ABSTRACT

Effects of Glucosamine and Chondroitan Supplementation in Women with Knee Osteoarthritis Participating in the Curves Fitness and Weight Loss Program: A Randomized, Placebo Controlled, Double Blind Clinical Trial

Teresa Magráns-Courtney, B.S., M.S.Ed.

Committee Chairperson: Richard B. Kreider, Ph.D.

The purpose of this study was to determine whether participation in the Curves fitness and weight loss program and/or ingesting a commercially available glucosamine and chondroitan joint support dietary supplement improved functional status and/or health outcomes in women with knee osteoarthritis (OA). Thirty sedentary women with OA participated in a 14-week exercise and diet program and ingested either a glucosamine and chondroitan supplement or placebo. Participants were assigned to follow an isoenergenic high protein/carbohydrate restricted diet (HPD) or high carbohydrate/low protein diet (HCHO). Subjects participated in a supervised 30-minute resistance training circuit program that was interspersed with calisthenic exercises and performed 3-d per week. At 0, 2, 10, and 14 weeks, subjects completed a battery of assessments. Data were analyzed by repeated measures analysis and are presented as means ± SD from baseline. Results indicated that women with knee OA experienced significant training adaptations including decreased body mass (3±4%), decreased fat mass (6%±8), decreased body fat (4%±3), increased 1 repetition maximal muscular

strength (11%±12), increased muscular endurance (13%±12), increased isokinetic strength (ranging from 10-25%±4), decreased knee pain (112%±317), stiffness (70%±234), limitations in physical function (96%±1,356), improved quality of life variables of physical functioning (37%±52), energy/fatigue (55%±69), social functioning (40%±76), and mental health (22%±84). Perceptions of appetite (13%±36), hunger (17%±34), energy (24%±35), and quality of diet (19%±38) were also improved. Glucosamine chondroitan supplementation tended to decrease perceptions of pain, with no statistically significant improvement in strength, or functional status. However, a strong effect size (d=1.1) was observed in VAS knee pain and moderate effect sizes were observed in WOMAC^{TM} pain (d=0.4), left knee flexion (d=0.53), 1 repetition max (d=0.53), total work (d=0.72), and maximal systolic blood pressure (d=0.69). These findings suggest that glucosamine and chondroitan supplementation during a weight loss and fitness program may have therapeutic benefits for women with OA.

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by

Teresa Magrans-Courtney

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Approved by the Dissertation Committee

Richard B. Kreider, Ph.D., Chairperson

Lori D. Greenwood, Ph.D.

Brian C. Leutholtz, Ph.D.

Rodney G. Rowden, Ph.D.

LuAnn L. Soliah, Ph.D., R.D.

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J. Larry Lyon, Ph.D., Dean

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CHAPTER ONE

Introduction and Rationale

Background

According to the Centers for Disease Control and Prevention (CDC), there are approximately 42.7 million Americans suffering from arthritis with 21 million affected by osteoarthritis (OA) (CDC, 1999) reaching 60 million Americans by the year 2020 (CDC, 1999). Arthritis is second to cardiovascular disease in the number of Americans suffering from disability (Porth, 1998). It is believed that 6% of adults 30 years and older are affected by symptoms associated with knee osteoarthritis (OA) (Felson, & Zhang, 1998). The general incidence and prevalence of OA increases 2 to 10 fold from age 30 to 65 years (Oliveria, Felson, Reed, et al., 1995).

OA is a disease that affects the joints, particularly the fingers, knees, and spine. The cartilage is avascular, creating a dependency on the diffusion of nutrients form the tissues. Lack of nutrients and movement cause the cartilage to deteriorate. Additionally, this disease causes problems in function and mobility for many people, which can lead to decreases in quality of life. Therefore, OA patients should eat healthfully and maintain movement to prevent cartilage deterioration (Balady, Berra, Golding, et al.,2000).

The symptoms of OA include disability of the joints caused by swelling, pain after exercise or use, and joint stiffness (Rothenberg, & Chapman, 1994). Although the cause of OA is unknown, it is believed that stress placed upon the joints is a factor. Treatments for OA vary and have included rest, heat, anti-inflammatory and pain-

relieving medications, corticosteroid injections, and/or surgery. Researchers are discovering that physical activity is beneficial for OA patients and inactivity can serve as a risk factor for developing OA (Balady, Berra, Golding, et al.,2000). OA patients can reduce their pain and enhance their physical function with moderate physical activity (Rall, Meydani, Kehayias, et al., 1996). Exercise training does not exacerbate the pain and progression of OA (Noreau, Moffett, Drolet, et al., 1997). In addition, nutritional supplementation with glucosamine chondroitan has been shown to alleviate the symptoms and associated with OA and delay the disease progression (Reginster, Deroisy, Rovati, et al., 2001).

A second risk factor identified in the literature for OA is gender, which tend to be differentiated by different areas of localized pain. Women tend to suffer from hand and knee OA and men are affected by hip OA (Oliveria, Felson, Reed, et al., 1995). Research from the Framingham Knee Osteoarthritis Study displayed that overweight men and women have a higher risk for developing OA, than those people not overweight (Felson, Zhang, Hannan, et al., 1997). These researchers also reported that weight loss helped to decrease pain associated with OA (Felson, Zhang, Anthony, et al., 1992). Other clinical trials have indicated that decreases in OA symptoms are correlated with fat mass reductions, rather than to weight loss alone (Slemenda, Heilman, Brandt, et al., 1998). In addition, these researchers demonstrated that reduced strength in relative terms to body weight, can promote the development of OA (Slemenda, Heilman, Brandt, et al., 1998). As a result, it is believed that interventions to strengthen the muscles and reduce body fat may reduce pain and enhance daily physical function for people affected by OA.

Prior to beginning an exercise program, participants with OA should consult with their physician. All exercise programs should ensure joint protection for OA patients by including non-ballistic type exercises and stretches. In addition, special attention should be given to OA participants so that joint overstretching does not occur. If joint swelling and pain occur after exercise, the OA patients should apply ice to the affected joint and rest. While high-intensity exercise should be avoided, strengthening the joints with weight bearing activities should be a priority with all exercise programs to promote nourishment of cartilage and bone. Exercise prescriptions for OA patients should include varying aerobic exercises to prevent overuse syndrome, such as bicycling, swimming, and low impact aerobics (Balady, Berra, Golding, et al.,2000). In addition, daily exercise can include activities of daily living, such as gardening, and walking the dog. (Pollock, Mengelkoch, Graves, et al., 1997).

Researchers have indicated that glucosamine sulfate supplementation in patients with knee pain improved joint pain and function levels (Xing, Gao, & Giacovelli, 1998). Results showed that symptoms associated with knee pain were lessened after eight weeks of glucosamine sulfate supplementation (Xing, Gao, & Giacovelli, 1998). Pavelka et al. (2002) evaluated the treatment effects of glucosamine sulfate in a long-term (3-year) study. The purpose was to determine if glucosmaine sulfate affects the progression of the joint structure and evaluate the symptoms associated with knee OA. Results displayed that OA symptoms, such as knee pain, physical function, and stiffness identified by a WOMAC^{TM} index scale were improved over the 3-year span. Usha, et al. (2004) studied the efficacy and safety of glucosamine, methlysulfonylmethane (MSM), their combination, and placebo in patients with knee OA. Results indicated that combination

therapy reduced joint pain and swelling, while improving the physical function of the joints (Usha, Naidu, 2004). These findings and others indicate that glucosamine chondroitan supplementation have some therapeutic benefits for OA patients.

The Curves International fitness and weight loss program has become a very popular means of promoting health and fitness among women. Approximately 5 million women belong to nearly 10,000 Curves centers in the United States and abroad. The program involves a 30-minute circuit training session incorporating thirteen bidirectional hydraulic exercise machines that trains all major muscle groups interspersed with eight calisthenics type exercises. The program is designed to maintain an elevated heart rate and increase energy expenditure. For members wishing to lose weight, the program recommends following a short caloric restricted diet (1,200 kcals/day) designed to promote weight loss followed by a moderately caloric restricted diet (1,600 kcals/day) that is designed to promote a gradual reduction in body fat. The diet recommends one of two types of macronutrient manipulations based on initial dietary practices and response to a carbohydrate tolerance questionnaire. Since resting energy expenditure (REE) decreases during periods of caloric restriction and the reduction of REE has been implicated as a contributor to weight regain, the program recommends intermittent periods of increased caloric intake designed to normalize hormone levels and REE. This program is designed to promote fat loss and improve fitness without maintaining a very low calorie diet (i.e., $\leq$ 800 kcals/day) that is often used in weight loss trials. Additionally, it is designed to decrease the incidence of participants experiencing a weight regain once their weight goals have been achieved.

The Exercise & Sport Nutrition Lab at Baylor University has been conducting extensive studies on the efficacy of the Curves for Women program. Kreider, et al. (2005) has performed extensive research on the Curves fitness and diet program. The research findings demonstrate that women following this program for 14 weeks lost 10-14 pounds, decreased body fat by 1-3%, increased resting energy expenditure by 100-400 kcal/day, and had a reduction in waist & hip measurements of 1.5-2 inches. Maximal aerobic capacity increased by 10% and muscular strength/endurance improved by 10-15%. Resting heart rate decreased by 3-5 beats/min. While total cholesterol decreased by 4%, LDL decreased by 3%, triglycerides decreased by 12%, and leptin was reduced overall by 17%. In addition, fasting insulin was reduced by 15% overall, while insulin sensitivity improved by 19%. Body image, self-esteem, and quality of life increased among the participants. Biomechanical and energy expenditures analysis performed on the Curves fitness program indicated that exercise intensity of 65% of VO_{2max} support the ACSM guidelines. Women new to exercise can burn approximately 164-238 kcals during a 30-minute Curves workout. Highly trained women can burn 238-522 kcals/30 minute-workout at 65% $VO_{2max.}$ In addition, the strength training components of the program indicated a 50-75% of 1RM with an average of 15-20 repetitions performed per 30-second time frame (Campbell, et al., 2006). As a result, the research has shown that the Curves program is highly effective in promoting weight loss, improving markers of health, and enhancing fitness. Theoretically, the Curves fitness and weight loss program may be efficacious for OA patients in that it promotes improvements in strength, flexibility, and weight loss. In addition, Curves has also developed a dietary supplement containing glucosamine and chondroitan designed to provide joint and connective tissue

support. Following the Curves fitness and weight loss program, as well as supplementation with a dietary supplement containing glucosamine chondroitan, may help promote fitness, weight loss, and lessen symptoms of pain in patients with OA.

Statement of the Problem

Does participating in the Curves fitness and weight loss program and/or supplementation with a commercially available supplement containing glucosamine and chondroitan significantly affect knee pain, knee function, body composition, heart rate, blood pressure, blood profiles, maximal cardiopulmonary exercise capacity, knee flexion, knee circumference, and knee strength in sedentary, overweight (BMI > 27) females with clinically diagnosed knee osteoarthritis?

Purpose

The purpose of this study was to determine whether participation in the Curves fitness and weight loss program and/or ingesting a commercially available glucosamine and chondroitan joint support dietary supplement affects knee pain and function, body composition, heart rate, blood pressure, blood profiles, maximal cardiopulmonary exercise capacity, knee flexion, knee circumference, and knee strength in sedentary, overweight (BMI > 27) women with knee osteoarthritis.

General Study Overview

The study was conducted in a double-blind, placebo-controlled, and randomized manner. Participants with physician diagnosed OA participated in a 14-week fitness and weight loss program. Participants were randomly assigned to ingest in a double-blind manner either a placebo or a glucosamine and chondroitan containing dietary supplement.

The independent variable was nutritional supplementation. Dependent variables included: standardized quality of life (SF-36), eating satisfaction, and health status questionnaires; fasting clinical blood profiles [white cells, C-Reactive Protein, interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and cortisol]; body composition; body water assessment; knee pain; knee function; knee circumference; active range of knee motion; knee muscle strength; balance tests; and maximal cardiopulmonary exercise capacity.

Hypotheses

Based on the number of published studies on the separate components found in the supplement to be studied, the following hypotheses were evaluated:

H^1: There will be statistically significant reductions in body weight and fat mass in both dietary supplement groups.

H^2: There will be statistically significant improvements in muscular strength and muscular endurance in both dietary supplement groups.

H^3: There will be no statistically significant differences between dietary supplement groups in dietary inventories among women following the Curves diet and fitness program.

H^4: There will be no differences between dietary supplement groups in psychometric assessments (Quality of Life, Eating Satisfaction) among women following the Curves diet and fitness program.

H^5: There will be statistically significant differences between dietary supplement groups and time changes in knee pain among women consuming the dietary supplement.

H^6: There will be statistically significant differences between dietary supplement groups and time changes in knee function among women consuming the dietary supplement.

H^7: There will be statistically significant differences between groups and time changes in knee flexion among women consuming the dietary supplement treatment.

H^8: There will be statistically significant differences between groups and time changes in knee circumference among women consuming the dietary supplement treatment.

H^9: There will be statistically significant differences between groups and time changes in knee function and strength among women consuming the dietary supplement treatment.

H^{10}: There will be time effects with no significant interactions between dietary supplement groups in body composition, heart rate, and blood pressure among women following the Curves diet and fitness program.

H^{11}: There will be time effects with no significant interactions between dietary supplement groups in maximal cardiopulmonary exercise capacity among women following the Curves diet and fitness program.

H^{12}: There will be time effects with no significant interactions between dietary supplement groups in blood profiles among women following the Curves diet and fitness program.

Delimitations

The research study followed the following guidelines:

1. There were 30 sedentary and overweight female participants with knee pain (BMI > 27) between the ages 18 to 70 that participated in this study. The female participants were diagnosed by a physician to have knee osteoarthritis.

2. Participants were recruited with flyers posted on campus, physician offices/clinics, and at area fitness centers. Advertisements were placed in the newspaper.

3. Familiarization and testing sessions were conducted in the Exercise & Sport Nutrition Laboratory (ESNL) at Baylor University.

4. Participants were randomly assigned in a double-blind manner to one of two supplement groups: treatment or placebo.

5. Participants participated in a supervised Curves 30-minute fitness program three times per week throughout the investigation.

6. Participants were randomized to follow an isocaloric higher carbohydrate or higher protein diet based on responses to a carbohydrate tolerance questionnaire.

7. Participants were randomized to ingest either the treatment or placebo supplementation.

Limitations

1. The number of participants that completed the study was limited to those volunteers that qualified to be in the study and followed the research guidelines.

2. Participants were sedentary and overweight female participants with knee pain (BMI > 27) between the ages 18 to 70.

3. All participants were diagnosed by a physician to have clinically significant knee osteoarthritis.

4. Participants were required to participate in the Curves 30-minute fitness program three times per week throughout the investigation.

5. Participants were required to follow the Curves International weight loss program within a free-living environment.

6. Since participants recorded all food intake on dietary record forms for four days (4-d), some elected to complete this process by recall. Therefore, memory of food recall posed a limitation.

Assumptions

1. Participants followed the Curves International weight loss program as specified by the assigned diet plan.

2. Participants followed the supplement protocols for the course of the study.

3. Participants recorded any adverse effects, pain, and acetaminophen ingestion on a weekly follow-up assessment form.

4. Participants were instructed to refrain from exercise for 48 hours prior to baseline testing.

Definition of Terms

1. Active Range of Motion – Goniometer Procedures - Procedure used to determine the knee range of motion present in the experimental groups and the control group based on supplementation product/placebo.

2. Anthropometric Procedures – Knee Circumference - Procedures for measurement of knee circumference used as an indicator of knee inflammation/swelling caused by osteoarthritis.

3. Bioelectrical Impedance Analysis (BIA) – Body Water Assessment - Procedure used to estimate total body water and body fat percentage by measuring bio-resistance of water and body tissues based on a minute low energy, high frequency current (500 micro-amps at a frequency of 50 kHz) transmitted through the body.

4. Body Composition – Test used to determine body fat percentage.

5. Chondroitan – Serves as a natural substance found in and around cartilage and is generally used alone or combined with glucosamine as an osteoarthritis treatment.

6. Cortisol – Hormone produced by the body to fight stress and serve as an anti-inflammatory helper.

7. C-Reactive Protein – Protein produced by the liver that can indicate acute inflammation.

8. Dietary Inventory – Form used by participants to record all fluid and food intake three days during one week and one weekend day for the length of the study in order to standardize nutritional intake.

9. Dual-energy x-ray absorptiometry (DEXA) – Procedure used for limited x-ray technology to determine body composition and bone mineral density.

10. Eating Satisfaction – Questionnaire used to determine eating satisfaction of assigned diet.

11. Equi-Test Procedures – Balance Tests - Testing procedures used to collect data on postural balance and mobility utilizing the following tests in order: Sit to Stand (STS), Forward Step Up and Over (SUO), Forward Lunge (FL).

12. Fat Mass – Term used to describe the fat weight of the human body.

13. Glucosamine – Composed of a natural substance found in the body formed by the combination of glucose and glutamine. It is found primarily in cartilage and plays an important role in its health and resilience. Glucosamine is primarily derived from crab shells, so individuals with allergies and sensitivity to shell fish should not ingest it.

14. Interleukin-6 (IL-6) – Cytokine secreted by T cells and macophages that can indicate tissue damage leading to inflammation.

15. Isokinetic Testing Procedures – Knee Muscle Strength - Testing procedures that allow a specific limb to contract at a fixed speed to determine knee muscle strength.

16. Knee Pain Scale – Scale used by participants to determine perceived knee pain on a Graphic Pain Rating Scale.

17. Lean Body Mass – Term used to describe the weight of the human body excluding the fat mass.

18. Maximal Cardiopulmonary Exercise Capacity – Procedure used to determine maximal aerobic capacity and anaerobic threshold to evaluate the effects of exercise training on fitness and exercise capacity.

19. Osteoarthritis – The most common form of arthritis arising from degenerative changes of the hyaline cartilage that lines the surfaces of joints.

20. Psychometric Assessments – Questionnaires completed by participants to determine the eating satisfaction and quality of life throughout the length of the study.

21. Quality of Life (SF-36) - Questionnaire used to measure health-related quality of life by assessing eight different dimensions: physical functioning, role limitations caused by physical health problems, bodily pain, general health perceptions, energy/fatigue, social function, role limitation caused by emotional problems, and emotional well-being.

22. Standard Warm Up Isokinetic Biodex – Systematic warm-up performed on the Isokinetic Biodex machine to allow specific limb warm-up consisting of three submaximal reciprocal concentric extension and flexion repetitions at each test velocity with increasing intensity (i.e. first repetition at 25% perceived effort, second repetition at 50% perceived effort, etc.).

23. Tumor Necrosis Factor-Alpha (TNF-α) – Cytokine produced by macrophages and involved in systemic inflammation.

24. Western Ontario and McMasters University Osteoarthritis Index (WOMAC™ 3.1 Index) – A self-administered index used to assess the three dimensions of pain, joint stiffness, and physical function in knee and hip osteoarthritis using a battery of 24 questions.

25. White Blood Cells – Cells responsible for responding to cellular injury and engulfing bacteria. There are five types of white blood cells: neutrophils, basophils, eosiniphils, lymphocytes, and monocytes.

CHAPTER TWO

Review of Literature

Etiology of Osteoarthritis

Osteoarthritis (OA) is a form of arthritis classified as a condition caused by the degeneration of the hyaline cartilage surrounding the joints (Rothenberg, & Chapman, 1994). The most common type of cartilage is hyaline cartilage and lines the surfaces of joints. Hyaline cartilage has been characterized as a bluish, white elastic cartilage responsible for covering the ends of bones, connecting the ribs to the sternum, and supporting the trachea and facial structures (Rothenberg, & Chapman, 1994). The symptoms of OA include disability of the joints caused by swelling, pain after exercise or use, and joint stiffness (Rothenberg, & Chapman, 1994). Although the cause of OA is unknown, it is believed that physiological stress placed upon the joints is a factor.

