENT FORM

PROJECT TITLE: Effect of a Home Exercise Program on Index of Kyphosis, Height, Balance, and Quality of Life in Postmenopausal Women With Low Bone Mass.

INVESTIGATORS: Victoria "Vickie" Cannella, PT, Principal Investigator
Mary Thompson, PT, Ph.D., Co – Investigator

TELEPHONE NUMBERS: Vickie – work 972-579-8155, cell 214-215-1711

INTRODUCTION:

Before you say that you will be in this clinical trial (a kind of research study) you need to read this form. It is important for you to understand all the information in this form. This form will tell you what the clinical trial is about and how it will be done. It will tell you about some problems that might happen during the clinical trial. It will also tell you about the good things that might happen for you during the clinical trial. When you read a paper like this to learn about a clinical trial it is called "informed consent." The people who are doing this clinical trial are giving you very important information about the clinical trial. When you give your consent for something, it is the same as giving your permission. This consent form may contain words that you do not understand. Please talk with one of the therapists or their staff if you have questions. Do not sign this consent form unless all your questions have been answered and you feel comfortable with the information you have read. You will be given a copy of the form to keep.

You are being asked to take part in this study because you have been diagnosed as having low bone mass and a thoracic kyphosis (increased roundness in the upper back).

Why Is This Study Being Done?

The purpose of this study will be to demonstrate whether a woman with low bone mass can reduce the curve in her upper back, and improve her balance and quality of life through the performance of a home exercise program and four clinic visits.

What is the Status of the Procedure involved in this study?

None of the measurements you will be asked to do are unusual. All the test and measurements are in common use in physical therapy clinics. The exercise protocol used in this study was previously used in a study involving only supervised sessions.

How Many People Will Take Part In The Study?

About 36 people will take part in this study.

What Is Involved In The Study?

You will be asked to complete a medical questionnaire and your spinal curves will be measured by having a flexible ruler placed on your back by a trained therapist. The ruler will be placed on graph paper and the shape of your spine drawn so that the curves can be measured. If it is determined that you are eligible for the study, you will be placed in one of two groups – the group to perform the exercises or the group that does not perform the exercises. Neither you nor the investigator will choose which group you will be in. You will be randomly placed in a group by drawing an item from a hopper that will be marked "control" or "exercise". Further testing will include measurement of your height by standing next to a measuring board that is attached to the wall, testing your balance through the performance of specific activities, and completion of a quality of life questionnaire. These tests will be repeated in eight weeks. The complete testing procedure will take approximately 90 minutes

If you are in the exercise group, you will be asked to come into the Baylor- Irving physical therapy clinic for 4 consecutive weeks for approximately 30 minutes. You will be given an exercise program that will be progressed during these visits and your technique monitored. These exercises are performed while lying on your back, your belly, and in standing. You will be asked to perform these exercises on a daily basis and to record their performance on an exercise log.

If you are in the non-exercise group you have the option to receive the same instruction given to the exercise group after the completion of the testing at eight weeks.

How Long Will I Be In The Study?

You will be in the study for 8 weeks. If you are in the exercise group, you will be asked to come into the physical therapy clinic for 4 consecutive weeks.

The researcher may decide to take you off the study if any of the following occur:

- She feels that it is in your medical best interest.
- Your condition worsens.
- New information becomes available.

You can stop participating in this study at any time. However, if you decide to stop participating in the study, we encourage you to talk to the researcher first.

What Are The Risks of The Study?

Risks and side effects related to the exercise program we are studying include:

- Possible discomfort during spinal curve and/or height measurements.
- Possible fear or discomfort during the balance testing.
- Temporary joint or muscle soreness after performance of the exercise.
- You will be required to donate approximately 90 minutes of your time on two separate occasions.
- If you are in the exercise group, you will be asked to donate approximately 30 minutes of your time on four other occasions to come into the clinic and approximately 20 minutes a day for eight weeks to perform the exercises.

Are There Benefits to Taking Part in The Study?

If you agree to take part in this study, there may or may not be direct medical benefit to you. We hope that the information learned from this study will benefit other patients with this disease in the future.

The possible benefits of taking part in the study are the same as receiving physical therapy without being in the study.

What Other Options Are There?

Instead of being in this study, you have the following options:

- You may choose to receive no therapy at this time and receive only care to help you feel more comfortable from your regular doctor.
- You may choose not to participate in the study.
- You may choose to receive physical therapy without participating in the study.

Please talk to your regular doctor about these and other options.

What About Confidentiality?