OA has been treated to control short-term symptoms and treatments have included rest, heat, anti-inflammatory and pain-relieving medications, corticosteroid injections, and/or surgery. In addition, research has indicated that glucosamine sulfate supplementation in osteoarthritis patients with knee pain improved joint pain and function levels after eight weeks (Xing, Gao, & Giacovelli, 1998).

According to the Centers for Disease Control and Prevention (CDC), there are approximately 42.7 million Americans suffering from arthritis with 21 million affected by OA (CDC, 1999). The CDC has projected that 60 million Americans will be affected with arthritis by the year 2020 (CDC, 1999). According to the CDC, arthritis costs the

United States approximately 65 billion dollars per year; $15 billion for 39 million physician visits annually and the remaining due to indirect costs resulting from lost wages (CDC, 1999). Arthritis is the second cause of disability after cardiovascular disease in the United States (Porth, 1998; Guccione, Felson, Anderson, et al., 1994). Yet, the amount of knee OA disability occurring among the elderly is greater than that caused by cardiovascular disease (Guccione, Felson, Anderson, et al., 1994). It is believed that 6% of adults 30 years and older are affected by symptoms associated with knee OA (Felson, & Zhang, 1998). The general incidence and prevalence of OA increases 2 to 10 fold from age 30 to 65 years (Oliveria, Felson, Reed, et al., 1995).

The number of Americans representing 65 years of age or older is increasing rapidly due to the maturing "baby-boom" generation (MMWR Morb Wkly Rep, 1995). One-fourth of patients seen by their primary physician have a musculoskeletal condition (Mazzuca, Brandt, Katz, et al., 1993). The most prevalent articular disease seen in these patients over the age of 65 is OA (MMWR Morb Wkly Rep, 1995). It is estimated that half of all people over the age of 65 are affected by OA (Frontera, Meredith, O'Reilly, et al., 1988) and this prevalence increases to 85% for those over the age of 75 (Verbrugge, 1995). Therefore, it has become a national priority to provide health care needs and therapeutic interventions to OA patients.

Although it is believed that the leading risk factor for OA is age (Lawrence, et al. 1998), there are many other risk factors associated with this outcome with the incidence of delevloping OA compounded by multiple risk factors. Included in these risk factors are age, gender, joint trauma, muscle weakness, and inactivity. While the prevalence of OA increases in women over the age of 40, the prevalence increases in men over the age

of 50 (van Saase, van Romunde, et al., 1989). Researchers found that 27% of people age 63 to 70 had knee OA and this number increased to 44% among those over the age of 80 (Felson, Naimark, Anderson, et al., 1987).

Gender is also a significant risk factor for OA. Women tend to suffer from hand/knee OA and men are affected by hip OA (Oliveria, Felson, Reed, et al., 1995). Research from the Framingham Knee Osteoarthritis Study reported that overweight men and women have a higher risk for developing OA than those women of healthy weight (Felson, Zhang, Hannan, et al., 1997). These researchers also reported that weight loss helped to decrease pain associated with OA (Felson, Zhang, Anthony, et al., 1992). Similarly, clinical trials have indicated that decreases in OA symptoms are correlated with fat mass reductions, rather than to weight loss alone (Slemenda, Heilman, Brandt, et al., 1998). In addition, these researchers reported that reduced strength in relative terms to body weight, can promote the development of OA (Slemenda, Heilman, Brandt, et al., 1998). As a result, it is believed that interventions to strengthen muscularity, joint stability, and reduce body fat may reduce pain and enhance daily physical function for people affected by OA.

Another risk factor for OA is joint trauma, or joint instability (Lawrence, Helmick, Arnett, at al., 1998). Researchers have reported that major trauma to a joint can increase the risk for OA development (Turner, Barlow, & Healthcote-Elliott, 2000). In addition, muscle weakness and reduced joint proprioception are also risk factors for developing OA. It is common to see weakness in the quadriceps for patients with knee OA due to reduced joint stability and lack of shock absorbing capacity (Hurley, 1999). Quadricep muscle weakness also leads to inactivity and disability (Harries, & Bassey,

1990). Research has also demonstrated that joint proprioception or diminished position sense declines with age (Pai, Rymer, Chang, et al., 1997). However, those patients with knee OA had decreased knee propcrioception when compared to those without knee OA (Pai, Rymer, Chang, et al., 1997).

Inactivity is another risk factor for developing OA. While research has demonstrated that the development of OA is not magnified by moderate amounts of recreational activity (Buckwalter, & Lane, 1997), strenuous physical activity or intense sports have been shown to lead to OA (Saxon, Finch, & Bass, 1999). The importance of these research studies is that exercise designed to improve muscle strength and joint proprioception reduce pain and improve physical function among those suffering from OA (Rogind, Bibow-Neilson, Jensen, et al., 1998). OA patients can reduce their pain and enhance their physical function with moderate physical activity (Rall, Meydani, Kehayias, et al., 1996). In addition, exercise training does not exacerbate the pain and progression of OA (Noreau, Moffett, Drolet, et al., 1997).

Exercise, Diet, and Osteoarthritis

Inactivity has been reported to hasten the symptoms and progression of OA: muscle weakness, atrophy, decreased flexibility and cardiorespiratory fitness, osteoporosis, depression, and lowered pain threshold (King, & Minor, 2005). Standard medical practice, suggest rest as the best treatment for OA (Mazzuca, Brandt, Katz, et al., 1993). However, more contemporary studies have demonstrated that people with knee OA can benefit from participating in weight-bearing exercises (Rogind, Bibow-Neilson, Jensen, et al., 1998). The Arthritis, Diet, and Activity Promotion Trial (ADAPT) compared long-term exercise and dietary weight loss to the usual treatments as described

above on OA for the improvement of knee pain, function, and mobility (Messier, Loeser, Miller, et al., 2004). This study was performed on 316 older overweight and obese adults (BMI>28kg/m^2) with knee OA. The participants were randomized into four groups: healthy lifestyle (control), diet only, exercise only (walking and stair-climbing), and diet plus exercise. There were 252 adults that completed the study with a 73% adherence rate for the control, 72% diet only, 60% exercise only, and 64% diet plus exercise. The diet plus exercise group displayed significant reductions in knee pain, improvements in knee function, 6-minute walk distance and stair-climb time (exercise capacity). The exercise group had significant improvement in the 6-minute walk distance. No significant differences occurred in this test for the diet only and control groups. Significant decreases in body weight were noted in the weight-loss groups (diet and diet plus exercise) compared to the control. No significant changes occurred in joint space between the groups. This study indicated that weight loss plus exercise provided improvements in self-reported measures of knee pain and function among older overweight and obese adults with knee OA.

Brenda, et al., (2001) studied the effects of knee OA in older adults (≥60 years) and activities of daily living (ADL). The study randomly assigned 439 participants to an aerobic exercise program, resistance exercise program, or a control group. The reported results demonstrated that ADL disability was lower in the exercise group (37.1%) than the control group (52.5%). The aerobic and resistance groups showed significant improvement in ADL and the greatest improvements were noted in the participants with the highest exercise compliance. Therefore, aerobic and resistance exercise may lead to a

decrease in the incidence, prevention, and possibly prolong ADL disability in older adults with knee OA.

Another study evaluated 439 older adults with knee OA over an 18-month period, and is known as the Fitness Arthritis and Seniors Trial (FAST) (Ettinger, Burns, Messier, et al., 1997). The participants were randomly assigned to three treatment interventions: aerobic exercise program, resistance exercise program, and a health education program. The study measured self-reported physical disability scores, knee pain, physical function performance measures, x-ray scores, aerobic capacity, and knee muscular strength. Three hundred and sixty-five participants completed the study with a 68% compliance rate in the aerobic group and 70% in the resistance group. While the aerobic exercise group showed a 10% lower adjusted mean score on self-reported physical disability scores, the resistance group had an 8% decrease. Significant results were seen in the aerobic group for knee pain, 6-minute walk-tests, time to lift and carry, and time to get in and out. The health education group did not display significant results for the above-mentioned items. In addition, the resistance group reported an 8% decrease in pain scores and faster times in the above-mentioned items than the health education group. No significant differences occurred in the x-rays among all three groups. This study summarized that older adults with knee OA had improvements in knee disability, physical performance, and pain when participating in either aerobic or resistance exercise programs.

Prior to beginning an exercise program, participants with OA should consult with their physician with all exercise programs ensuring joint protection for OA patients, specifically avoiding overstretching. If joint swelling and pain occurs after exercise, the OA patients should apply ice to the affected joint and rest. While high-intensity exercise

should be avoided, strengthening the joints with weight bearing activities should be a priority with all exercise programs to promote nourishment of cartilage and bone. These activities should not be longer than 2-4 hours and should be followed with 1-hour of non-weight bearing activity (King, & Minor, 2005). In addition, regular physical activity can help prevent joint pain and stiffness, while providing health benefits (King, & Minor, 2005).

O'Grady, et al. (2000) reviewed the benefits of increased physical activity for OA patients. This research suggests that consistent physical activity can provide older OA patients with similar physical, psychological, and functional benefits found in the general population (O'Grady, Fletcher, Ortiz, 2000). Some of these benefits include improved postural and gait stability. These benefits cause reductions in falls and disabilities can improve the physical function for OA patients (O'Grady, Fletcher, Ortiz, 2000). As a result, physical activity helps to decrease disabilities in OA patients (O'Grady, Fletcher, Ortiz, 2000).

Minor, et al. (1993) and O'Reilly, et al. (1999) reported that aerobic exercise and strength-training programs improve the functional capacity in OA patients. Therefore, regular physical activity can improve the health and physical functioning for OA patients and inactivity leads to disabilities (O'Reilly, Muir, & Doherty, 1999).

It is well known that the basic components of an exercise program are to improve strength, flexibility, and endurance (Balady, Berra, Golding, et al.,2000). The following exercise recommendations for OA patients are based on the American College of Sports Medicine (ACSM) guidelines (Balady, Berra, Golding, et al.,2000). Initially, OA patients should engage in flexibility exercises that statically stretch the muscle and joint

to sensation resistance once daily. The goal is to stretch to full range of motion 3-5 times per week. Flexibility exercises allow joint health to improve due to enhanced range of motion, muscle performance, injury reductions, and improved nutrition for cartilage (Minor & Brown, 1993). The goal for OA patients is to decrease joint stiffness and increase joint mobility (Pollock, Mengelkoch, Graves, et al., 1997).

It is important to note that isotonic or dynamic exercises allow both changes in muscle length and movement of the joint (Balady, Berra, Golding, et al.,2000). Isotonic strength exercises should initially include low to moderate (40-60% MCV) submaximal contractions involving the key muscle groups daily. The key muscle groups should be selected based on OA patient's joint stability and degree of pain/inflammation. The goal should be to include low (40% 1RM) to high (>60% 1RM) 3-5 times per week. This includes 10-15 repetitions for low intensity and 6-8 repetitions for high intensities. However, OA patients should not strength train to fatigue (Pollock, Mengelkoch, Graves, et al., 1997). All exercises should be performed submaximally.

Aerobic endurance exercises should include intensities of low to moderate (40%-60% of VO_{2max}/HR_{max}) for a daily total of 20-30 minutes performed 3-5 times per week. The type of aerobic activity for an OA patient is dependent upon the patient's current disease status, joint stability, and interest level (Pollock, Mengelkoch, Graves, et al., 1997). It is important to include varying aerobic exercises to prevent overuse syndrome. These exercises can include, bicycling, swimming, low-impact aerobics, or activities of daily living, such as gardening, and walking the dog.

Dietary Supplements and Pharmacological Interventions for Osteoarthritis

Since OA is a leading cause of disability for older adults and has been shown to reduce functional mobility causing inactivity (CDC, 1999), the effectiveness of dietary supplements, such as glucosamine chondroitan have been studied in patients with knee OA (Davis, Ettinger, Neuhaus, et al., 1997). Management of OA has included patient education, therapeutic modalities, exercise assessment and prescription, and pharmacologic therapy.

It is important for OA patients to understand the disease for successful rehabilitation. Conventional therapeutic modalities include topical applications of heat and cold to encourage muscle relaxation and help with pain (Schnitzer, 1998). As previously mentioned, exercise assessment and prescription has been found to help manage the symptoms of OA. Exercise benefits for OA patients include the reduction in pain, swelling, enhancement of joint range of motion, muscle weakness, and postural instability. Pharmacologic therapies have been used in the treatment of OA. However, non-pharmacologic interventions should be used initially, followed by pharmacologic therapies (AGS Panel, 1998).

Acetominophen has generally been the preferred treatment for the management of OA pain (AGS Panel, 1998). Non-steroidal anti-inflammantory drugs (NSAIDs) benefit OA patients. However, gastrointestinal (GI) side effects have been associated with NSAIDs (Eccles, Freemantle, & Mason, 1998). There are also risks involved with taking NSAIDs and other medications that can lead to congestive heart failure, hypertension, and renal disease (Eccles, Freemantle, & Mason, 1998; Langman, Jensen, Watson, et al., 1999).

Cyclooxygenase (COX-2) inhibitors have been shown to help in the management of OA pain for people with GI adverse events (Crofford, Lipsky, Brooks, et al., 2000). These inhibitors have been shown to be as effective as NSAIDs (Crofford, Lipsky, Brooks, et al., 2000). However, as with NSAIDs, negative cardiovascular and renal side effects can occur with the use of COX-2 inhibitors (Crofford, Lipsky, Brooks, et al., 2000).

Topical solutions, such as methyl salicylate, menthol, or capsaicin cream have also been used for the treatment of OA (Schnitzer, 1998). Injections of corticosteroids or hyaluronic acid have been used in OA patients to control pain and reduce joint swelling (Bradley, Brandt, Katz, et al., 1991). Glucosamine and chondroitan supplements have also been used as treatment for OA patients (McAlindon, LaValley, Gulin, et al., 2000).

A study evaluating the long-term effects of knee OA joint structure changes with glucosamine sulphate supplementation was performed in 2001 on 212 participants (Reginster, Deroisy, Rovati, et al., 2001). These participants were randomized in a double-blind trial to ingest either 1,500 mg of oral glucosamine sulphate or a placebo for three years (Reginster, Deroisy, Rovati, et al., 2001). Radiographs of the knee in full extension were recorded at baseline, one and three years post baseline (Reginster, Deroisy, Rovati, et al., 2001). Mean joint-space widths of the tibiofemoral joint were studied with digital imaging analysis and minimum joint-space widths at the narrowest sections were evaluated using a magnifying glass (Reginster, Deroisy, Rovati, et al., 2001). In addition, WOMAC^{TM} test scores recorded OA symptoms of the knee (Reginster, Deroisy, Rovati, et al., 2001). Mean joint-space losses of 0.31 mm were noted in 106 placebo participants after three years. The treatment group (n=106) did not

reflect statistically significant joint-space changes or minimum joint-space narrowing after three years (Reginster, Deroisy, Rovati, et al., 2001). While WOMAC™ scores demonstrated an increase in symptoms in the placebo group (n=106), the treatment group demonstrated decreases in symptoms (Reginster, Deroisy, Rovati, et al., 2001). This study indicated that glucosamine sulphate supplementation could provide long-term effects for treating OA symptoms and joint structure modifications (Reginster, Deroisy, Rovati, et al., 2001).

Other researchers have evaluated the effects of oral glucosamine supplementation on knee function and pain in participants with knee pain due to osteoarthritis and cartilage damage (Braham, Dawson, & Goodman, 2003). Participants were randomly assigned to ingest either 2,000 mg/day of oral glucosamine or a placebo for 12 weeks and were tested four times with clinical and functional tests (Braham, Dawson, & Goodman, 2003). Clinical and functional tests improved during the 12 weeks, but no statistically significant differences in the treatment and placebo groups were reported. However, the treatment group reported significant differences on the Knee Injury and Osteoarthritis Outcome Score (KOOS) and lower Knee Pain Scale (KPS) scores at week eight of the trial when compared to the placebo group (Braham, Dawson, & Goodman, 2003). Approximately 88% of the treatment group reported an improvement in knee pain when compared to only 17% of the placebo group (Braham, Dawson, & Goodman, 2003). This study has led researchers to believe that 2,000 mg/day of glucosamine supplementation can help to reduce knee pain and improve function for individuals with cartilage damage and/or osteoarthritis after eight weeks (Braham, Dawson, & Goodman, 2003).

Pavelka et al. (2002) evaluated the treatment effects of glucosamine sulfate in a longitudinal (3-year) study. The purpose was to determine if glucosmaine sulfate affects the progression of the joint structure and evaluate the symptoms associated with knee OA. There were 202 participants with knee OA classified by the American College of Rheumatology. These participants randomly received 1,500 mg once per day or a placebo. Minimum joint space widths were measured in the tibiofemoral joint. Pain symptoms were assessed using the Lequesne and WOMAC^{TM} scales. Results indicated that the placebo group had progressive joint space narrowing of -0.19 mm after three years. The treatment group saw no average joint space change (0.04 mm). There was a significant difference between groups ($p<.001$) with OA symptoms improving for the placebo group. However, the treatment group had improvements of 20-25% and significant differences occurred on the Lequesne and WOMAC^{TM} scales (Pavelka, Gatterova, Olejarova, et al., 2002). These results were favorable toward using glucosamine sulphate for long-term treatment of knee OA (Pavelka, Gatterova, Olejarova, et al., 2002).

Usha, et al. (2004) studied the efficacy and safety of glucosamine, methlysulfonylmethane (MSM), their combination, and placebo in patients with knee OA. There were 118 participants with mild to moderate knee OA randomized to receive either 500 mg of glucosamine, 500 mg MSM, combination of glucosamine and MSM, or a placebo three times/day for 12-weeks. Data for efficacy and safety was collected at 0, 2, 4, 8, and 12 weeks. Efficacy was evaluated using a pain index, swelling index, visual analog scale for pain intensity, 15-minute walk test, Lequesne index, and the consumption of rescue medication. Results indicated that glucosamine, MSM, or a

combination improved OA symptoms when compared to the placebo group. There was a statistically significant decrease in mean (±SD) from baseline (1.74±0.47) to week 12 in the pain index for the glucosamine (0.65±0.71; $p<0.001$), MSM (1.53±0.51 to 0.74±0.65), with greater results in the combination (1.7±0.47 to 0.36±.33; $p<0.001$) treatment groups. Additionally, there were significant decreases in joint swelling at week 12 for the glucosamine and MSM groups. However, there was a greater decrease with the combination group (1.43±0.63 to 0.14±0.35; $p<0.05$). The data revealed statistically significant results for the Lequesne index. Results from this study indicate that combination therapy reduced joint pain and swelling, while improving the physical function of the joints (Usha, Naidu, 2004).

Xing, et al. (1998) studied the effects of treating knee OA with glucosamine sulfate or ibuprofen. There were 178 Chinese participants with knee OA randomized to two groups: 1,500 mg glucosamine sulfate/day or 1,200 mg ibuprofen/day. Resting, moving, pressure, swelling, adverse knee pain and improvement/therapeutic variables were studied at 0, 2, 4, and 2 weeks after. Both treatments significantly decreased the symptoms of OA. However, glucosamine sulfate was better tolerated than ibuprofen. This tolerability is best explained by the glucosmaine sulphate mechanism in that it does not inhibit COX-2, as do the anti-inflammatory treatments. In addition, glucosmaine sulphate decreases the progression of OA (Xing, Gao, Giampaolo, et al., 1998). Collectively, these studies and others suggest that glucosamine chondroitan supplementation may have therapeutic benefits for patients with knee osteoarthritis.

Joint and Connective Tissue Support

As previously mentioned, there have been clinical research studies evaluating the effects of dietary supplements containing glucosamine and chondroitin on joint pain, function, and ability for decreasing joint degeneration due to OA. The dietary supplement that was evaluated in this study contained glucosamine and chondroitin. In addition, this supplement included other nutrients and herbs believed to help reduce joint pain, function, and degeneration among OA patients. Table 1 provides a list of nutrients found in the dietary supplement studied. The following overviews the available literature concerning the role of nutrients found in the supplement to be evaluated in this study.

Table 1: Joint & Connective Tissue Nutrients

Ingredient	Daily Value (Two Tablets)	Study Daily Dose (Six Tablets)	DRI/RDA Availability	Purpose	References
Rutin Powder	5 mg	15 mg	Studies evaluated: 25-50 mg	Maintains resistance of capillary walls for permeation, pressure changes, provide synergistic effects with vitamin C, and anti-inflammatory characteristics	Kim, W., Bang, & Kim, E.., 2005; Martinez, Ortega, gascon, et al., 2005
Sodium	40 mg	120 mg	<2,300 mg	maintains fluid balances in body by regulating blood pressure, water balances, and helping to maintain proper nerve functioning	McCutcheon, Geor, & Sweating, 1998
Niacin (as Niacinamide)	40 mg	120 mg	14 mg	serves as a substrate for DNA binding proteins, functions in energy metabolism, cellular respiration, and help to decrease blood lipids and decrease homocysteine levels in the body for patients with hypercholesterolemia	Tighe, Ward, & McNulty, 2005; Urberg,Benyi, & John, 1988; Phillip, 1998
Vitamin B-6 (as Pyridoxine Hydrochloride)	50 mg	150 mg	6-10 mg	helps to decrease homocysteine levels in the body for preventing heart disease, balances hormones, assists the immune system, metabolism of fats and carbohydrates, balances	Folsum, Neito, & McGovern, 1998; Tighe, Ward, & McNulty, 2005; Wei, Giovannucci, & Selhub,

(table continues)

Ingredient	Daily Value (Two Tablets)	Study Daily Dose (Six Tablets)	DRI/RDA Availability	Purpose	References
				sodium and potassium levels in the body, and red blood cell production, has antioxidant properties, and helps with the creation of niacin.	2005
Zinc (as Zinc Oxide)	15 mg	45 mg	8 mg	aids with digestion, decreases upper respiratory tract infections in athletes participating in heavy intensity exercises, reduces exercise-induced alterations of the immune system	Kreider, Almada, & Antonio, 1999; Nieman, 2001; Gleeson, Lancaster, & Bishop, 2001
Glucosamine (from d-glucosamine HCL)	500 mg	1,500 mg	1,000 mg-2,000 mg Studies evaluated: 1,500 mg	normalizes cartilage metabolism, rebuilds experimentally damaged cartilage, and demonstrates mild anti-inflammatory properties	Xing, Gao, & Giacovelli, 1998; Braham, Dawson, & Goodman, 2003; Noack, Fisher, & Forster, 1994; Das, & Hammond, 2000; Nguyen, Mohamed, & Gardiner, 2001, Scroggie, Albright, & Harris, 2003
Chondroitan Sulfate (from Chondroitan Sulfate Sodium)	400 mg	1,200 mg	800 mg-1,200 mg Studies evaluated: 1,200 mg	Gives cartilage its resiliency, helps to maintain cartilage, and prevent osteoarthritis	Xing, Gao, & Giacovelli, 1998; Braham, Dawson, & Goodman, 2003; Noack, Fisher, & Forster, 1994; Nguyen, Mohamed, & Gardiner, 2001, Scroggie, Albright, & Harris, 2003; Leffler, C., Philippi, Leffler, S., 1999

Glucosamine Chondroitan

Glucosamine chondroitan compounds contain a cartilage matrix composed of collagen and proteoglycans. Collagen is an endogenous structural protein that forms

connective tissue, while providing strength, resilience, with support for skin, ligaments, tendons, and bones. Proteoglycans serve as cartilage components that provide the joints with strength, elasticity, and help absorb shock caused by bodily movements. Both collagen and proteoglycans are composed of a core protein to which polysaccharides, known as glycosaminoglycans (GAGs, which bind water in the cartilage matrix) or mucopolysaccharides, are attached (Braham, Dawson, & Goodman, 2003). Glucosamine serves as a GAG precursor to form tissue that binds collagen. As a result, GAGs and collagen act as a team to consistently rebuild cartilage (Braham, Dawson, & Goodman, 2003). Chondroitan, a natural substance found in cartilage helps to decrease enzyme activity associated with the breakdown of cartilage, and is an ingredient commonly added to dietary supplements in conjunction with glucosamine to better support the symptoms associated with OA (Richy, Bruyere, Cucherat, et al., 2003; Braham, Dawson, & Goodman, 2003). The most common form of chondroitan is chondroitan sulphate (Richy, Bruyere, Cucherat, et al., 2003).

There are 500 mg/two tablets of glucosamine in the dietary supplement studied which is formed by the combination of glucose and glutamine. It is composed of an amino sugar occurring in vertebral tissues found in marine life, known as crustaceans. As a result, glucosamine supplementation is generally derived from crab shells. People with allergies and sensitivity to shell fish should not ingest glucosamine. Noack, et al. (1994) found that 1,500 mg of glucosamine was effective in treating osteoarthritis of the knee and there were no statistically significant differences between the treatment and placebo groups. Dosages for clinical trials investigating glucosamine alone or with chondroitan range from 1,000 mg (Das, & Hammad, 2000) to 2,000 mg (Braham, Dawson, &

Goodman, 2003) of glucosamine per day with 1,500 mg (Noack, Fischer, Forster, et al., 1994; Nguyen, Mohamed, Gardiner, et al., 2001; Leffler, C., Philippi, Leffler, S., 1999; Scroggie, Albright, & Harris, 2003) being the most common. Daily dosages for chondroitin combined with glucosamine range from 800 mg (Das, & Hammad, 2000) to 1,200 mg (Nguyen, Mohamed, Gardiner, et al., 2001; Leffler, C., Philippi, Leffler, S., 1999; Scroggie, Albright, & Harris, 2003) of chondroitin. The most common dosage utilized in studies of glucosamine and chondroitin supplementation is 1,500 mg of glucosamine and 1,200 mg of chondroitin per day. The National Institute of Health is currently conducting a multicenter clinical trial to test the effect of glucosamine and chondroitin for treatment of knee osteoarthritis (NIH, 2004).

Rutin

Rutin is isolated from the n-butanol soluble portion of the aqueous section of the extract leaves of the plant known as Daniellia oliveri (Ahmadu, Haruna, Garba, et al. 2004). There are 5 mg of rutin in two tablets of the supplement to be studied. Rutin is a bioflavinoid (Ahmadu, Haruna, Garba, et al. 2004). Bioflavinoids help to maintain the resistance of capillary walls for permeation, pressure changes, and provide synergistic antioxidant effects with vitamin C. Bioflavinoids are water-soluble compounds found in citrus fruits, wheat extracts, such as buckwheat, and the rosehip plant (Ahmadu, Haruna, Garba, et al. 2004). Rutin powder has been reported to strengthen capillaries and is helpful to individuals that bruise or bleed easily (Ahmadu, Haruna, Garba, et al. 2004; Spencer, Kuhnle, Hajirezaei, et al., 2005). Kim, et al. (2005) studied the metabolic and pharmacological properties of rutin in its use to heal colitis in rats. It was found that rutin administration delivered quercetin to the large intestine to ameliorate inflammatory bowel

disease. Rutin serves as a very potent antioxidant that can be found in tomatoes and modulates age-related diseases and prevents DNA damage (Spencer, Kuhnle, Hajirezaei, et al., 2005; Dean, & Musich, 2003). Researchers have also found that rutin in the amount of 50 mg/day aids in reducing melanoma and colon cancers (Kim, W., Bang, Kim, E., et al, 2005; Martinez, Ortega, Gascon, et al., 2005). It is believed that OA patients can benefit from the anti-inflammatory effects of rutin (Kim, W., Bang, Kim, E., et al, 2005; Martinez, Ortega, Gascon, et al., 2005).

Methylsulfonylmethane (MSM)

There are 300 mg of methylsulfonylmethane (MSM) in two tablets of the dietary supplement studied. MSM, a sulfur-based compound derived from dimethyl sulfoxide (Harvard Health Letter, 2000), occurs naturally in plants and animals (Tufts University Health Letter, 2002). MSM can be found in vegetables, fruits, eggs, meat, fish, dairy, and poultry. MSM has been found to help with seasonal allergic rhinitis (Total Health, 2002) and is believed to help with joint pain by acting as an anti-inflammatory agent (Rosinski, 1999). Recommendations for daily dosages range from 500 mg to 3000 mg/day (Rosinski, 1999). MSM should not be taken by people on blood thinning medications, unless under supervision by a physician, because it acts similarly to aspirin (Rosinski, 1999).

As previously mentioned, Usha, et al. (2004) studied the efficacy and safety of glucosamine (1,500 mg/day), MSM (1,500 mg/day), their combination, and placebo in patients with knee OA. The results indicated that combination therapy of glucosmaine sulphate and MSM reduced joint pain and swelling, while improving the physical function of the joints (Usha, Naidu, 2004).

Zinc

The dietary supplement studied contains 15 mg/two tablets of the mineral called zinc. Studies have shown that zinc aids with digestion and enhances the immune system (Neiman, 2001). Zinc has also been associated with decreasing upper respiratory tract infections in athletes participating in heavy intensity exercises (Neiman, 2001). Research has shown that ingesting 25 mg of zinc daily during exercise training can reduce exercise-induced alterations of the immune system (Gleeson, Lancaster, & Bishop, 2001; Gleeson, & Bishop, 2000). The recommended daily dose of zinc is 11mg for males and 8 mg for females (Kreider, 1999). Kulkarni, et al. (1991) reviewed the treatment of osteoarthritis with a herbomineral formulation containing roots of Withania somnifera. These roots are derived from the stem of Boswellia serrata, which are rhizomes of Curcuma longa and a zinc complex, known as Articulin-F. Forty-two OA patients were evaluated in a placebo-controlled, cross-over study. The participants were randomized in a cross-over study to receive the treatment or a placebo for three months followed by placement into the opposite group, after a 15-day washout. Efficacy was evaluated based on pain, morning stiffness, articular index, joint and disability score, and grip strength. In addition, erythrocyte sedimentation rate and radiological examinations were performed. Statistically significant results were seen in joint pain and disability scores for the herbomineral formulation treatment. Both groups displayed no significant results in radiological assessments. The role of zinc in the treatment of osteoarthritis warrants further research.

Pyridoxine (Vitamin B-6)

The dietary supplement studied contains 50 mg/two tablets of Vitamin B-6 (pyridoxine). This vitamin is also known as pyridoxine. B-6 can be found in plant and animal sources, such as cereals, whole-grains, nuts, eggs, and fish. B-6 has been shown to be a water-soluble vitamin that decreases homocysteine levels in the plasma (Folsum, Neito, McGovern, et al., 1998; Tighe, Ward, & McNulty, 2005), and helps in the prevention of heart disease. In addition, this vitamin has several functions, such as assisting the immune system, metabolism of fats and carbohydrates, balancing sodium and potassium levels in the body, and red blood cell production. Vitamin B6 helps with the production of niacin and the recommended daily intake for B6 is 1.3 to 1.7 mg/day. Vitamin B6 has been linked to having antioxidant properties that may have aided in the prevention of cancer (Wei, Giovannucci, Selhub, et al., 2005). A nested-case study on 32,826 female participants revealed that an inverse relationship with vitamin B6 intake and colon cancer risk (Wei, Giovannucci, Selhub, et al, 2005). Women taking appropriate levels of vitamin B6 (RDA of 6-10 mg/day) had lower risk to colon cancer (Wei, Giovannucci, Selhub, et al., 2005). Chiang, et al. (2003) performed a cross-sectional research study on abnormal levels of vitamin B6 and rheumatoid arthritis. Thirty-seven participants with rheumatoid arthritis were evaluated for pain, fatigue, disability status, number of swollen and tender joints, vitamin B6, homocysteine levels, and markers for inflammation. Results indicated that low levels of vitamin B6 were seen in people with more severe cases of rheumatoid arthritis. These participants also had higher disability scores, number of swollen joints, and increases in inflammation. They have concluded that people with rheumatoid arthritis have low levels of vitamin B6. The

rationale is that people with a vitamin B6 deficiency have problems breaking down homocysteine in the body due to a methionine load (Chiang, Bagley, Selhub, et al. 2003). Researchers concluded that these low levels of vitamin B6 were caused by inflammation due to severity of disease, synovial burden, and amount of joint pain (Chiang, Bagley, Selhub, et al. 2003). According to the Arthritis Foundation (2003), similar research is being performed on all types of arthritis.

Niacin

Niacin (40 mg/two tablets) was also an ingredient of the dietary supplement studied. The vitamin serves is a water-soluble nutrient and is formed from the conversion of tryptophan in the periphery. Trytophan and niacin are converted to nicotinamide adenine dinucleotide, which serves as a substrate for DNA binding proteins. Niacin functions in energy metabolism, and cellular respiration (Tighe, Ward, & McNulty, 2005). The recommended daily intake of niacin has been 16 mg Niacin Equivalent (NE) for males and 14 mg NE for females. Studies have shown that daily niacin supplementation of 100 to 500 mg can help to decrease blood lipids and homocysteine levels in the plasma in patients with hypercholesterolemia (Urberg, Benyi, & John, 1988). Preliminary studies have indicated that niacin may improve symptoms associated with arthritis, such as joint mobility, reducing anti-inflammatory medication use, and aid in cartilage repair (McAlindon, Jacques, Zhang, et al., 1996). In additions, these researchers believe that niacin can be used with NSAIDs safely. However, further research is needed in this area to determine long-term use for slowing the progression of OA.

Sodium

The dietary supplement studied has 40 mg of sodium in two tablets. Increases in sodium intake can create fluid retention. Sodium is an essential mineral needed in the human body and is found in most foods eaten by humans as sodium chloride or table salt. However, sodium is a mineral needed to help maintain endogenous fluid balances by regulating blood pressure, water balances, and helping to maintain proper nerve function (McCutheon, Geor, & Sweating, 1998). The recommended daily intake for sodium has been to consume less than 2,300 mg/day (McCutheon, Geor, & Sweating, 1998). Some people with high blood pressure should consume only 1,500 mg of sodium each day (McCutheon, Geor, & Sweating, 1998).

White Willow Bark Extract

The dietary supplement studied contains 60 mg of white willow bark extract (salicis cortex) in every two tablets. This nutrient has been widely used for the treatment of pain associated with child-birth and the lower back (Chrubaski, & Eisenberg, 1998). The main ingredient of white willow bark extract consists of salicin, which includes salicylate products that serve as salts used in many pain and inflammatory prescription medications, and over-the-counter products, such as aspirin. It has been recommended that individuals with allergies or salicylate sensitivities not use any willow bark derivatives. Willow bark lacks an acetyl group in its chemical composition and as a result, provides less hemorrhagic risk than aspirin. However, it should still be avoided in patients with reduced thrombocytic function until further studies have been conducted (Krivoy, Pavlotsky, Chrubasik, et al., 2001).

Chrubasik, et al. (2000) studied white willow bark usage for the treatment of low back pain. They compared the ingestion of 120 mg and 240 mg of white willow bark extract to a placebo. There was a 40% reduction in pain after four weeks of treatment in the group ingesting 240 mg, as opposed to only a 19% pain reduction in the group receiving 120 mg of white willow bark. Schmid, et al. (2001) also studied the clinical efficacy of comparing OA patients that ingested 240 mg salicin/day of willow bark extract (n=39) to patients ingesting a placebo (n=39) for two-weeks. WOMAC™ pain dimension scores indicated a statistically significant difference in the treatment and placebo groups. A 14% reduction occurred in the WOMAC™ pain scores for the treatment, when compared to a 2% increase in pain for the placebo group. As a result, willow bark extract appeared to be tolerated well and helped with pain reduction among OA patients.

Boswellia Serrata Extract

The dietary supplement studied contains 100 mg/two tablets of Boswellia Serrata Extract. This ingredient is composed of Frankincense, which serves as the gum resin of Boswellia Serrata Extract. This constituent has been used for the treatment of inflammatory diseases in folk medicine among the regions of North Africa, India and China (Singh, & Atal, 1986). In addition, it is classified as having anti-inflammatory properties similar to non-steriodal anti-inflammatory medications, and is often used to treat arthritis, asthma, and ulcerative colitis in Ayurvedic practices (Singh, & Atal, 1986). Boswellia acids have been found to inhibit leukotriene synthesis in vitro by inhibiting 5-lipoxygenase activity in rat neutrophils and human platelets (Wildfeuer, Neu, Safayhi, et al., 1998). In addition, a pharmacological investigation of Boswellia has been shown to

have anti-inflammatory and anti-arthritic effects in rats (Singh, & Atal, 1986). Other than gastrointestinal disturbances and rashes, there are no known side-effects to the use of Boswellia Serrata Extract in normal quantities (Pavelka, K., Gatterova, Olejarova, et al., 2002).

Summary

OA is a disease that affects the joints, particularly the fingers, knees, and spine. This disease causes decreases in function and mobility for millions of people, which has lead to decreases in quality of life. Since cartilage is avascular, there is a dependency on the diffusion of nutrients from the tissues. Lack of nutrients and movement causes the cartilage to deteriorate. Therefore, OA patients should maintain movement to prevent cartilage deterioration (Balady, Berra, Golding, et al.,2000).

The Curves fitness program involves the use of hydraulic machines. These machines provide a double positive resistance, which implies there is no eccentric phase, or lengthening of the muscle fibers. Eccentric contractions result in muscle soreness and stress. Therefore, the use of hydraulic machines helps to avoid muscle soreness and stress.

The hydraulic machines use fluid chambers to generate resistance, similar to exercising in a swimming pool where the water density creates resistance. The movements performed on the machine cause the size of the hydraulic tubes that the fluid passed to decrease. The resistance generated is controlled by the speed of movement, with a decrease in movement causing a decrease in resistance. This speed of movement is beneficial for someone new to exercise (Heavin, 1999). Exercise movements can be faster, which cause the resistance to increase as a person increases their fitness level.

Hydraulic machines have been demonstrated to be beneficial for OA patients, because there is very little torque or pressure applied to the joints (Balady, Berra, Golding, 2000; Heavin, 1999).

Kreider, et al. (2005) has performed extensive research on the Curves fitness and diet program. This research has shown that women following this program for 14 weeks lost 10-14 pounds, decreased body fat by 1-3%, increased resting energy expenditure by 100-400 kcal/day, and had a reduction in waist & hip measurements of 1.5-2 inches. Maximal aerobic capacity increased by 10% and muscular strength/endurance improved by 10-15%. Resting heart rate and decreased by 3-5 beats/min. While total cholesterol decreased by 4%, LDL decreased by 3%, triglycerides decreased by 12%, and leptin was reduced overall by 17%. In addition, fasting insulin was reduced by 15% overall, while insulin sensitivity improved by 19%. Body image, self-esteem, and quality of life increased among the participants. Biomechanical and energy expenditures analysis performed on the Curves fitness and program indicated that exercise intensity of 65% of VO_{2max} support the ACSM guidelines. Women new to exercise can burn approximately 164-238 kcals during a 30-minute Curves workout. Highly trained women can burn 238-522 kcals/30 minute-workout at 65% $VO_{2max.}$ In addition, the strength training components of the program indicated a 50-75% of 1RM with an average of 15-20 repetitions performed per 30-second time frame (Kreider, et al., 2005). As a result, the research has shown that the Curves program is highly effective in promoting weight loss, improving markers of health, and improving fitness.