You have a right to privacy. This means that all the information about you from this study will only be shown to the people working on the study. The results of this study may be published in a scientific book or journal. If this is done, your name will not be used. All information about you from this research project will be kept in a locked office.

The privacy law requires that Baylor Research Institute get your permission before giving any of your health information to other people. There are people who need to review your information to make sure the study is done correctly. These people may look at or copy your information while they are doing this review. When you sign this form you give permission to Baylor Research Institute to give other people information about your health as needed for the research project. These groups include people who work for Baylor Research Institute, the Office for Human Research Protections, the Association for the Accreditation of Human Research Protection Programs, the Institutional Review Board at Texas Woman's University, instructors at TWU Department of Physical Therapy, and your doctor. Even though we usually remove your name from the information, the people who get this information may be able to figure out who you are. The kinds of health information that might be given to these people include results from tests such as your DEXA scan. This information might also be notes written by your doctor from your medical record or notes written by your doctor asking for tests to be done on you.

You do not have to give this permission and it is all right to refuse to sign this form. Your doctor will still treat you and your insurance company will still pay your medical bills (according to their policy) even if you do not give your permission for us to release this information. However, since it is important for the people listed above to have access to your information, if you do not sign this form, you cannot be in the research study.

If you give permission to Baylor Research Institute to give other people information about your health and the other people are not part of the group that must obey this law, your health information will no longer be protected by the privacy law.

If you change your mind and later want to withdraw your permission, you may do so. You must notify Baylor Research Institute in writing at 3434 Live Oak, Suite 125, Dallas, TX 75204. If you decide to do this, it will not apply to information that was given before you withdrew your permission.

You may not be allowed to look at your health information during this study. However, at a later time you will be able to look at this information. This later time will be sometime after the study is completed.

Unless permission is withdrawn, this permission will not expire at the end of the research study.

What Are the Costs?

The only cost to you is your time, approximately 90 minutes on two separate occasions. If you are in the exercise group, there will also be four therapy session of approximately 30 minutes each and approximately 20 minutes per day for 8 weeks in order to perform the exercises.

Will I Be Paid For Participating in This Study?

You will not be paid for being in this study.

What if I am Injured or Become Ill While Participating in this Study?

The people doing this research project will do everything they can to make sure you do not get hurt during the project. If you do get hurt, there are some rules about research you need to know:

- The people doing the research project have not set funds aside to pay you money if you are hurt.
- **Baylor Health Care System** has not set funds aside to pay you money if you are hurt.
- **Baylor Research Institute** has not set funds aside to pay you money if you are hurt.
- **Baylor Medical Center at Irving** has not set funds aside to pay you money if you are hurt.
- **Texas Woman's University** has not set funds aside to pay you money if you are hurt.
- If you have an emergency illness during the project, the people working with you will provide emergency care. You or your insurance company may need to pay for the emergency care if that happens.
- You have not given up any of your legal rights by signing this form.

What are My Rights As a Participant?

Taking part in this study is voluntary. You may choose not to take part or may leave the study at any time. If you agree to take part and then decide against it , you can withdraw for any reason. Deciding not to be in the study, or leaving the study early, will not result in any penalty or loss of benefits that you would otherwise receive.

We will tell you about any new information that may affect your health, welfare, or willingness to stay in this study.

All of the people working on the project must be careful not to carelessly harm you. If you are hurt during this project, you have the right to seek legal counsel. Nothing in this consent form takes away that right if you are hurt during this research.

Whom Do I Call If I have Questions or Problems?

If you have questions about the study or have a research-related injury, contact Vickie Cannella at 972-579-8155 or 214-215-1711.

For questions about your rights as a research subject, contact Lawrence R. Schiller, M.D., IRB Chair, at 214-820-2687.

Statement of Person Obtaining Consent:

I have explained to ______________________ the purpose of the research project, the procedures required and the possible risks and benefits to the best of my ability. They have been encouraged to ask questions related to participation.

______________________________ ______________________

Signature of Person Obtaining Consent Date and Time

Statement of Principal Investigator:

As Principal Investigator of this study, I confirm that to the best of my knowledge this subject has voluntarily agreed to participate in this study and has had an opportunity to ask questions and has received answers to these questions. If another individual was responsible for obtaining informed consent, then this individual has signed above.