Researchers have demonstrated that 2,000 mg/day of glucosamine supplementation can help reduce knee pain and improve function for individuals with

cartilage damage and/or osteoarthritis after eight weeks (Braham, Dawson, & Goodman, 2003). In addition, research has indicated that combination therapy reduced joint pain and swelling, while improving the physical function of the joints (Usha, Naidu, 2004). These findings and others indicate that glucosamine chondroitan supplementation have some therapeutic benefits for OA patients.

The combination of the Curves program, as well as the dietary supplement studied may provide additional benefits for women with knee pain, as opposed to glucosamine and chondroitin supplementation alone. Theoretically, the Curves fitness and weight loss program may be efficacious for OA patients in that it promotes improvements in strength, flexibility, and weight loss. Following the Curves fitness and weight loss program, as well as supplementation with a dietary supplement containing glucosamine chondroitan, may help promote fitness, weight loss, and lessen symptoms of pain in patients with OA. Therefore, the purpose of this study was to determine whether participation in the Curves fitness and weight loss program and/or ingesting a commercially available glucosamine and chondroitan joint support dietary supplement affects knee pain and function, body composition, heart rate, blood pressure, blood profiles, maximal cardiopulmonary exercise capacity, knee flexion, knee circumference, and knee strength in sedentary, overweight (BMI > 27) women with knee osteoarthritis.

The study determined girth swelling, atrophy in muscle, range of motion, pain scores, and strength decreases due to pain and swelling. This was accomplished by studying the effects of two groups in the program. The first goal was to see if women with knee osteoarthritis had less knee pain and better function, if they consumed an oral dose of the dietary supplement and followed the Curves fitness and diet program. The

treatment group determined whether adding the glucosamine chondroitan dietary supplement enhances training adaptations and/or lessens the symptoms associated with OA. The second group served as the control group for women having knee pain and followed the Curves International fitness and diet program. The control group ingested a placebo three times per day. This group allowed the researcher to determine if the Curves fitness and weight loss program alone can improve fitness and/or lessen OA symptoms.

CHAPTER THREE

Methods

Participants

There were 30 sedentary and overweight female participants with knee pain (BMI > 27) between the ages 18 to 70 who participated in this study. The female participants were diagnosed by a physician with knee osteoarthritis. Participants were not allowed to participate in this study if they were pregnant, became pregnant, or had a desire for pregnancy; had any metabolic disorder including known electrolyte abnormalities; heart disease, arrhythmias, diabetes, thyroid disease, or hypogonadism; a history of hypertension, hepatorenal, musculoskeletal, autoimmune, or neurological disease; if they were taking thyroid, hyperlipidemic, hypoglycemic, anti-hypertensive, or androgenic medications; if they had taken ergogenic levels of nutritional supplements that affected muscle mass (e.g., creatine, HMB), anabolic/catabolic hormone levels (androstenedione, DHEA, etc), or weight loss (e.g., ephedra, thermogenics, etc) within three months prior to the start of the study; were ingesting any anti-inflammatory products two weeks before the start of the study or additional products during the study; if any unusual adverse events associated with this study were reported that in consultation with the supervising physician recommended removal from the study; if the participants had significant injury or surgery to the lower extremity, or spine within the last six months; if they did not indicate at least 3 cm out of the 12 cm on a VAS; if they didn't have a minimum of "a little" difficulty with at least two WOMAC^{TM} physical function items; if they had severe

arthritis that required surgery and greatly limited functionality (inability to perform lunge); if they had arthritis that required the current use of physiotherapy modalities; had contraindications for the use of aspirin since white willow bark extract contains salicin; if they were allergic to shellfish since glucosamine is derived from shellfish; and had any absolute or relative contraindication for exercise testing or prescription as outlined by the American College of Sports Medicine. Participants could use acetaminophen as a rescue drug during the clinical trial but had to document this in their pain diary and were not allowed to use it the day before or of testing. The only exception was if the prospective participant had a medical condition or history that the participant's personal physician felt was controlled and therefore was not a limitation for them to participate in the study. Participants meeting eligibility criteria were informed of the requirements of the study and signed informed consent statements in compliance with the Human Participants Guidelines of Baylor University and the American College of Sports Medicine. Participants were required to obtain clearance to participate in the study from their personal physician before participating in baseline assessments.

Study Site

All testing was conducted in the Exercise & Sport Nutrition Laboratory (ESNL) and/or the Athletic Training and Sports Medicine Lab in the Department of Health, Human Performance, and Recreation at Baylor University.

Experimental Design

Table 2 shows the general research design and time course for assessments. The study was conducted in a double-blind, placebo-controlled, and randomized manner.

Participants with physician diagnosed OA participated in a 14-week fitness and weight loss program. Participants were randomly assigned to ingest in a double-blind manner either a placebo or a glucosamine and chondroitan containing dietary supplement. The independent variable was nutritional supplementation. Dependent variables included: standardized quality of life (SF-36), eating satisfaction, and health status questionnaires; fasting clinical blood profiles [white cells, C-Reactive Protein, interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and cortisol]; body composition; body water assessment; knee pain; knee function; knee circumference; active range of knee motion; knee muscle strength; balance tests; and maximal cardiopulmonary exercise capacity.

Entry and Familiarization Session

Participants were recruited by advertisements/flyers in Waco, Texas and surrounding communities. The advertisements/flyers briefly described the study, outlined the qualifications, and instructed those interested to call the ESNL. Participants that expressed interest in participating in this study were interviewed on the phone to determine whether they appeared to qualify to participate in this study. Participants believed to meet eligibility criteria were invited to attend an entry/familiarization session. During this session, participants signed Informed Consent Statements and completed personal and medical histories. Participants underwent a general physical examination to determine whether they met eligibility criteria. Participants meeting entry criteria were familiarized to the study protocol via a verbal and written explanation outlining the study design. This included describing the training and dietary program, familiarizing the participants to the tests to be performed, and practicing the isotonic and isokinetic

knee/muscle strength tests. Participants were then given an appointment time to perform baseline/pre-supplementation assessments.

Table 2: Overview of Research Design

Familiarization and Entry	Baseline 0 week (T1)	2 weeks (T2)	10 weeks (T3)	14 weeks (T4)
Phone interview Familiarization session General medical exam by a registered nurse or physician to determine qualifications to participate in study.	QOL/ Questionnaires Diet Logs VAS WOMAC™ 3.1 REE Blood Weight HR/BP BIA DEXA Knee Circumference Active Range of Motion Equitest Balance Tests • Forward Lunge • Sit-to-Stand • Step-Up & Over Isokinetic Knee Ext Tests Treadmill Test Isotonic Bench Press	QOL/ Questionnaires Diet Logs VAS WOMAC™ 3.1 Blood Weight HR/BP BIA DEXA Knee Circumference Active Range of Motion Equitest Balance Tests • Forward Lunge • Sit-to-Stand • Step-Up & Over Isokinetic Knee Ext Tests	QOL/ Questionnaires Diet Logs VAS WOMAC™ 3.1 Blood Weight HR/BP BIA DEXA Knee Circumference Active Range of Motion Equitest Balance Tests • Forward Lunge • Sit-to-Stand • Step-Up & Over Isokinetic Knee Ext Tests Treadmill Test Isotonic Bench Press	QOL/ Questionnaires Diet Logs VAS WOMAC™ 3.1 REE Blood Weight HR/BP BIA DEXA Knee Circumference Active Range of Motion Equitest Balance Tests • Forward Lunge • Sit-to-Stand • Step-Up & Over Isokinetic Knee Ext Tests Treadmill Test Isotonic Bench Press

Pre-Supplementation/Baseline Testing

Following the familiarization/practice session, the participants recorded all food and fluid intake on dietary record forms four days before each testing session for weeks 0, 2, 10, 14. The dietary record included three days during the week and one weekend day prior to starting the study and prior to each testing session (0, 2, 10, 14). Participants were instructed to refrain from exercise for 48 hours prior to baseline testing. Participants reported to the ESNL for knee pain and functional assessments. Once reporting to the lab, participants completed the SF-36 quality of life (QOL) and eating satisfaction questionnaires.

The Visual Analog Scale (VAS) was used to measure knee pain. The Western Ontario and McMasters University Osteoarthritis Index (WOMAC^{TM} 3.1 Index) was used as a self-assessment for knee function. Medical history forms were completed. Participants were then weighed, had total body water determined by bioelectrical impedance (BIA), and had body composition determined using a Discovery W Dual Energy X-ray Absorptiometer (DEXA). Following these assessments, participants had their blood pressure determined using standard procedures. Participants donated approximately 20 ml of fasting blood using venipuncture techniques of an antecubital vein in the forearm according to standard procedures. Blood samples were analyzed by the Baylor Exercise & Biochemistry Laboratory (Waco, TX) for clinical chemistry profiles [glucose, total protein, blood urea nitrogen (BUN), creatinine, BUN/creatinine ratio, aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transpeptidase (GGT), albumin, calcium, total bilirubin, alkaline phosphatase, triglycerides, cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL)

and whole blood cell counts including hemoglobin, hematocrit, red blood cell counts, white blood cell counts, [neutrophils, lymphocytes, monocytes, eosinophils, baosphils]. In addition, serum samples were assayed to quantify the hormonal markers of knee inflammation for C-reactive protein, interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and cortisol, using standard ELISA and spectrophotometric techniques in the ESNL at Baylor University. Participants then had their resting energy expenditure measured using standard protocols with the Parvo Medics TrueMax 2400 Metabolic Measurement System. Next, participants had measurements taken of their knees to include knee circumference, and active range of motion of the knee to determine swelling secondary to osteoarthritis and flexibility of knee. The following Equitest balance tests were then performed: Sit-to-Stand, Step-Up and Over, Forward Lunge. Participants then performed a knee muscular strength test using the isokinetic dynamometer. These tests determined knee strength and function. Next, participants performed a maximal cardiopulmonary exercise stress test to assess aerobic capacity and anaerobic threshold. Finally, participants performed an upper body muscular strength and endurance bench press test. Each testing session lasted approximately 2 1/2 hours. Participants completed weekly a medical safety/side effect report that was analyzed by the lab research nurse.

Randomization

All participants were matched based on age. All participants were randomly assigned in a double-blind manner to either a dosage of the dietary or a placebo supplement composed of dextrose with base material to match the supplement. (The placebo appeared and smelled the same as the treatment.) This was accomplished by studying the effects of two groups in the program. The first goal was to see if women

with knee osteoarthritis had less knee pain and better function, if they consumed an oral dose of the dietary supplement and followed the Curves fitness and diet program. The treatment group determined whether adding the glucosamine chondroitan dietary supplement enhances training adaptations and/or lessens the symptoms associated with OA. The second group served as the control group for women having knee pain and followed the Curves International fitness and diet program. The control group ingested a placebo three times per day. This group allowed the researcher to determine if the Curves fitness and weight loss program alone can improve fitness and/or lessen OA symptoms. Both the treatment and control groups followed the Curves exercise and diet program to promote weight loss as described below.

Participants who responded positively to the carbohydrate tolerance quiz were entered into a very low calorie, high protein/carbohydrate restricted diet (HPD). Remaining participants who responded negatively to the carbohydrate tolerance quiz were randomized into a traditional very low calorie, high carbohydrate/low protein diet group (HCHO). Participants were asked to follow a diet plan developed by a registered dietitian that adhered to the macronutrient intake described in Table 3.

Table 3: Dietary Intervention Program

Diet Period	Group	Macronutrient	Grams /Day	Kcals/Day	Percentage of Daily Diet (%)
Phase I	HPD + Exercise (n=30)	Protein	190	760	63
(One week)	(1,200 kcals/day)	Carbohydrate	20	80	7
		Fat	40	360	30
	HCHO + Exercise (n=30)	Protein	45	180	15

(table continues)

Diet Period	Group	Macronutrient	Grams /Day	Kcals/Day	Percentage of Daily Diet (%)
	(1,200 kcals/day)	Carbohydrate	165	660	55
		Fat	40	360	30
Phase II	HPD + Exercise (n=30)	Protein	220	880	55
(Nine	(1,600 kcals/day)	Carbohydrate	60	240	15
Weeks)		Fat	40	360	30
	HCHO + Exercise (n=30)	Protein	60	240	15
	(1,600 kcals/day)	Carbohydrate	220	880	55
		Fat	40	360	30
Phase III	HPD + Exercise (n=30)	Protein	100	400	15
(Four	(2,600 kcals/day)	Carbohydrate	360	1440	55
Weeks)		Fat	90	810	30
	HCHO + Exercise (n=30)	Protein	100	400	15
	(2,600 kcals/day)	Carbohydrate	360	1440	55
		Fat	90	810	30
Maintenance Period	Alternate with Phase I and Phase III of diet during weeks 11 – 14 of study on a 2/3, 2/5, and 2/10 day interval. Stay on Phase III until 3 lbs are gained Follow Phase I for two days and then go back on the Phase III diet.				

Participants maintained the Phase I diet for one week. Participants then followed a 9-week exercise and dietary intervention program according to the protocol described in Table 3. Participants then consumed a normal diet (Phase III) and then alternated Phase I (1,200 kcals/day) and Phase III diets (2,600 kcals/day) on a 2/3, 2/5, and 2/10 day pattern

in an attempt to maintain weight loss. Previous research has demonstrated that this 14-week program promoted a 10 – 14 lbs weight loss (Kreider, et al., 2005).

Supplementation Protocol

Participants ingested six tablets daily providing a total of 1,500 mg of glucosamine, 1,200 mg of chondroitan sulfate, 120 mg of niacin, 120 mg of sodium, 45 mg of zinc, 900 mg MSM, 300 mg of boswellia serrata extract, 180 mg of white willow bark extract, and 15 mg of rutin powder or a suitable placebo. Three of the six daily tablets were ingested in the morning and the remaining three in the evening, 30-minutes before a meal for 14-weeks. The supplements were prepared in capsule form and packaged in generic bottles for double blind administration by Nutra (Greenville, SC). Supplementation compliance was monitored by having the participants return empty bottles of the supplement at the end of each testing phase. In addition, internal monitoring of supplementation compliance occurred with participants signing a compliance/honesty statement in a post-study questionnaire.

Training Protocol

Participants randomized to ingest either the supplement or placebo participated in a Curves 30-minute supervised fitness program three times per week throughout the investigation. This involved performing thirteen hydraulic resistance exercise machines with bidirectional resistance that worked all major muscle groups interspersed with floor-based exercises designed to maintain an elevated heart rate. The Curves equipment was located on the third floor of the Student Life Center (SLC). Research assistants monitored exercise sessions and recorded attendance.

Medical Monitoring

Interested participants attended familiarization sessions where they signed consent forms and completed medical history information. Participants then underwent a general exam with a trained researcher to determine whether the participant met entry criteria to participate in the study. This exam included evaluating the medical and training history questionnaires and performing a general physical examination according to ACSM exercise testing guidelines (Balady, Berra, Golding, et al., 2000). Based on this examination, a recommendation was made on whether the participant met entry criteria and could therefore participate in the study. Participants who met entrance criteria obtained a letter of medical clearance from their personal physician on their practice letterhead to participate in the study. Trained, non-physician exercise specialists certified in CPR supervised participants during the exercise assessments. A telephone and an automated electronic defibrillator were located in the laboratory in case of any emergencies and there were always two ore more researchers working with each participant during testing sessions. In the event of any unlikely emergency one researcher checked for vital signs and began any necessary interventions while the other researcher contacted Baylor's campus police at extension 2222. Instructions for emergencies were posted above the phone in the event that any other research investigators were available for assistance. Participants were informed to report any unexpected problems or adverse events they encountered during the course of the study to Richard B. Kreider, Ph.D., EPC or Chris Rasmussen, M.S., MX, EPC, CSCS. If clinically significant side effects were reported, the participants were referred to discuss the problem with the research nurse (currently Melyn Galbreath, MSRN, FNP) or Lori

Greenwood, Ph.D., ATC, LAT who is an Associate Professor of Athletic Training at Baylor University. If deemed necessary, Dr. Greenwood referred the participant to Ronald Wilson, MD for medical follow-up. Dr. Wilson is one of the Sports Medicine physicians for Baylor University and is an adjunct Professor in the Department of Health, Human Performance, and Recreation (HHPR). He agreed to provide medical support and consultation for this study and to the ESNL. Dr. Wilson evaluated the complaint and made a recommendation whether any medical treatment was needed and/or whether the participant could continue in the study. If Dr. Wilson felt medical follow-up was necessary, the participant was referred to obtain medical treatment from their personal physician. This was a similar referral/medical follow-up system that Baylor University athletes are provided with the exception that participants in this study were not provided medical care. New findings and/or medical referrals of unexpected problems and/or adverse events were documented, placed in the participants research file, and reported to the Baylor IRB committee.

Testing Methods- Dietary Inventories

Participants recorded all food and fluid intake on dietary record forms four days before each testing session for weeks 0, 2, 10, 14. The dietary record included three days during the week and one weekend day prior to starting the study and prior to each testing session (0, 2, 10, 14). All dietary inventories were assessed by Food Processor III Nutrition Software (ESHA Nutrition Research, Salem, OR) and verified by a registered dietitian.

Psychometric Assessments

Participants completed the appetite/eating satisfaction questionnaire, and the SF-36 Quality of Life (QOL) inventory to determine their eating satisfaction and changes in quality of life scores throughout the length of the study (Ware, et al., 1995). The SF-36 covered 40 concepts related to health and was developed and used in the Medical Outcomes Survey. The SF-36 was a generic instrument which measured health-related quality of life (HRQOL) by assessing eight different dimensions: physical functioning (10 items), role limitations caused by physical health problems (4 items), bodily pain (2 items), general health perceptions (6 items), energy/fatigue (4 items), social function (2 items), role limitation caused by emotional problems (3 items), and emotional well-being (5 items). The items were scored, with the higher score representing better HRQOL. Following the study, participants were asked to complete a post-study questionnaire to assess impressions about the research study.

Pain Scale

To determine perceived knee pain a Graphic Pain Rating Scale as developed by Denegar & Perrin (1992) was utilized. Graphic rating scales have been shown to be the best available method to measure pain and pain relief (Denegar, & Perrin, 1992). This type of pain scale has been shown to be more sensitive than other scales and is easily used by participants (Denegar, & Perrin, 1992). Participants marked an "X" at any point on the 12-cm line that best described the soreness they felt in their knee on a daily basis. The Graphic Pain Rating Scale ranged from "No Pain" to "Unbearable Pain".

Western Ontario and McMasters University Osteoarthritis Index (WOMAC™ 3.1 Index)

A self-administered index that assessed the three dimensions of pain, joint stiffness and disability in knee and hip osteoarthritis used a battery of 24 questions. Participants placed an "X" on each line corresponding to the inquiry to indicate their level of joint pain, joint stiffness, and knee disability. The WOMAC™ 3.1 has been widely used in the evaluation of knee and hip osteoarthritis. It was a valid, reliable and responsive measure of outcome (Scott, & Huskisson, 1997).