______________________________ ______________________

Signature of Principal Investigator Date and Time

Confirmation of Consent by Research Subject:

You are making a decision about being in this research study. You will be asked to give your written consent if you want to be in the study. Giving consent is like giving permission. You should not give your permission to be in this study until you have read and understood all the pages in this form. If you cannot read, then someone can read the form to you. Make sure that all your questions about this research project have been answered before you sign this form. When you sign this form, you are giving your permission to be in the study. By signing this form, you have not given up any of your legal rights or released anyone from liability for negligence.

________________________________ has explained to me the purpose of the research project, the study procedures that I will have, and the possible risks and discomforts that may happen. I have read (or have been read) this consent form. I have been given a chance to ask questions about the research study and the procedures involved. I believe that I have enough information to make my decision. I have also been told my other options. To the best of my knowledge, I am not in any other medical research. Therefore, I agree to give my consent to participate a as subject in this research project.

____________________________________ ____________________

Signature of Subject Date and Time

APPENDIX F

Medical Questionnaire

PIN #______

Medical Questionnaire

Date: ______________
Age: _______________
Bone Density: ____
Current exercise, leisure sports:
____
____
How long postmenopausal: __________________________________
Hormone replacement? Y N How long? ______________________
Calcium supplements? Y N How much? ______________________
Medications: ____
____

Steroids? Y N How long? ______________________
Fractures? Y N Where/when? ______________________

Spinal Surgery? Y N Where/when? ______________________
Abd/thoracic surgery? Y N Where/when? ______________________

Falls? Y N Frequency? ______________________
Dizziness? Y N ______________________
Amb. with assistive device? Y N Type? ______________________

Cardiac problems? Y N ______________________
Respiratory problems? Y N ______________________
Hypertension? Y N ______________________
Cancer? Y N ______________________
Stroke? Y N ______________________

Diabetes? Y N Blood glucose? ______________________
Peripheral neuropathy? Y N Treatments? ______________________

Thyroid problems? Y N Last checked? ______________________

Other medical problems? ______________________________________

APPENDIX G

Exercise Log

EXERCISE LOG

Mark the days in which you perform the exercises given to you.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

APPENDIX H

Berg Balance Scale

BERG BALANCE SCALE

Instructions: Therapist will need to have the following items available to perform this test: 2 chairs (one with arms, one without), 1 ruler, one shoe or slipper, one 6" stool, and one stop watch. All scores on this test range from 0 to 4. No assistive device allowed on test.

1. **Sitting to standing**
   Instructions: Please stand up. Try not to use your hands for support.
   [ ]4 able to stand without using hands and stabilize independently
   [ ]3 able to stand independently using hands
   [ ]2 able to stand using hands after several tries
   [ ]1 needs minimal aid to stand or to stabilize
   [ ]0 needs moderate or maximal assist to stand

2. **Standing unsupported**
   Instructions: Please stand for two minutes without holding onto anything.
   [ ]4 able to stand safely for 2 minutes
   [ ]3 able to stand 2 minutes with supervision
   [ ]2 able to stand 30 seconds unsupported
   [ ]1 able to sit 10 seconds
   [ ]0 unable to sit without support 10 seconds

If patient is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to question #4.

3. **Sitting with back unsupported but feet supported on floor or on a stool.**
   Instructions: Please sit with arms folded for 2 minutes
   [ ]4 able to sit safely and securely 2 minutes
   [ ]3 able to sit 2 minutes under supervision
   [ ]2 able to sit 30 seconds
   [ ]1 able to sit 10 seconds
   [ ]0 able to sit without support 10 seconds

4. **Standing to sitting**
   Instructions: Please sit down.
   [ ]4 sits safely with minimal use of hands
   [ ]3 controls descent by using hands
   [ ]2 uses back of legs against chair to control descent
   [ ]1 sits independently but has uncontrolled descent
   [ ]0 needs assistance to sit

5. **Transfers**
   Instructions: Arrange chair(s) for a pivot transfer. Ask patient to transfer one way toward a seat with armrests and one way toward a seat without armrests.
   [ ]4 able to transfer safely with minor use of hands
   [ ]3 able to transfer with definite need of hands
   [ ]2 able to transfer with verbal cueing and/or supervision
   [ ]1 needs one person to assist
   [ ]0 needs two people to assist or supervise to be safe

6. **Standing unsupported with eyes closed**
Instructions: Please close your eyes and stand still for 10 seconds
[ ]4 able to stand 10 seconds safely
[ ]3 able to stand 10 seconds with supervision
[ ]2 able to stand 3 seconds
[ ]1 unable to keep eyes closed 3 seconds but stays safely
[ ]0 needs help to keep from falling