Body Composition Assessments

Participants underwent body composition tests in the ESNL. Prior to each assessment, height was measured using standard anthropometry and total body weight was measured using a calibrated electronic scale (Cardinal Detecto Scale Model 8430, Webb City, Missouri) with a precision of +/-0.02 kg. Other than general instructions, special skills were not required to measure body weight.

Total body water was then estimated using a Xitron 4200 Bioelectrical Impedance Analyzer (San Diego, CA) which measured bio-resistance of water and body tissues based on a minute low energy, multi-frequency current (measures impedance at 50 frequencies logarithmically ranging from 5 KHz to 1 KHz) transmitted through the body (NHANES, 2004). This analyzer has been commercially available and has been used in the health care/fitness industry as a means to assess body composition and body water for over 10 years. The use of this device has been approved by the Food and Drug Administration (FDA) to assess total body water and the current to be used has been deemed safe (NIH, 1996). This was measured through four electrodes placed on the body: one electrode was placed on the posterior surface of the right wrist, in between the

radial and ulna styloid processes (wrist bones), another electrode was placed on the posterior surface of the right hand at the distal base of the second metacarpal; the third electrode was placed on the anterior surface of the right foot at the distal end of the first metatarsal. The fourth electrode was placed on the posterior surface of the talus. Participants lied on a table in the supine position and electrodes were connected to the analyzer. After the participant was connected, age, gender, weight, and height were entered into the unit by the technician. After the unit had measured the resistance, which took approximately 30 seconds, the unit then calculated total body water and body water percent. The analyzer was calibrated internally to a standard electrical current by pressing the calibration key located on the unit.

Body composition/bone density was then determined using a calibrated Discovery W dual-energy x-ray absorptiometry (DEXA) by qualified personnel with limited x-ray technology training under the supervision of Richard B. Kreider, Ph.D., MX. Body composition measurements were determined by qualified personnel (in compliance with State Regulations) using a Discovery W dual energy x-ray absorptiometer (Waltman, MA). Quality control (QC) calibration procedures were performed on a spine phantom (Discovery W-CALIBER Model DPA/QDR-1 anthropometric spine phantom) prior to each testing session. In addition, weekly calibration procedures were performed on a density step calibration phantom.

The DEXA body composition test involved having the participant lie down on their back in a standardized position in a pair of shorts/t-shirt or a gown. A low dose of radiation then scaned their entire body for approximately six (6) minutes. The DEXA segmented regions of the body (right arm, left arm, trunk, right leg, and left leg) into

three compartments for determination of fat, soft tissue (muscle), and bone mass. Radiation exposure from DEXA for the whole body scan was approximately 1.5mR per scan. This is similar to the amount of natural background radiation a person would receive in one month while living in Waco. The maximal permissible x-ray dose for non-occupational exposure is 500 mR per year. Total radiation dose was less than 7.5mR for the entire study. Participants completed a radiation exposure questionnaire and applied the 10 or 14-day rule for x-ray exposure. Test-retest reliability studies performed on male athletes with this DEXA machine yielded mean deviation for total BMC and total fat free/soft tissue mass of 0.31% with a mean intra-class correlation of 0.985.

Resting Heart Rate & Blood Pressure

Heart rate was determined by palpitation of the radial artery using standard procedures (Balady, Berra, Golding, et al., 2000). Blood pressure was assessed by auscultation of the brachial artery using a mercurial sphygmomanometer using standard clinical procedures (Balady, Berra, Golding, et al., 2000). Blood pressure measurements were taken on the participant in the supine position after resting for 5-min.

Blood Samples

Participants fasted overnight for twelve (12) hours and then donated approximately 4 teaspoons of fasting venous blood (20 milliliters). Blood samples were obtained using standard phlebotomy procedures using standard sterile venipuncture of an antecubital vein by laboratory technician's trained in phlebotomy in compliance with guidelines established by the Texas Department of Health and Human Services. The phlebotomists and lab technicians wore personal protective clothing (gloves, lab coats,

etc.) when handling blood samples. Participants were seated in a phlebotomy chair. Their arm was cleaned with a sterile alcohol wipe and sterile gauze. A standard rubber tourniquet was then placed on the brachium. An antecubital vein was palpated and then a 23 gauge sterile needle attached to a plastic vacutainer holder was inserted into the vein using standard procedures. Three serum separation vacutainer tubes (red tops) and one EDTA vacutainer tubes (purple top) were inserted into the vacutainer holder for blood collection in succession using multiple sample phlebotomy techniques. Once samples were obtained, the vacutainer holder and needle were removed. The needle was discarded as hazardous waste in a plastic sharps container. The site of the blood draw was then cleaned with a sterile alcohol wipe and gauze and a sterile Band-Aid was placed on the site. The blood collection tubes was labeled and placed in a test tube rack. Laboratory technicians (who had received blood borne pathogen training and were wearing personal protective clothing) centrifuged the serum samples, transferred serum into labeled serum storage containers, and prepared samples for storage into a -20° Celsius freezer for subsequent analysis. Serum and whole blood samples were analyzed by the Baylor Biochemical & Nutrition Laboratory (Waco, TX) for assay of a standard clinical chemistry profile clinical chemistry profiles [glucose, total protein, blood urea nitrogen (BUN), creatinine, BUN/creatinine ratio, aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transpeptidase (GGT), albumin, calcium, total bilirubin, alkaline phosphatase, triglycerides, cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL) and whole blood cell counts including hemoglobin, hematocrit, red blood cell counts, white blood cell counts, neutrophils, lymphocytes, monocytes, eosinophils, baosphils] using a DADE Dimension RXL clinical

chemistry analyzer (Dade-Behring, Inc., Newark, DE), and an Abbott Cell Dyn 3500 hematology analyzer (Abbott Laboratories, Chicago, IL). Test to test reliability (within and between) of performing these assays ranged from 2 to 6% for individual assays with an average variation of ±3%. Samples were run in duplicate to verify results if the observed values were outside control values and/or clinical norms according to standard procedures.

Serum Hormone Detection

Serum C-Reactive Protein, IL-6, TNF-α, and cortisol were determined with either an enzyme linked immuno-absorbent assay (ELISA) or enzyme immuno-absorbent assay (EIA) (Cayman Chemical, AnnArbor, MI; Diagnostic Systems Laboratories, Webster, TX). IL-6 and TNF-α involved the use of ELISA kits that were coated into the wells of the microtiter strips with monoclonal antibodies specific for each hormone. In the assay, samples, known standards, controls and unknowns are pipeted into the wells and incubated for binding to the antibody. After incubation and washing, a biotinylated monoclonal antibody specific for each hormone was added and then incubated again for additional binding. The excess second antibody was washed and the wells were incubated with streptavidin-peroxidase enzyme which binds to the biotinylated antibody for completion of the four-layer sandwich. The streptavidin-peroxidase enzyme was washed to remove any unbound enzyme, and a substrate solution is added specific for each hormone. This solution was acted upon by the bound enzyme and color was produced. The degree and intensity of the color produced was indicative of the concentration of the hormone present. An acidic stopping solution (0.5 N HCL) was then added and the degree of enzymatic turnover of the substrate was determined by using a

Wallac Victor-1420 microplate reader (Perkin-Elmer Life Sciences, Boston, MA). The assays will be performed at either a dual wavelength absorbance at 405 or 450 nm. The same procedures were followed for all hormones, except C-Reactive protein and cortisol involved the use of an EIA, instead of ELISA. EIA kits use a competitive binding biotin immunoassay format. The C-Reactive protein involved using a TMB Substrate Solution and cortisol used a TMG Chromogen Solution prior to the addition of the stopping solution. Intra-assay and inter-assay coefficient of variation for TNF-α varied from 5.3-6.7%, and 8.2-9.7%, respectively. Intra-assay and inter-assay coefficient of variation for IL-6 varied from 4.71-8.33%, and 6.70-10.0%, respectively. The intra-assay and inter-assay coefficient of variation for C-Reactive protein was 6.9%, and 13.1%, respectively. Finally, the intra-assay and inter-assay coefficient of variation for cortisol varied from 2.4-10.3%, and 8.0-12.0%, respectively.

Resting Energy Expenditure Assessment

Resting energy expenditure assessments were made according to standard protocols using the Parvo Medics TrueMax 2400 Metabolic Measurement System (Sandy, UT). This involved the subjects lying down on an exam table, having a light blanket placed over them to keep warm, and inserting ear plugs in their ears to reduce distractions. A see through metabolic canopy was then placed over the subject's neck and head so that metabolic measurements were obtained. The subject lied motionless without going to sleep for 20-minutes. Metabolic measurements were then obtained to determine resting oxygen uptake and energy expenditure. Test-to-test reliability yielded the following intraclass values: VE/O_2 = 0.95, 5.3%; RER = 0.87, 9.8%; VE/VCO_2 = 0.87, 12.1%; Max VTW = 0.98, 2.6% (Amann, M., Subudhi, A., Walker, J., et al., 2004).

Cardiopulmonary Exercise Tests

Maximal cardiopulmonary measurements were obtained using Parvo Medics 2400 TrueMax metabolic measurement system. Participants were attached to the Quinton 710 ECG (Bothell, WA) and walked on a Trackmaster TMX425C treadmill (Newton, KS). These tests assessed maximal aerobic capacity. Cardiopulmonary exercise tests were performed by certified exercise physiologists in accordance to standard procedures described by the American College of Sports Medicine's (ACSM) Guidelines for Exercise Testing and Prescription (Balady, Berra, Golding, et al., 2000). This involved preparing the participant's skin for placement of 10 ECG electrodes. Electrode sites were cleansed with a sterile alcohol gauze using a circular motion. The site was allowed to air dry or was dried with a gauze pad. Electrodes were placed on the right subclavicular fossa (RA), left subclavicular fossa (LA), right abdomen (RL), left abdomen (LL), 4th intercostals space at the right sternal border (V1), 4th intercostals space at the left sternal border (V2), equidistant between V2 and V4 (V3), 5th intercostal space at the midclavicular line (V4), 5th intercostal space at the anterior axillary line (V5), and 5th intercostals space at the axillarly line (V6) of the chest. The participant was then attached to a Quinton 710 ECG. Resting blood pressure, heart rate, and a 12-lead ECG were obtained. The exercise specialist reviewed the 12-lead ECG to ensure that no contraindications for exercise testing were apparent based on the ACSM guidelines (Balady, Berra, Golding, et al., 2000). Participants were then positioned on a treadmill. A sterile mouthpiece attached to a head harness was secured on the participant. The participant then had a noseclip placed on their nose. Resting expired gases were collected using the Parvo Medics 2400 TrueMax Metabolic Measurement System. Once

the participant was ready to begin the test protocol, the participant straddled the treadmill with both legs while the treadmill was turned on at a speed of 1.7 mph and at a 0% grade. The participant then used one foot to repeatedly swipe the belt in order to gauge the speed of the motion. Once the participant was familiar with this speed, the participant stepped onto the belt while still gripping the handrail with both hands. Once the participant became comfortable walking on the treadmill, she let go of the handrail and began walking freely. The participant then performed a standard symptom-limited Bruce treadmill maximal exercise test (Balady, Berra, Golding, et al., 2000) using the following speeds and grades as described in Table 4.

Table 4: Bruce Treadmill Test

Stage	Speed	Grade (%)	Duration (Min.)
1	1.7	10	3
2	2.5	12	3
3	3.3	14	3
4	4.2	16	3
5	5.0	18	3
6	5.5	20	3
7	6.0	22	3

The participant was encouraged to exercise to their maximum unless the participant experienced clinical signs to terminate the exercise test as stated by the ACSM's Guidelines for Exercise Testing and Prescription [i.e., angina, dyspnea, dizziness, a decline in systolic blood pressure, dangerous dysrhythmias (increasing or multi-form premature ventricular contractions, ventricular tachycardia, supraventricular tachycardia, new atrial fibrillation, or A-V block), lightheadedness, confusion, ataxia, cyanosis, nausea, excessive rise in systolic blood pressure over 250 mmHg or diastolic

over 120 mmHg, chronotropic impairment, failure of the monitoring system, or other signs or symptoms for terminating the test] (Balady, Berra, Golding, et al., 2000). The test was also terminated at the request of the participant. Once the exercise test was completed, the participant observed a 3-6 minute active recovery period followed by a 3-6 minute seated recovery period. The normal exercise time to maximum of the Bruce treadmill protocol for untrained women has been typically about 9 minutes (near the completion of stage III or just entering stage IV). Heart rate (HR), ECG tracings, and expired gases were monitored continuously throughout the exercise test. Blood pressure (BP) and ratings of perceived exertion (RPE) were obtained toward the end of each stage. Participants were asked to report any unusual signs or symptoms to the exercise specialists during the exercise test. These tests determined maximal aerobic capacity and anaerobic threshold to determine the effects of the exercise training on fitness and exercise capacity. Results of this test, was forwarded to the participant's personal physician if any unusual or abnormal results were observed. In this case, the participant's personal physician had to once again clear the individual for enrollment in the study before she was able to start the diet/training portion of the study. The mean coefficient of variation (assessing Vo_{2max}) for this protocol is 6.5% (range 2-14%).

Isotonic Bench Press

A standard isotonic Olympic bench press (Nebula Fitness, Versailles, OH) was used for the isotonic bench press tests. A one repetition maximum (1 RM) and 70% of 1 RM endurance repetition bench press test was performed using standard procedures. Participants performed two warm-up sets of 10 repetitions (approximately 40% 1 RM). Participants rested for three minutes in between each successive one repetition lift until

the 1 RM was determined. The participant rested for five minutes and then lifted 70% of the 1 RM as many times as possible to determine upper body muscular endurance. Test to test reliability of performing these strength tests on resistance-trained subjects in the ESNL have yielded low mean coefficients of variation and high reliability for the bench press (1.9%, intraclass $r = 0.94$).

ROM – Goniometer Procedures

Active range of motion for right/left knee extension and flexion was measured with a standard 12" Universal Goniometer to determine knee range of motion. The participant lied supine with one leg extended and the other leg bent with the heel resting on table. The extended leg was measured for knee extension. Next, the measurement of the same leg was measured for flexion range of motion by having the participant raise the extended leg slightly off the table and bring the heel toward the gluteus maximus. These procedures were repeated on the opposite leg. Specifically, this procedure allowed the investigators to determine the range of motion present in the experimental groups and the control group based on supplementation product/placebo. Test to test reliability of performing these tests were 0.75-0.98.

Anthropometric Procedures

As an indicator of knee inflammation/swelling caused by OA, measurements of Knee Circumference (CIRC) was taken. The participant lied supine with one leg extended and the other leg bent with the heel resting on table. The circumference of the extended leg was measured and then repeated on the opposite leg. Measurements of CIRC were performed utilizing a Gulick anthropometric tape (Model J00305, Lafayette

Instruments, Lafayette, IN) at the joint line of both knees. Test to test reliability of performing these tests were 0.86-0.92.

Equi-Test Procedures

Measurements of knee function were collected utilizing the Neurocom SmartEquitest® (Neurocom International, Portland, OR). The SmartEquitest® consisted of a long static force plate which measured balance and mobility. The Equi-Test testing session lasted no longer than 15 minutes and was used to determine knee function. Test-to-test reliability in women aged 65-75 has been reported to be r=0.92 (Carter, Khan, Petit, et al., 2001). Data was collected on postural balance and mobility utilizing the following tests in order:

1. Sit to Stand (STS): The STS test quantified the patient's ability to rise from a seated to a standing position. The participant sat on a platform placed on a stationary forceplate with the knees at 90 deg. of flexion. The participant was asked to rise from the seated position to a static standing position. There were 3 trials of the STS test.
2. Step Up and Over (SUO): On a stationary forceplate, the participant was instructed to step forward up on to a stable wooden box with their right leg, lift the left foot over the box and down onto the forceplate back to an upright standing position. The test consisted of three trials of each side. The height of the step was 8-12" and determined based on the participant's height and knee position. If the participant's knee flexion position exceeded 90 degrees when their foot was placed on the 12" box, the 8" box was used.
3. Forward Lunge (FL): On a stationary forceplate, the participant performed 3

lunges on each leg. The FL quantified movement characteristics as the participant lunged or stepped forward onto one leg followed by pushes back with that leg to return to a standing position. Each side was tested 3 times for a total of 6 lunges.

Standard Warm Up Isokinetic Biodex

Isokinetic testing was performed using the Biodex Multijoint Isokinetic Testing System (Biodex Medical Systems, Shirley, NY) to measure knee strength. Specific limb warm-up on the isokinetic device consisted of three submaximal reciprocal concentric extension and flexion repetitions at each test velocity with increasing intensity (i.e. first repetition at 25% perceived effort, second repetition at 50% perceived effort, etc.). In addition, the participant completed two maximal intensity repetitions at each velocity, then rested for one minute prior to testing. This test allowed participants to prepare the body and warm-up prior to testing.

Isokinetic Testing Procedures

Isokinetic strength was assessed bilaterally. Testing began from a dead stop with the participants' leg at 90 degrees of flexion and consisted of five, ten, and fifteen maximal concentric reciprocal knee extension and flexion repetitions at 3 different test speeds. Velocities were presented in a fixed order at 60, 180 and 300 degrees per second with one-minute rest between bouts. The identical testing procedure was repeated for each testing day. Each participant was encouraged to contact the mechanical end stops during both the extension and flexion motions. Consistent and identical verbal encouragement was provided during each test session, but no visual feedback of any kind

was used. This test was used to evaluate knee strength. Test-to-test reliability data for women with osteoarthritis varies from 0.83 to 0.94 (Wessel, 1996). Test to rest reliability has been shown to be between 0.78 and 0.82 (Pincivero, D., Gear, W., Sterner, R, 2001).

Statistical Analysis

Data were analyzed using analysis of variance (ANOVA) repeated measures univariate tests with SPSS for Windows Version 11 software (SPSS Inc., Chicago, IL). Data were considered statistically significant when the probability of type I error was 0.05 or less. Least significant differences (LSD) post-hoc procedures were performed when a significant interaction was observed. Effect sizes were calculated using Cohen's d statistic to quantify the size and significance that may exist between groups independent of group size. Power analysis of the design indicated that an n-size of 10-15 per group yielded high power (>0.8) for delta values of 0.75 to 1.25.

CHAPTER FOUR

Results

Demographics

There were 30 participants that volunteered for the study and completed informed consent statements in compliance with Baylor University's Institutional Review Board. The 30 participants completed the 14-week study (Table 2), which included four testing sessions to collect data on the following: Quality of Life, Eating Satisfaction, pain scale, WOMAC™ 3.1, REE, fasting blood, heart rate, blood pressure, weight, BIA, DEXA, knee circumference, active range of motion, Equitest balance tests (sit-to-stand, step-up & over, forward lunge), isokinetic knee tests, treadmill test, and isotonic bench press. Table 5 depicts the participant's average age and height for each dietary supplement group. There were no statistically significant differences between the means for age (p=0.14), height (p=0.48), T1 weight (p=0.63), and T1 body fat (p=0.67). This implied that there were no differences between dietary supplement groups.

Table 5

Group Demographics

Variable	Active Group (±SD)	Placebo Group (±SD)	p-value
Age (years)	52.6 (9.8)	56.8 (6.8)	0.14
Height (inches)	64.5 (2.9)	63.8 (2.5)	0.48
T1 Weight (kg)	89.7 (13.1)	87.3 (14.0)	0.63

(table continues)

Variable	Active Group (±SD)	Placebo Group (±SD)	p-value
T1 Body Fat (%)	45.9 (2.7)	46.4 (3.6)	0.67

Note: All data represented as means (±SD).

Dietary Inventories

Participants recorded all food and fluid intake on dietary record forms four days before each testing session for weeks 0, 10, 14. The dietary record included three days during the week and one weekend day prior to starting the study and prior to each testing session (weeks 0, 10, 14). Table 6 summaries the average total daily calories, proteins, carbohydrates, and fats for both dietary supplement groups. Statistical results revealed no significant differences in group, time or group x time interactions for total calories (p=0.83, p=0.19; p=0.23, respectively), proteins (p=0.65, p=0.14; p=0.73, respectively), carbohydrates (p=0.84, p=0.17; p=0.07, respectively), or fats (p=0.32, p=0.12; p=0.95, respectively) among the two dietary supplement groups. Based upon the data collected, we accept hypothesis H^3 stating that there will be no statistically significant differences between dietary supplement groups in dietary inventories among women following the Curves diet and fitness program.

General Health Variables- Resting Heart Rate & Blood Pressure

Statistical results in Table 7 revealed no significant time, or group x time interaction effects for resting heart rate (p=0.43; p=0.24; p=0.56, respectively), and systolic blood pressure (SBP) (p=0.43; p=0.25, respectively). There were no time effects

for diastolic blood pressure (DBP) (p=0.86, respectively) for dietary supplement groups. A negligible effect size (d=0.11) was present for the group value of DBP. However, statistical analysis revealed a medium effect size (d=0.69) for the SBP group x time interaction, which may indicate statistical significance with a larger sample size. There was a statistically significant group x time interaction for diastolic blood pressure (p=0.04). Statistical post hoc tests indicate that the DBP significant interaction effect is due to the Curves fitness and diet program.

Based on the data collected, we reject hypothesis H^{10} stating there will be time effects with no significant interactions between dietary supplement groups in heart rate, and blood pressure among women following the Curves diet and fitness program.

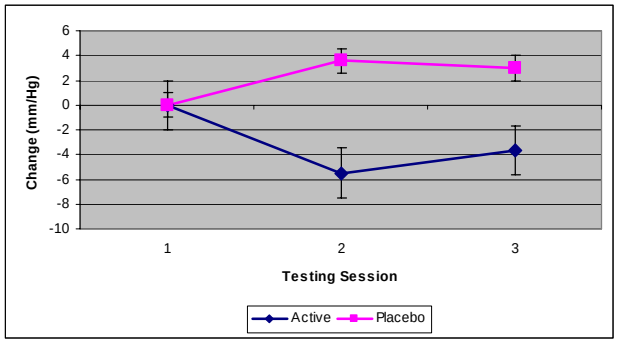

Figure 1. Changes in diastolic blood pressure (mmHg) over the course of the study. A statistically significant group x time interaction (p=0.04) was present.

Body Composition Assessments- Resting Energy Expenditure Assessment

Table 8 displayed the statistical variables for resting energy expenditure. There were no statistically significant time or interaction effects for VO_2 (L/min) (p=0.80; p=0.47, respectively), VO_2 (ml/kg/min) (p=0.98; p=0.50, respectively), kcal/kg/min (p=0.89; p=0.84) and kcal/day (p=0.33; p=0.87, respectively) for the dietary supplement groups. Raw data mean time differences for the active group indicate a higher

kcal/kg/min at 1.05±0.21 compared to the placebo group of 0.98±0.15. In addition, raw data mean differences for the active group indicate a higher kcal/day at 1490±298 compared to the placebo group of 1395±193, even though there were no significant time or group x time interaction effects.

Table 6

Dietary Inventories

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Calories (kcal/d)	T1	2046.5 (609.8)	1740.7 (593.5)	-	-	-
	T3	1623.4 (527.7)	1651.2 (372.2)	-	-	-
	T4	1690.3 (390.4)	1856.8 (520.9)	0.83	0.19	0.23
Proteins (g/d)	T1	82.9 (15.9)	72.2 (20.9)	-	-	-
	T3	91.9 (28.1)	93.9 (44.4)	-	-	-
	T4	79.6 (16.5)	78.2 (18.9)	0.65	0.14	0.73
Carbohydrates (g/kg/d)	T1	257.9 (111.3)	197.1 (70.7)	-	-	-
	T3	170.6 (87.4)	195.9 (84.1)	-	-	-
	T4	194.5 (67.4)	247.2 (100.6)	0.84	0.17	0.07
Fats (g/kg/d)	T1	78.5 (20.9)	68.4 (34.9)	-	-	-
	T3	63.3 (23.4)	56.9 (15.1)	-	-	-
	T4	68.9 (21.1)	62.1 (15.8)	0.32	0.12	0.95

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Table 7

Resting Heart Rate and Blood Pressure

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Resting HR (bpm)	T1	75 (12)	71 (9)	-	-	-
	T3	70 (7)	71 (8)	-	-	-
	T4	71 (7)	68 (15)	0.43	0.24	0.56
SBP (mm/HG)	T1	126 (17)	128 (17)	-	-	-
	T3	117 (13)	130 (20)	-	-	-
	T4	123 (12)	132 (16)	0.07	0.43	0.25
DBP (mm/HG)	T1	82 (7)	76 (8)	-	-	-
	T3	77 (8)	80 (6)	-	-	-
	T4	78 (11)	79 (7)	0.82	0.86	0.04*

Note: Data represents hormonal variables for the study. All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Body Composition

Table 9 represents body compositions for the study. Figure 2 displays changes in weight (kg) over the course of the study. A statistically significant time effect for weight (p=0.00) was present. Figure 3 reflects changes in fat mass (gm) over the course of the study. A statistically significant time effect for fat mass (p=0.00) was present. Figure 4 displays changes in body fat (%) over the course of the study. A statistically significant time effect for body fat (p=0.00) was present. There were statistically significant time effects for weight (p=0.00). Raw data mean differences in the active and placebo group

for weight (kg) were 87.7±13.8 and 85.1±13.5, respectively. Changes over time in weight (kg) for the active group were -2.02±2.8 versus -2.27±3.14 for the placebo group. This indicates that all participants significantly reduced body weight throughout the course of the study. There were statistically significant time effects for fat mass (p=0.00), and fat percentage (p=0.00). Raw data mean differences in the active and placebo group for fat mass were 35,825±6,879 gm and 35,913±7,786 gm, respectively.

Table 8

Resting Energy Expenditure

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
VO_2 (L/min)	T1	0.22 (0.04)	0.20 (0.03)	-	-	-
	T4	0.22 (0.04)	0.20 (0.03)	0.18	0.80	0.47
VO_2 (ml/kg/min)	T1	2.48 (0.37)	2.39 (0.30)	-	-	-
	T4	2.52 (0.39)	2.36 (0.17)	0.25	0.98	0.50
Kcal/kg/min	T1	1.03 (0.15)	0.98 (0.14)	-	-	-
	T4	1.05 (0.21)	0.98 (0.15)	0.27	0.89	0.84
Kcal/day	T1	1,531 (276)	1,424 (214)	-	-	-
	T4	1,490 (298)	1,395 (193)	0.26	0.33	0.87

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Raw data mean differences in the active and placebo group for body fat were 43.9±3.0 % and 45.1±3.5 %. Changes over time in fat mass for the active group were -2,498±2,302 gm versus -1,988±2,643 gm for the placebo group. Changes over time in body fat for the

active group were -1.98±1.61% versus -1.25±2.13% for the placebo group. These results implied the participants decreased fat mass and body fat due to the Curves fitness and diet program. As a result, there was a training effect for both the active and placebo groups for lost fat mass and body fat. Fat free mass was maintained among both groups, which generally decreases during weight loss. Statistical analysis revealed a small effect size (d=0.37) for lean body mass group x time interaction. There were no significant time or interaction effects for lean body mass (p=0.26; p=0.35, respectively) or fat free mass (FFM) (p=0.30; p=0.45, respectively). There were no statistically significant interactions for fat mass (p=0.73), fat percentage (p=0.44), and weight (p=0.94). Therefore, based on the data collected, we accept hypothesis H^1 stating there will be statistically significant reductions in body weight and body fat in both dietary supplement groups and hypothesis H^{10} stating there will be statistically significant reductions in fat mass and statistically significant time effects with no significant interactions between dietary supplement groups in body composition.

Table 9

Body Composition

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Lean Body Mass (gm)	T1	43,343 (6,913)	41,640 (6,034)	-	-	-
	T3	43,329 (6,659)	41,085 (5,964)	-	-	-
	T4	43,851 (7,516)	41,409 (5,681)	0.38	0.26	0.35
Fat Free Mass (gm)	T1	45,151 (7,059)	43,362 (6,364)	-	-	-
	T3	45,144 (6,804)	42,874 (6,217)	-	-	-

(table continues)

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
	T4	45,643 (7,608)	43,204 (5,932)	0.38	0.30	0.45
Fat Mass (gm)	T1	38,323 (6,257)	37,900 (7,798)	-	-	-
	T3	36,335 (7,193)	36,482 (8,119)	-	-	-
	T4	35,825 (6,879)	35,913 (7, 786)	0.98	0.00*	0.73
Body Fat %	T1	45.6 (2.7)	46.4 (3.6)	-	-	-
	T3	44.4 (2.8)	45.7 (3.6)	-	-	-
	T4	43.9 (3.0)	45.1 (3.5)	0.38	0.00*	0.44
Weight (kg)	T1	89.7 (13.1)	87.3 (13.9)	-	-	-
	T3	87.7 (13.9)	85.3 (13.9)	-	-	-
	T4	87.7 (13.8)	85.1 (13.5)	0.63	0.00*	0.94

Note: Data represents body composition and bone mineral content variables for the study. All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

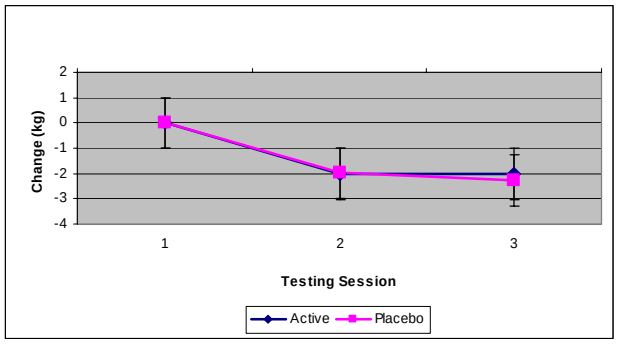

Figure 2. Changes in weight (kg) over the course of the study. A statistically significant time effect for weight (p=0.00) was present.

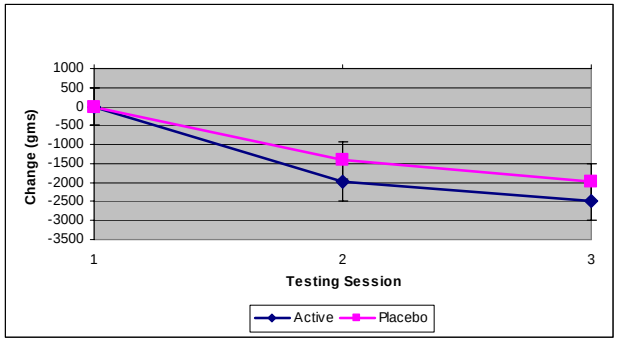

Figure 3. Changes in fat mass (gm) over the course of the study. A statistically significant time effect for fat mass (p=0.00) was present.

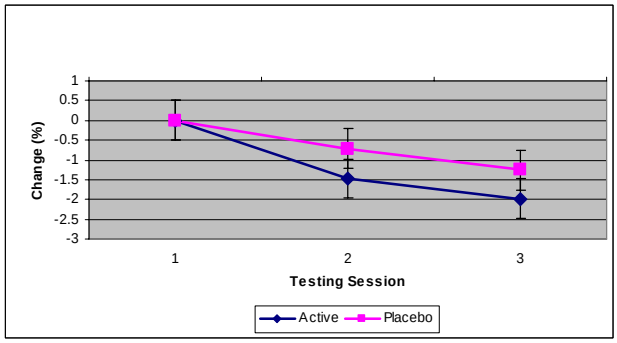

Figure 4. Changes in body fat (%) over the course of the study. A statistically significant time effect for body fat (p=0.00) was present.

Anthropometric Procedures

Statistical results in Table 10 revealed a significant time effect for the left knee circumference (p=0.05). Figure 5 displays changes in left knee circumference (cm) over the course of the study. A statistically significant time effect for the left knee circumference (p=0.05) was present. There were no statistically significant differences between groups (p=0.50) for left knee circumference. Changes for the time effects over the course of the study were 0.60±5.6 cm for the active group versus 1.37±5.1 cm for the placebo group. This implied that increases in the left knee circumference occurred over time due to women participating in the Curves fitness and diet program and could have

been caused by measurement error, but further research is needed. Thus, based on the collected data, we accept hypothesis H^8 stating there will be statistically significant differences between groups and time changes in knee circumference among women consuming the dietary supplement treatment. There were no statistically significant time or group x time interaction effects for the right knee circumference (p=0.36; p=0.91, respectively) and no statistically significant interaction effects for the left knee circumference (p=0.22) for the dietary supplement groups.

Table 10

Knee Circumferences

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Right Knee Circumference (cm)	T1	38.6 (5.4)	36.0 (1.9)	-	-	-
	T3	37.1 (3.1)	36.1 (2.3)	-	-	-
	T4	38.2 (5.7)	37.4 (5.0)	0.25	0.36	0.91
Left Knee Circumference (cm)	T1	37.0 (4.3)	36.0 (2.3)	-	-	-
	T3	37.1 (3.2)	36.0 (2.9)	-	-	-
	T4	38.3 (5.1)	38.8 (5.2)	0.50	0.05*	0.22

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

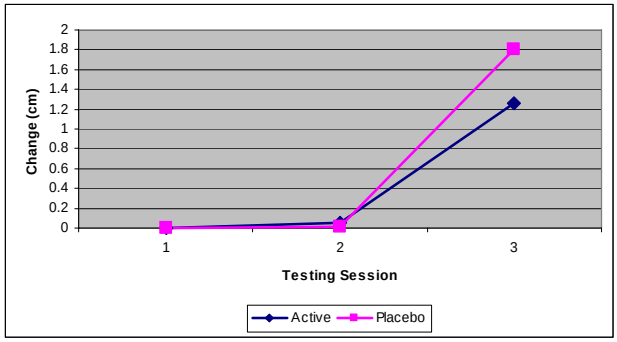

Figure 5. Changes in left knee circumference (cm) over the course of the study. A statistically significant time effect for the left knee circumference (p=0.05) was present.

Performance Variables- Cardiopulmonary Exercise Tests

Table 11 displayed statistical data for cardiopulmonary exercise capacity. Figure 6 displays changes in max systolic blood pressure (mmHg) over the course of the study. A statistically significant group x time interaction (p=0.03) for max systolic blood pressure was present. The data revealed statistically significant time effects for VO_2 (ml/kg/min) (p=0.01), and maximal ventilatory expiration (L/min) (p=0.00). A statistically significant interaction existed for maximal systolic blood pressure (p=0.03). Statistical post hoc tests for the maximal systolic blood pressure significant interaction revealed that the significance is due to the Curves fitness and diet program. The results indicated the women increased their relative oxygen consumption and maximal minute ventilation due to participating in the Curves fitness and diet program. Raw data mean time differences in VO_2 (ml/kg/min) for the active and placebo groups are as follows: 21.2±3.2; 18.8±4.9, respectively. This implied the active group had higher relative oxygen consumptions than the placebo group overall. The participants also decreased their maximal systolic blood pressure due to participating in the Curves fitness and diet program and taking the treatment. Raw data mean differences for significant interaction

effects in max systolic blood pressure were as follows for the active and placebo groups: 154±25; 172±28. Maximal systolic blood pressure changes over time for the active group were -13±28 mmHg and 9±26 mmHg for the placebo group further implying that a trend exists in the active group for maximal systolic blood pressure.

Isotonic Bench Press

Table 12 displayed statistical data for isotonic bench press. There were statistically significant time effects for 1 repetition maximum (p=0.00), 70% of 1 repetition maximum (p=0.00), and total work (p=0.05). There was also a statistically significant group effect for 70% of 1 repetition maximum (p=0.01) and total work (p=0.01). Based on the data collected, we accept hypothesis H^2 stating there will be statistically significant improvements in muscular strength and muscular endurance in both dietary supplement groups. This indicated the women improved their muscular strength and muscular endurance over the course of the study due to the Curves fitness and diet program. In addition, the participants increased their total work (70% of 1 repetition maximum x reps) over the course of the study. Changes in 1 repetition maximum over time were 3.9±3.5 kg for the active group and 2.9±4.1 kg for the placebo. Changes in 70% of 1 repetition maximum over time were 2.9±2.8 kg for the active group and 2.9±3.1 kg for the placebo group. Group changes in total work were 37.8±100.5 for the active group and 15.4±83.3 for the placebo group. Statistical analysis indicated medium effect sizes (d=0.53; d=0.72) for group 1 repetition maximum and total work, respectively. This indicated the potential for possible significance with a larger sample size. There were no statistically significant interactions for the dietary supplement groups (p=0.96).

Table 11

Cardiopulmonary

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
VO_2 (L/min)	T1	1.8 (0.3)	1.5 (0.3)	-	-	-
	T3	1.8 (0.4)	1.5 (0.3)	-	-	-
	T4	1.9 (0.4)	1.5 (0.3)	0.03*	0.11	0.42
VO_2 (ml/kg/min)	T1	19.6 (3.3)	18.1 (4.6)	-	-	-
	T3	20.4 (4.0)	18.6 (4.7)	-	-	-
	T4	21.2 (3.2)	18.8 (4.9)	0.19	0.01*	0.49
Max Mets	T1	5.6 (0.92)	5.2 (1.3)	-	-	-
	T3	5.8 (1.2)	6.2 (3.3)	-	-	-
	T4	6.1 (0.9)	6.1 (2.6)	0.98	0.08	0.46
Max VE (L/min)	T1	44.1 (13.4)	36.9 (12.3)	-	-	-
	T3	48.6 (15.8)	38.7 (12.5)	-	-	-
	T4	53.3 (13.3)	42.0 (13.8)	0.06	0.00*	0.33
Peak Heart Rate (bpm)	T1	157 (20)	146 (22)	-	-	-
	T3	156 (18)	143 (17)	-	-	-
	T4	154 (20)	148 (18)	0.15	0.67	0.23
Max Systolic Blood Pressure (mm Hg)	T1	166 (30)	163 (21)	-	-	-
	T3	165 (29)	160 (28)	-	-	-
	T4	154 (25)	172 (28)	0.69	0.87	0.03*
Max Diastolic Blood Pressure	T1	75 (8)	81 (9)	-	-	-

(table continues)

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
(mm Hg)						
	T3	77 (8)	78 (15)	-	-	-
	T4	75 (10)	74 (13)	0.47	0.37	0.34

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

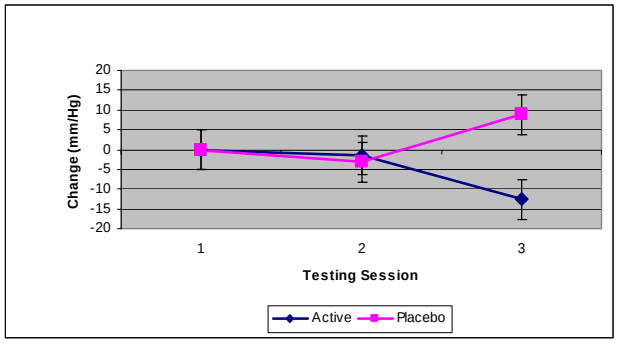

Figure 6. Changes in max systolic blood pressure (mmHg) over the course of the study. A statistically significant group x time interaction (p=0.03) for max systolic blood pressure.