7. **Standing unsupported with feet together**
Instructions: Place layout feet together and stand without holding onto anything.
[ ]4 able to place feet together independently and stand 1 minute safely
[ ]3 able to place feet together independently and stand for 1 minute with supervision
[ ]2 able to place feet together independently but unable to hold for 30 seconds
[ ]1 needs help to attain position but able to stand 15 seconds with feet together
[ ]0 needs help to attain position and unable to hold for 15 seconds

8. **Reaching forward with outstretched arm while standing**
Instructions: Lift arm to 90°. Stretch out your fingers and reach forward as far as you can. (Therapist places ruler at end of fingertips Record the distance forward that the finger reaches).
[ ]4 can reach forward confidently 25 cm (10')
[ ]3 can reach forward 12 cm safely (5")
[ ]2 can reach forward 5 cm safely (2")
[ ]1 reaches forward but needs supervision
[ ]0 loses balance while trying – requires external support

9. **Pick up object from the floor from a standing position**
Instructions: Pick up the shoe/slipper which is placed in front of your feet.
[ ]4 able to pick up slipper safely and easily
[ ]3 able to pick up slipper but needs supervision
[ ]2 unable to pick up but reaches 2-5 cm (1-2") from slipper and keeps balance I
[ ]1 unable to pick up and needs supervision while trying
[ ]0 unable to try – needs assist to keep from losing balance

10. **Turning to look behind over left and right shoulders while standing**
Instructions: Turn to look directly behind you over toward the left shoulder. Repeat to the right.
[ ]4 looks behind from both sides and weight shifts well.
[ ]3 looks behind one side only – other side shows less weight shift
[ ]2 turns sideways only but maintains balance
[ ]1 needs supervision when turning
[ ]0 needs assist to keep from losing balance

11. **Turn 360°**
Instructions: Turn completely around in a full circle. Pause then turn a full circle in the other direction.
[ ]4 able to turn 360° safely in 4 seconds or less
[ ]3 able to turn 360° safely on one side only in 4 seconds or less
[ ]2 able to turn 360° safely but slowly
[ ]1 needs close supervision or verbal cueing
[ ]0 needs assistance while turning

12. **Place alternate foot on step or stool while standing unsupported**

[ ]4 able to stand I and safely completes 8 steps in 20 seconds
[ ]3 able to stand I and completes 8 steps in > 20 seconds
[ ]2 able to complete 4 steps without aid and with supervision
[ ]1 able to complete >2 steps – needs minimal assist
[ ]0 needs assistance to keep from falling – unable to try

13. **Standing unsupported with one foot in front**

Instructions: Demonstrate tandem standing.

[ ]4 able to place foot tandem I and hold 30 seconds
[ ]3 able to place foot ahead of other I and hold 30 seconds
[ ]2 able to take small step I and hold 30 seconds
[ ]1 needs help to step but can hold 15 seconds
[ ]0 loses balance while stepping or standing

14. **Standing on one leg**

Instructions: Stand on one leg as long as you can without holding onto anything.

[ ]4 able to lift leg I and hold >10 seconds
[ ]3 able to lift leg I and hold 5-10 seconds
[ ]2 able to lift leg I and hold = or > 3 seconds
[ ]1 tries to lift leg – unable to hold 3 seconds but remains standing I
[ ]0 unable to try or needs assist to keep from falling

TOTAL SCORE = ________ **/56**

Interpretation:

Tests # 11 – 14 are an advanced subset of the Berg Balance test.
< 46/56 = pt is at HIGH risk for falls
< 48/56 = pt should be considered candidate for assistive device
< 45/56 = pt will require assistive device to ambulate safely

APPENDIX I

Osteoporosis Quality of Life Questionnaire

OSTEOPOROSIS QUALITY OF LIFE QUESTIONNAIRE

The questionnaire includes 30 questions. Each has one of five sets of seven response options, identified by the color of the card (grey, blue, pink, orange, yellow). Before reading each question ensure that the patient is looking at the correct color-coded card.