Range of Motion

Statistical results from Table 13 revealed significant time effects for left knee flexion (p=0.00). Figure 7 displays changes in range of motion left knee flexion (cm) over the course of the study. A statistically significant time effect for the left knee flexion (p=0.00) was present. Changes over time for left knee flexion for the active group were 3.7±7.3 cm and 7.7±7.8 cm. This implied the participants had increases in flexing their left knee due to the exercise and diet program. Thus, based on the data collected, we partially accept hypothesis H^7 stating there will be statistically significant differences between groups and time changes in knee flexion among women participating in the Curves fitness and diet program. There were no statistically significant group

effects for right knee extension (p=0.13), right knee flexion (p=0.09), and left knee flexion (p=0.15). There were no statistically significant time effects for left knee extension (p=0.08).

Table 12

Isotonic Bench Press

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
1 RM (kg)	T1	28.5 (5.6)	26.3 (5.8)	-	-	-
	T3	31.8 (7.3)	28.4 (4.9)	-	-	-
	T4	32.5 (7.1)	29.2 (5.5)	0.17	0.00*	0.58
70% of 1 RM (kg)	T1	20.0 (3.9)	18.5 (4.4)	-	-	-
	T3	22.6 (5.1)	20.9 (3.7)	-	-	-
	T4	23.0 (5.2)	21.4 (4.8)	0.32	0.00*	0.99
70% of 1 RM Repetitions	T1	11.3 (1.9)	9.1 (2.7)	-	-	-
	T3	12.7 (3.9)	8.3 (3.1)	-	-	-
	T4	11.6 (4.2)	8.8 (4.9)	0.01*	0.89	0.30
Total Work (kg)	T1	226.1 (58.9)	166.8 (72.9)	-	-	-
	T3	285.9 (121.6)	175.2 (86.8)	-	-	-
	T4	263.9 (114.9)	182.2 (114.1)	0.01*	0.05*	0.22

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Statistical analysis indicated a medium effect size for left knee flexion (d=0.53), which implied this could lead to be significant with a larger sample size. Statistical analysis

indicated a small effect size (d=0.20) for right knee extension and negligible effect size (d=0.01) for left knee flexion. There was a statistically significant group x time interaction effect for right knee flexion (p=0.05). Statistical post hoc tests for the right knee flexion significant interaction revealed that the significance is due to the Curves fitness and diet program. There were no statistically significant interaction effects for right knee extension (p=0.49), left knee extension (p=0.83), and left knee flexion (p=0.20). Statistical analysis revealed a negligible group x time interaction effect (d=0.06) for right knee extension and a large group effect (d=1.0) for right knee flexion, indicating possible significance with a larger sample size.

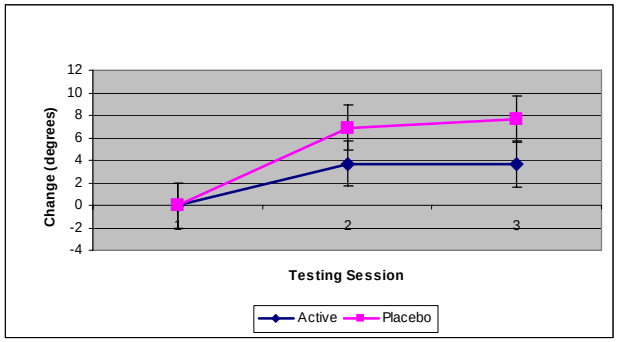

Figure 7. Changes in range of motion left knee flexion (cm) over the course of the study. A statistically significant time effect for the left knee flexion (p=0.00) was present.

Table 13

Range of Motion

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Right Knee Extension (º)	T1	3.5 (2.7)	2.5 (2.4)	-	-	-
	T3	5.1 (3.2)	3.1 (2.3)	-	-	-
	T4	4.3 (2.6)	3.7 (3.6)	0.13	0.13	0.49

(table continues)

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Left Knee Extension (º)	T1	2.8 (2.3)	3.2 (1.8)	-	-	-
	T3	4.5 (3.8)	4.1 (2.5)	-	-	-
	T4	4.1 (3.5)	4.1 (2.9)	0.99	0.08	0.83
Right Knee Flexion (º)	T1	123.7 (6.4)	124.1 (8.6)	-	-	-
	T3	124.0 (6.1)	127.1 (6.5)	-	-	-
	T4	121.9 (6.6)	128.9 (6.6)	0.09	0.39	0.05*
Left Knee Flexion (º)	T1	121.2 (8.0)	121.1 (7.6)	-	-	-
	T3	124.6 (5.2)	127.9 (6.9)	-	-	-
	T4	124.8 (6.6)	128.8 (8.8)	0.15	0.00*	0.20

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Equi-Test Procedures

Measurements of knee function were collected to measure knee function, balance and mobility. Data were collected on postural balance and mobility utilizing the following tests in order:

Sit to Stand (STS)

The STS test quantified the patient's ability to rise from a seated to a standing position. Table 14 showed that there were no statistically significant time or interactions effects for weight transfer (p=0.84; p=0.10, respectively), rising index (p=0.08, p=0.29, respectively), or sway velocity (p=0.84; p=0.10, respectively). Statistical analysis indicated a small effect size for the sit-to-stand rising index (d=0.30)

and a negligible effect size for the sit-to-stand sway velocity (d=0.03). This implied there were no statistically significant differences in the sit-to-stand balance tests for women participating in the Curves fitness and diet program and taking the treatment.

Forward Step Up and Over (SUO)

Table 15 revealed statistical data for the step up and over knee function test. Statistically significant time effects were observed for the lift up index on the right and left leg (p=0.02; p=0.01, respectively), movement time on the right and left leg (p=0.00; p=0.00, respectively), and impact index on the right leg (p=0.03). Raw data mean time differences in the lift up index on the right leg were 44.5±8.6% and left leg 38.4±7.5% for the active group. Raw data mean time differences in the lift up index on the right leg were 44.4±9.0% and left leg 39.4±6.9% for the placebo group. Changes over time in mean lift up index on the right leg were 4.2±6.6 % and left leg 2.6±7.0 % for the active group. Changes over time in mean lift up index on the right leg were 5.2±7.1 % and 2.5±4.8 % left leg for the placebo group. Raw mean data time differences in movement time on the right leg were 1.5±0.2 % and 1.5±0.2 % left leg for the active group. Raw mean data differences in movement time on the right leg were 1.5±0.1 and left leg 1.5±0.4 for the placebo group. Changes over time in mean movement time on the right leg were -0.34±0.20 sec and left leg -0.36±0.20 sec for the active group. Changes over time in mean movement time on the right leg were -0.19±0.26 sec and left leg -0.22±0.48 sec for the placebo group. Raw mean data differences in impact index on the right leg were 47.9±11.1 for the active group and 48.6±11.1 for the placebo group. Changes over time in mean impact index on the right leg were 0.94±10.46 sec for the active group and -1.9±7.3 sec for the placebo group.

Table 14

Sit-to-Stand Knee Function

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Weight Transfer (sec)	T1	0.4 (0.2)	0.4 (0.1)	-	-	-
	T3	0.4 (0.2)	0.3 (0.1)	-	-	-
	T4	0.4 (0.2)	0.4 (0.3)	0.71	0.84	0.77
Rising Index (% Body Weight)	T1	17.2 (4.4)	16.0 (4.4)	-	-	-
	T3	18.9 (5.2)	18.3 (6.6)	-	-	-
	T4	17.4 (5.7)	19.1 (5.7)	0.99	0.08	0.29
Sway Velocity (deg/sec)	T1	4.4 (1.4)	4.9 (1.1)	-	-	-
	T3	4.5 (1.1)	4.6 (1.1)	-	-	-
	T4	4.6 (1.4)	4.6 (1.0)	0.59	0.84	0.10

Note: All data represented as means (±SD). Significant time and/or group x time interactions are depicted with an asterisk.

The results implied that women participating in the Curves fitness and diet program had decreases in both legs with the amount of force that was applied concentrically to lift themselves up and over the box. The women also experienced decreases in their movement time to step-up-and-over the box. Movement time was influenced by losing weight, gaining strength, and improving balance. There were no statistically significant time effects for impact index on the left leg (p=0.40). There were no statistically

significant interaction effects for lift up index on the right and left leg (p=0.16; p=0.31, respectively), movement time (p=0.26; p=0.26, respectively), and impact index (p=0.31; p=0.38, respectively).

Forward Lunge (FL)

On a stationary forceplate, the participant performed 3 lunges on each leg. Table 16 displayed the statistical analysis for the forward lunge knee function. There were statistically significant time effects for distance on the right and left leg (p=0.00; p=0.00, respectively), impact index on the right and left leg (p=0.00; p=0.00), contact time on the right and left leg (p=0.00; p=0.00, respectively), and force impulse on the right and left leg (p=0.00; p=0.00, respectively). Changes over time for the forward lunge distance were 2.9±4.5 % on the right leg and 3.6±4.9 % on the left leg for the active group. Changes over time for the forward lunge distance were 3.6±3.9 % on the right leg and 3.8±4.5 % on the left leg for the placebo group. Changes over time for the impact index were -0.62±4.4 % on the right leg and 1.2±3.9 % on the left leg for the active group. Changes over time for the impact index were 1.0±5.6 % on the right leg and 2.2±7.7 % on the left leg for the placebo group. Changes over time for contact time were -0.29±0.33 sec on the right leg and and -0.33±0.31 sec on the left leg for the active group. Changes over time for contact time were -0.32±0.33 sec on the right leg and and -0.33±0.63 sec on the left leg for the placebo group. Changes over time for force impulse were -26.6±36.9 % on the right leg and 1.2±3.9 % on the left leg for the active group. Changes over time for force impulse were -30.4±33.1 % on the right leg and 2.2±7.7 % for the placebo group. The data indicated that women participating in the Curves fitness and diet program were better able to step further with each leg when performing a

forward lunge. An assumption existed that the joint may be improving to allow for this to occur, but further research would be needed. In addition, the women participating in the Curves fitness and diet program had decreased contact times when performing a forward lunge, which indicates the amount of foot contact before returning to the starting position was less due to losing weight, gaining strength, and improving balance.

Table 15

Step Up and Over Knee Function

Variable	Side/Trial	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Lift-Up Index (% Body Weight)	Right	T1	40.8 (9.2)	41.7 (9.4)	-	-	-
	Right	T3	45.1 (9.9)	41.9 (9.5)	-	-	-
	Right	T4	44.5 (8.6)	44.4 (9.0)	0.80	0.01*	0.16
	Left	T1	32.7 (8.8)	37.0 (7.8)	-	-	-
	Left	T3	35.9 (9.1)	38.9 (6.8)	-	-	-
	Left	T4	38.4 (7.5)	39.4 (6.9)	0.29	0.00*	0.31
Movement Time (sec)	Right	T1	1.8 (0.3)	1.7 (0.2)	-	-	-
	Right	T3	1.6 (0.2)	1.5 (0.3)	-	-	-
	Right	T4	1.5 (0.2)	1.5 (0.1)	0.42	0.00*	0.26
	Left	T1	1.8 (0.3)	1.7 (0.3)	-	-	-
	Left	T3	1.5 (0.3)	1.6 (0.6)	-	-	-
	Left	T4	1.5 (0.2)	1.5 (0.4)	0.73	0.00*	0.26
Impact Index (% Body Weight)	Right	T1	47.0 (8.5)	50.6 (13.9)	-	-	-

(table continues)

Right	T3	46.9 (11.5)	50.0 (13.1)	-	-	-
Right	T4	47.9 (11.1)	48.6 (11.1)	0.51	0.03*	0.31
Left	T1	52.1 (9.5)	52.2 (12.1)	-	-	-
Left	T3	50.7 (8.9)	54.3 (17.6)	-	-	-
Left	T4	51.8 (12.5)	57.6 (16.3)	0.45	0.40	0.38

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Lastly, the women participating in the Curves fitness and diet program had decreases in their force impulse while performing a forward lunge. This was the percentage of body weight per second, which was the impact distance with contact time. It was assumed that since the women lost weight and their joints improved, the force impulse also improved. However, further research is needed. There were no statistically significant interactions for either leg for the following variables: distance (p=0.53; p=0.53), impact index (p=0.92; p=0.91, respectively), contact time (p=0.98; p=0.96, respectively), and force impulse (p=0.87; p=0.87, respectively).

Isokinetic Procedures

Table 17 displayed isokinetic knee strength 60 degrees/sec. Statistics revealed significant time effects for the following variables: left leg peak torque extension (p=0.00), right leg peak torque flexion (p=0.00), left leg peak torque flexion (p=0.00), left leg peak torque/body weight extension (p=0.01), right leg peak torque/body weight flexion (p=0.00), left leg peak torque/body weight flexion (p=0.00), right leg work fatigue flexion (p=0.02).

Table 16

Forward Lunge Knee Function

Variable	Side/Trial	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Distance (% Body Height)	Right	T1	43.1 (7.2)	43.9 (6.8)	-	-	-
	Right	T3	45.9 (7.3)	45.7 (6.8)	-	-	-
	Right	T4	45.9 (7.6)	47.6 (5.2)	0.75	0.00*	0.53
	Left	T1	42.5 (6.1)	42.5 (4.7)	-	-	-
	Left	T3	45.9 (7.1)	45.5 (6.8)	-	-	-
	Left	T4	46.1 (7.1)	46.3 (6.2)	0.96	0.00*	0.53
Impact Index (% Body Weight)	Right	T1	18.5 (4.4)	18.5 (6.3)	-	-	-
	Right	T3	18.8 (4.2)	19.3 (9.8)	-	-	-
	Right	T4	17.8 (5.1)	19.6 (4.8)	0.52	0.00*	0.92
	Left	T1	13.7 (3.8)	14.5 (6.8)	-	-	-
	Left	T3	16.0 (4.7)	16.9 (9.7)	-	-	-
	Left	T4	14.9 (4.4)	16.6 (6.7)	0.75	0.00*	0.91
Contact Time (sec)	Right	T1	1.6 (0.5)	1.7 (0.6)	-	-	-
	Right	T3	1.3 (0.3)	1.4 (0.3)	-	-	-
	Right	T4	1.3 (0.4)	1.4 (0.4)	0.74	0.00*	0.98
	Left	T1	1.6 (0.5)	1.7 (0.9)	-	-	-
	Left	T3	1.3 (0.3)	1.4 (0.4)	-	-	-
	Left	T4	1.2 (0.3)	1.4 (0.5)	0.46	0.00*	0.96
Force Impulse (% Body Weight-	Right	T1	165.2 (52.9)	173.2 (54.2)	-	-	-

(table continues)

Variable	Side/Trial	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
sec)							
	Right	T3	133.5 (31.2)	144.4 (41.5)	-	-	-
	Right	T4	138.6 (36.8)	142.8 (40.4)	0.58	0.00*	0.87
	Left	T1	156.2 (42.2)	169.6 (85.6)	-	-	-
	Left	T3	132.3 (30.4)	140.6 (37.0)	-	-	-
	Left	T4	126.5 (28.5)	139.2 (46.1)	0.61	0.00*	0.95

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Thus, based on the data collected, we partially accept hypothesis H^9 indicating there will be statistically significant differences between groups and time changes in knee function and strength among women consuming the dietary supplement treatment. Although there were no statistically significant differences between groups, there were time differences. These results implied the women were able to increase their peak torque knee strength, similar to performing a 1 repetition maximum, peak torque/body weight, and work fatigue, similar to muscular endurance test over the course of the study for the above specified legs when performed at a slower speed of 60 degrees/second. It is assumed that there will be less work fatigue as muscular strength and endurance improves. It is also assumed that the knees were stronger, because the women were participating in an exercise and diet program and so they are working harder. This implied that knee strength and work fatigue improved. However, further research is needed. There were no statistically significant interaction effects for the dietary supplement groups.

Table 18 displayed statistical data for isokinetic knee strength 180 degrees/sec. There were statistically significant time effects for the following variables: right peak

torque extension (p=0.04), left peak torque extension (p=0.00), right peak torque flexion (p=0.00), left peak torque flexion (p=0.00), right peak torque/body weight extension (p=0.02), left peak torque/body weight extension (p=0.00), right peak torque/body weight flexion (p=0.00), left peak torque/body weight flexion (p=0.00), left work fatigue extension (p=0.04).

Thus, as discussed above and based on the data collected, we partially accept hypothesis H^9 indicating there will be statistically significant differences between groups and time changes in knee function and strength among women consuming the dietary supplement treatment. Although there were no statistically significant differences between groups, there were time differences. These results implied the women were able

Table 17

Isokinetic Knee Strength 60 Deg/Sec

Variable	Side/Trial	ROM	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Peak Torque (Ft-lbs)	Right	Extension	T1	74.7 (16.6)	71.0 (13.4)	-	-	-
	Right	Extension	T3	80.1 (20.8)	72.5 (16.5)	-	-	-
	Right	Extension	T4	82.8 (21.0)	74.4 (19.6)	0.28	0.09	0.62
	Left	Extension	T1	70.0 (16.4)	63.5 (15.2)	-	-	-
	Left	Extension	T3	80.1 (20.9)	70.2 (18.9)	-	-	-
	Left	Extension	T4	78.3 (22.0)	73.9 (21.9)	0.27	0.00*	0.59
	Right	Flexion	T1	36.0 (11.0)	32.5 (12.3)	-	-	-
	Right	Flexion	T3	42.6 (13.4)	383.7 (9.9)	-	-	-
	Right	Flexion	T4	45.5 (13.3)	42.7 (17.9)	0.42	0.00*	0.97

(table continues)

Variable	Side/Trial	ROM	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
	Left	Flexion	T1	32.7 (14.6)	32.9 (9.2)	-	-	-
	Left	Flexion	T3	43.1 (14.5)	37.2 (9.9)	-	-	-
	Left	Flexion	T4	40.4 (12.9)	42.6 (16.1)	0.77	0.00*	0.20
Peak Torque/Body Weight (%)	Right	Extension	T1	38.4 (8.9)	36.5 (9.5)	-	-	-
	Right	Extension	T3	41.4 (9.8)	38.8 (12.0)	-	-	-
	Right	Extension	T4	43.3 (10.2)	37.6 (14.5)	0.33	0.21	0.53
	Left	Extension	T1	36.4 (8.6)	32.8 (10.5)	-	-	-
	Left	Extension	T3	41.4 (10.9)	37.1 (10.9)	-	-	-
	Left	Extension	T4	40.9 (10.7)	37.7 (15.3)	0.31	0.01*	0.96
	Right	Flexion	T1	18.3 (5.1)	18.3 (9.5)	-	-	-
	Right	Flexion	T3	22.0 (6.2)	26.4 (8.9)	-	-	-
	Right	Flexion	T4	23.8 (6.5)	23.4 (13.7)	0.99	0.00*	0.98
	Left	Flexion	T1	16.7 (7.3)	18.7 (8.2)	-	-	-
	Left	Flexion	T3	21.9 (6.8)	21.5 (8.4)	-	-	-
	Left	Flexion	T4	20.9 (5.8)	23.8 (23.6)	0.61	0.00*	0.48
Work Fatigue (%)	Right	Extension	T1	-4.9 (64.8)	4.0 (25.8)	-	-	-
	Right	Extension	T3	7.1 (20.9)	12.1 (15.2)	-	-	-
	Right	Extension	T4	7.4 (28.1)	10.2 (20.6)	0.44	0.47	0.94
	Left	Extension	T1	3.3 (22.2)	3.7 (37.3)	-	-	-
	Left	Extension	T3	13.5 (14.0)	8.4 (24.3)	-	-	-
	Left	Extension	T4	9.2 (17.9)	13.1 (18.3)	0.96	0.31	0.72
	Right	Flexion	T1	-26.1 (87.4)	11.0 (45.4)	-	-	-
	Right	Flexion	T3	12.2	22.1	-	-	-

(table continues)

Variable	Side/Trial	ROM	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
				(37.5)	(11.4)			
	Right	Flexion	T4	22.5	28.9	0.08	0.02*	0.35
				(10.7)	(15.7)			
	Left	Flexion	T1	7.5	18.4	-	-	-
				(38.8)	(12.6)			
	Left	Flexion	T3	22.9	15.4	-	-	-
				(12.9)	(14.4)			
	Left	Flexion	T4	21.7	25.4	0.61	0.14	0.23
				(10.6)	(8.9)			

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

to increase their peak torque knee strength, similar to performing a 1 repetition maximum, peak torque/body weight, and work fatigue, similar to muscular endurance test over the course of the study for the above specified legs when performed at a faster speed of 180 degrees/second. It is assumed that there will be less work fatigue as muscular strength and endurance improves. It is also assumed that the knees were stronger, because the women were participating in an exercise and diet program and so they worked harder. This implied that knee strength and work fatigue improved. However, further research is needed. There were no statistically significant interaction effects for the dietary supplement groups.