1. In general, how often during the last 2 weeks have you experienced a *lack of energy* because of your back problems due to osteoporosis? **(orange card)**

2. How often in the last 2 weeks have you felt *afraid of fractures?* **(orange card)**

3. How *difficult* has it been for you to *bend* in the last 2 weeks because of your back problems due to osteoporosis? **(blue card)**

4. How *difficult* has it been for you to *clean a bathtub* in the last 2 weeks? **(blue card)**

5. How *difficult* has it been for you to *garden* in the last 2 weeks because of your back problems due to osteoporosis? **(blue card)**

6. How often in the last 2 weeks did you experience *decreased flexibility?* **(orange card)**

7. How often in the last 2 weeks have you felt *afraid of falling?* **(orange card)**

8. How *difficult* has it been for you to *carry* things in the last 2 weeks because of your back problems due to osteoporosis? **(blue card)**

9. How *difficult* has it been for you *to cut your toenails* in the last 2 weeks? **(blue card)**

10. How *difficult* has it been for you to *participate in sports or other physical exercise* in the last 2 weeks because of your back problems due to osteoporosis? **(blue card)**

11. How much *distress or discomfort* have you had because of *pain* in the last 2 weeks? **(grey card)**

12. How often in the last 2 weeks have you felt *angry about having an illness at a time of life when you planned to enjoy yourself?* **(orange card)**

13. How *difficult* has it been for you to *lift* things in the last 2 weeks? **(blue card)**

14. How *difficult* has it been for you to *get into and out of a car* in the last 2 weeks because of your back problems due to osteoporosis? **(blue card)**

15. How *difficult* has it been for you to *travel* in the last 2 weeks? **(blue card)**

16. How much *distress or discomfort* have you had due to *pain from bending* in the last 2 weeks? **(grey card)**

17. How often in the last 2 weeks have you felt *frustrated?* **(orange card)**

18. In the last 2 weeks, how much *trouble* have you had *finding a comfortable chair to sit in?* **(yellow card)**

19. How *difficult* has it been for you *to do housework* in the last 2 weeks? **(blue card)**

20. How *difficult* has it been for you to take the *type of vacation or holiday* you enjoy because of your back problems due to osteoporosis? **(blue card)**

21. How much *distress or discomfort* have you had due to *pain from carrying* things in the last 2 weeks? **(grey card)**

22. How much has your *walking* been *limited* over the last 2 weeks because of your back problems due to osteoporosis? **(pink card)**

23. How *difficult* has it been for you *reaching and retrieving* something from *overhead* cupboards or shelves in the last 2 weeks? **(blue card)**

24. How much *distress or discomfort* have you had in the last 2 weeks because it has been *painful to sit for long?* **(grey card)**

25. How *difficult* has it been for you *to shop for clothes* in the last 2 weeks? **(blue card)**

26. How much *distress or discomfort* have you had in the last 2 weeks because it has been *painful to stand for a long time?* **(grey card)**

27. How *difficult* has it been for you *to shop for groceries* in the last 2 weeks? **(blue card)**

28. How much *distress or discomfort* have you had in the last 2 weeks because it has been *painful to walk?* **(grey card)**

29. How *difficult* has it been for you *to vacuum* in the last 2 weeks? **(blue card)**

30. How often in the last 2 weeks have you experienced *tiredness* because of your back problems due to osteoporosis? **(orange card)**

RESPONSE OPTIONS

Grey card

1 extreme distress or discomfort
2 very much distress or discomfort
3 quite a bit of distress or discomfort
4 moderate distress or discomfort
5 some distress or discomfort
6 a little distress or discomfort
7 no distress or discomfort

Blue card

1 extremely difficult – impossible to do
2 very difficult – almost impossible
3 quite a bit difficult
4 moderately difficult
5 somewhat difficult
6 a little difficult
7 not difficult
8 not applicable

Pink Card

1 extremely limited
2 very limited
3 quite a bit limited
4 moderately limited
5 somewhat limited
6 a little limited
7 not limited

Orange Card

1 all of the time
2 most of the time
3 a good bit of the time
4 some of the time
5 a little of the time
6 hardly any of the time
7 none of the time

Yellow Card

1 extreme trouble
2 very much trouble
3 quite a bit of trouble
4 moderate trouble
5 some trouble
6 a little trouble
7 no trouble

Subject ____________________ Date ____________________

SCORING

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

13. _____

14. _____

15. _____

16. _____

17. _____

18. _____

19. _____

20. _____

21. _____

22. _____

23. _____

24. _____

25. _____

26. _____

27. _____

28. _____

29. _____

30. _____

Domains:

The items are grouped into five domains as follows:

Symptoms: (1, 6, 11, 16, 21, 24, 26, 28, 30) _____

Emotional function: (2, 7, 12, 17) _____

Physical function: (3, 8, 13, 18, 22) _____

Activities of Daily Living (ADL): (4, 5, 9, 14, 19, 23, 25, 27, 29) _____

Leisure and Social Activities: (10, 15, 20) _____