Statistical results revealed in Table 19 that isokinetic knee strength 300 degrees/sec for the following time effect variables were significant: left peak torque extension (p=0.04), right peak torque flexion (p=0.00), left peak torque flexion (p=0.00), right peak torque/body weight extension (p=0.04), left peak torque/body weight extension (p=0.00), right peak torque/body weight flexion (p=0.00), and left peak torque/body weight flexion (p=0.00). Thus, as discussed above and based on the data collected, we partially accept hypothesis H^9 indicating there will be statistically significant differences

between groups and time changes in knee function and strength among women consuming the dietary supplement treatment. Although there were no statistically significant differences between groups, there were time differences. These results implied the women were able to increase their peak torque knee strength, similar to performing a 1 repetition maximum, peak torque/body weight, and work fatigue, similar to muscular endurance test over the course of the study for the above specified legs when performed at a faster speed of 300 degrees/second.

Table 18

Isokinetic Knee Strength 180 Deg/Sec

Variable	Side/Trial	ROM	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Peak Torque (Ft-lbs)	Right	Extension	T1	47.4 (18.9)	39.2 (13.1)	-	-	-
	Right	Extension	T3	53.4 (16.0)	40.9 (18.1)	-	-	-
	Right	Extension	T4	56.2 (18.2)	43.5 (15.6)	0.05*	0.04*	0.81
	Left	Extension	T1	47.3 (22.3)	34.5 (16.7)	-	-	-
	Left	Extension	T3	53.6 (20.3)	39.9 (18.3)	-	-	-
	Left	Extension	T4	54.4 (16.7)	46.1 (17.4)	0.08	0.00*	0.46
	Right	Flexion	T1	23.9 (12.0)	16.9 (7.9)	-	-	-
	Right	Flexion	T3	30.4 (14.8)	23.8 (10.2)	-	-	-
	Right	Flexion	T4	31.9 (13.4)	27.1 (14.5)	0.14	0.00*	0.81
	Left	Flexion	T1	21.4 (13.8)	17.9 (11.7)	-	-	-
	Left	Flexion	T3	27.7 (13.5)	23.5 (9.3)	-	-	-
	Left	Flexion	T4	29.9 (10.7)	27.4 (14.7)	0.42	0.00*	0.89
Peak	Right	Extension	T1	24.9	22.6	-	-	-

(table continues)

Variable	Side/Trial	ROM	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Torque/Body Weight (%)				(7.9)	(6.5)			
	Right	Extension	T3	27.4 (7.0)	25.6 (7.3)	-	-	-
	Right	Extension	T4	28.4 (8.7)	26.5 (7.5)	0.41	0.00*	0.96
	Left	Extension	T1	23.9 (9.9)	20.3 (7.1)	-	-	-
	Left	Extension	T3	27.5 (8.8)	24.7 (7.9)	-	-	-
	Left	Extension	T4	27.5 (7.3)	27.4 (7.4)	0.43	0.00*	0.24
	Right	Flexion	T1	12.4 (6.0)	9.5 (4.5)	-	-	-
	Right	Flexion	T3	15.7 (6.9)	13.4 (5.0)	-	-	-
	Right	Flexion	T4	16.7 (6.7)	14.4 (8.2)	0.24	0.00*	0.95
	Left	Flexion	T1	11.0 (6.9)	9.8 (6.7)	-	-	-
	Left	Flexion	T3	14.3 (6.4)	13.4 (4.9)	-	-	-
	Left	Flexion	T4	15.5 (5.2)	14.9 (8.3)	0.67	0.00*	0.96
Work Fatigue (%)	Right	Extension	T1	2.7 (30.9)	-7.2 (34.8)	-	-	-
	Right	Extension	T3	12.3 (13.9)	-34.9 (92.4)	-	-	-
	Right	Extension	T4	14.0 (14.2)	4.4 (34.5)	0.03*	0.19	0.16
	Left	Extension	T1	-3.7 (21.9)	-33.4 (74.8)	-	-	-
	Left	Extension	T3	11.7 (13.1)	-2.3 (35.5)	-	-	-
	Left	Extension	T4	2.1 (37.1)	-2.8 (58.4)	0.19	0.04*	0.41
	Right	Flexion	T1	-4.7 (77.1)	-338.1 (1198.51)	-	-	-
	Right	Flexion	T3	29.5 (17.6)	-139.0 (463.5)	-	-	-
	Right	Flexion	T4	17.1 (22.2)	18.4 (21.5)	0.12	0.36	0.46
	Left	Flexion	T1	-50.3 (110.7)	-47.4 (170.5)	-	-	-
	Left	Flexion	T3	18.7 (46.2)	-0.41 (59.9)	-	-	-

(table continues)

Variable	Side/Trial	ROM	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
	Left	Flexion	T4	-2.3 (91.1)	-139.9 (624.2)	0.33	0.51	0.57

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

It is assumed that there will be less work fatigue as muscular strength and endurance improves. It is also assumed that the knees are stronger, because the women were participating in an exercise and diet program and so they worked harder. This implied that knee strength and work fatigue improved. However, further research is needed. There were no statistically significant interaction effects for the dietary supplement groups.

Table 19

Isokinetic Knee Strength 300 Deg/Sec

Variable	Side/Trial	ROM	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Peak Torque (Ft-lbs)	Right	Extension	T1	34.5 (14.9)	30.1 (11.5)	-	-	-
	Right	Extension	T3	38.4 (14.7)	34.5 (13.9)	-	-	-
	Right	Extension	T4	38.5 (15.5)	33.5 (14.6)	0.90*	0.04*	0.94
	Left	Extension	T1	35.1 (18.9)	26.3 (10.4)	-	-	-
	Left	Extension	T3	38.9 (17.2)	33.0 (12.6)	-	-	-
	Left	Extension	T4	39.0 (18.0)	34.6 (11.6)	0.24	0.00*	0.44
	Right	Flexion	T1	16.6 (12.4)	12.7 (10.1)	-	-	-
	Right	Flexion	T3	20.2 (14.6)	17.7 (11.3)	-	-	-

(table continues)

Variable	Side/Trial	ROM	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
	Right	Flexion	T4	19.6 (13.8)	18.9 (13.4)	0.59	0.00*	0.52
	Left	Flexion	T1	13.9 (11.5)	11.2 (11.6)	-	-	-
	Left	Flexion	T3	18.0 (13.5)	16.2 (9.6)	-	-	-
	Left	Flexion	T4	18.1 (12.8)	17.1 (10.2)	0.64	0.00*	0.85
Peak Torque/Body Weight (%)	Right	Extension	T1	17.6 (6.9)	15.9 (6.5)	-	-	-
	Right	Extension	T3	19.8 (6.7)	18.9 (7.8)	-	-	-
	Right	Extension	T4	19.9 (7.0)	16.8 (8.3)	0.42	0.04*	0.52
	Left	Extension	T1	17.7 (8.1)	14.1 (6.2)	-	-	-
	Left	Extension	T3	19.8 (7.1)	17.9 (6.6)	-	-	-
	Left	Extension	T4	20.1 (7.9)	17.5 (7.5)	0.28	0.00*	0.65
	Right	Flexion	T1	8.6 (6.3)	6.4 (5.9)	-	-	-
	Right	Flexion	T3	10.4 (6.9)	9.9 (5.9)	-	-	-
	Right	Flexion	T4	10.2 (7.1)	9.8 (7.6)	0.66	0.00*	0.47
	Left	Flexion	T1	7.2 (5.8)	6.5 (6.5)	-	-	-
	Left	Flexion	T3	9.3 (6.2)	8.9 (6.1)	-	-	-
	Left	Flexion	T4	9.3 (6.3)	9.5 (7.0)	0.91	0.00*	0.86
Work Fatigue (%)	Right	Extension	T1	14.5 (52.3)	0.17 (28.0)	-	-	-
	Right	Extension	T3	10.0 (19.9)	11.7 (34.6)	-	-	-
	Right	Extension	T4	22.4 (31.7)	11.4 (24.9)	0.39	0.42	0.51
	Left	Extension	T1	10.2 (53.9)	-3.2 (42.1)	-	-	-
	Left	Extension	T3	9.4 (22.1)	13.6 (27.0)	-	-	-
	Left	Extension	T4	22.7 (37.2)	11.8 (37.3)	0.52	0.25	0.51
	Right	Flexion	T1	-10.0	-443.4	-	-	-

(table continues)

Variable	Side/Trial	ROM	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
				(101.6)	(1707.7)			
	Right	Flexion	T3	25.6	0.99	-	-	-
				(32.2)	(97.5)			
	Right	Flexion	T4	4.7	33.0	0.31	0.29	0.37
				(84.7)	(39.9)			
	Left	Flexion	T1	-1.6	-280.14	-	-	-
				(96.1)	989.1			
	Left	Flexion	T3	27.9	2.9	-	-	-
				(43.6)	(123.2)			
	Left	Flexion	T4	20.3	33.9	0.31	0.16	0.26
				(46.4)	(36.5)			

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Psychometric Questionnaires-Pain Scale

A Visual Analog Pain Scale was used to determine perceived knee pain. Participants marked an "X" at any point on the 12-cm line that best described the soreness they felt in their knee on a daily basis. The Graphic Pain Rating Scale ranged from "No Pain" to "Unbearable Pain". The statistical results for knee pain as depicted in Table 20 revealed significant time effects (p=0.00) and no significant interactions (p=0.20) for the dietary supplement groups. Figure 8 displays changes in visual analog scale knee pain (cm) over the course of the study. A statistically significant time effect for knee pain (p=0.00) was present.

Based on the data collected, we partially accept hypothesis H^5 stating there will be statistically significant differences between dietary supplement groups and time changes in knee pain among women consuming the dietary supplement. Although there were no statistically significant changes between groups, there were time effect differences due to the Curves fitness and diet program. This implied the women participating in the Curves

fitness and diet program had decreases in knee pain over the course of the study. There were no statistically significant group x time interactions (p=0.20) with knee pain. However, statistical analysis revealed a large group x time interaction effect size (d=1.1) for knee pain, indicating significance may be reached with a larger sample size.

Western Ontario and McMasters University Osteoarthritis Index (WOMAC™ 3.1 Index)

Participants completed a self-administered index that used a battery of 24 questions and assessed the three dimensions of pain, joint stiffness, and disability in knee and hip osteoarthritis. Table 21 revealed the statistical data for the WOMAC™ 3.1 Index Knee Pain, Stiffness, and Physical Function, respectively.

Table 20

Knee Pain Analysis

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Knee Pain	T1	4.2 (1.9)	3.7 (2.1)	-	-	-
	T3	2.7 (1.9)	2.3 (1.5)	-	-	-
	T4	2.6 (1.9)	0.9 (1.1)	0.08	0.00*	0.20

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Figure 9 displays changes in WOMAC knee pain (cm) over the course of the study A statistically significant time effect for knee pain (p=0.00) was present. Figure 10 displays changes in WOMAC knee stiffness (cm) over the course of the study. A statistically significant time effect for knee stiffness (p=0.00) was present. Figure 11 displays changes in WOMAC knee physical function . (cm) over the course of the study. A statistically significant time effect for knee physical function (p=0.00) was present.

There were statistically significant time effects for pain (p=0.00), stiffness (p=0.00), and physical function (p=0.00). Changes in knee pain mean time differences over the course of the study for the active group were -68.8±60.8 cm and -98.1±107.3 cm for the placebo group. Changes in knee stiffness mean time differences over the course of the study for the active group were -38.8±38.7 cm and -30.1±43.4 cm for the placebo group. Changes in knee physical function mean time differences over the course of the study for the active group were -416.01±381.4 cm and -447.8±308.74 cm for the placebo group. Thus, based on the data collected, we partially accept hypothesis H^5 and H^6 stating there will be statistically significant differences between groups and time changes in knee pain and knee function in women consuming the dietary supplement.

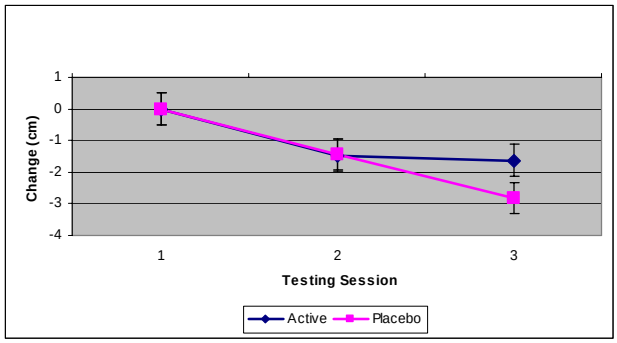

Figure 8. Changes in visual analog scale knee pain (cm) over the course of the study. A statistically significant time effect for knee pain (p=0.00) was present.

Although, there were no between group differences, there were time differences in knee pain, stiffness, and physical function as related to the WOMAC™ Index for women participating in the Curves fitness and diet program. Again, it is assumed that knee pain, stiffness, and physical function limitations will decrease due to the women participating in an exercise and diet program. There were no statistically significant interactions for the dietary supplement groups for pain (p=0.43), stiffness (p=0.74), and physical function

(p=0.91). Statistical analysis revealed a medium effect size (d=0.4) for pain, which could lead to significance with a larger sample size. A negligible (d=0.11) and small effect (d=0.22) size was demonstrated for stiffness and physical function limitations, respectively.

Table 21

Dimensions of Knee Pain

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Pain	1	152.8 (74.7)	159.5 (89.8)	-	-	-
Pain	3	95.9 (79.9)	70.7 (37.9)	-	-	-
Pain	4	84.1 (62.9)	61.4 (52.3)	0.50	0.00*	0.43
Stiffness	1	90.4 (43.5)	77.3 (38.4)	-	-	-
Stiffness	3	53.6 (44.9)	39.3 (42.5)	-	-	-
Stiffness	4	51.6 (42.1)	47.2 (39.2)	0.42	0.00*	0.74
Physical Function	1	922.3 (447.2)	830.3 (416.7)	-	-	-
Physical Function	3	584.4 (473.9)	437.0 (258.7)	-	-	-
Physical Function	4	506.3 (382.3)	394.7 (248.9)	0.33	0.00*	0.91

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

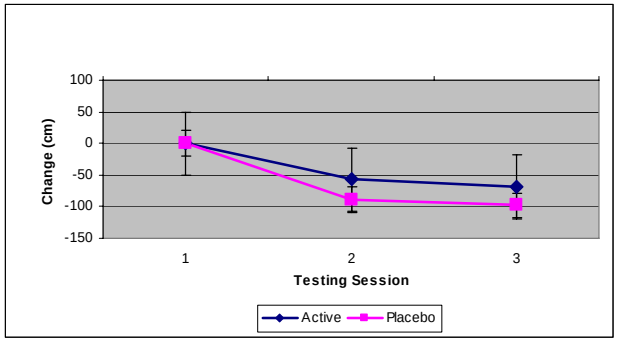

Figure 9. Changes in WOMAC™ knee pain (cm) over the course of the study. A statistically significant time effect for knee pain (p=0.00) was present.

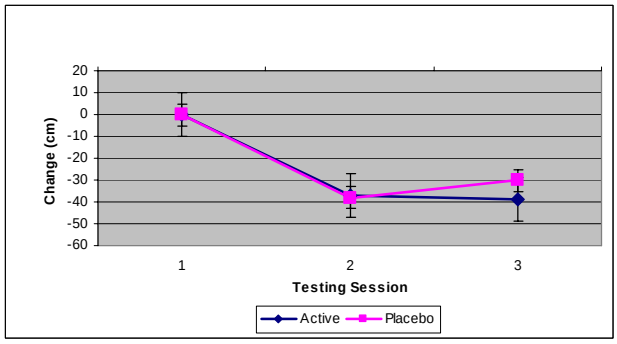

Figure 10. Changes in WOMAC™ knee stiffness (cm) over the course of the study. A statistically significant time effect for knee stiffness (p=0.00) was present.

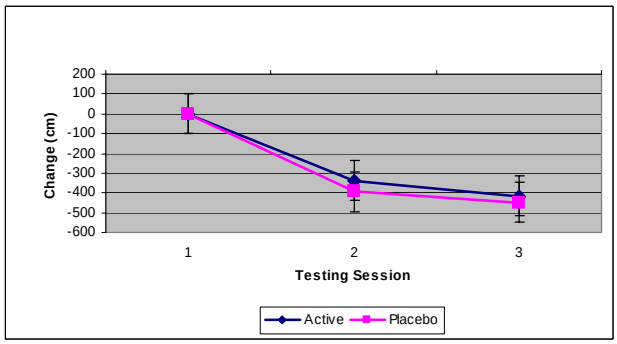

Figure 11. Changes in WOMAC™ knee physical function (cm) over the course of the study. A statistically significant time effect for knee physical function (p=0.00) was present.

Eating Satisfaction

Eating satisfaction statistics in Table 22 revealed significant time effects for appetite (p=0.00), hunger (p=0.02), satisfaction of food (p=0.02), energy (p=0.00), and quality of diet (p=0.01) for the dietary supplement groups. This implied that women following the Curves fitness and diet program experienced a decrease in appetite and hunger and enjoyed their diet, while losing weight. There were no statistically significant group x time interactions for appetite (p=0.07). There were no group x time interaction effects for appetite (p=0.07), hunger (p=0.98), satisfaction of food (p=0.40), feeling of fullness (p=0.37), energy (p=0.35), and quality of diet (p=0.40). Statistical analysis revealed a negligible effect size (d=0.12) for appetite. Thus, based on data collected we accept hypothesis H^4 stating there will be no differences between dietary supplement groups in psychometric assessments among women following the Curves fitness and diet program.

Table 22

Eating Satisfaction

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Appetite	T1	5.6 (1.8)	6.1 (1.2)	-	-	-
	T3	5.7 (1.4)	4.9 (0.8)	-	-	-
	T4	5.3 (1.7)	5.1 (1.8)	0.75	0.04*	0.07
Hunger	T1	5.4 (1.4)	5.5 (0.8)	-	-	-
	T3	4.5 (2.2)	4.4 (1.3)	-	-	-
	T4	4.6 (1.8)	4.7 (1.9)	0.97	0.02*	0.98
Satisfaction of Food	T1	6.2 (1.6)	5.6 (1.3)	-	-	-
	T3	6.4 (1.5)	5.8 (1.3)	-	-	-
	T4	6.2 (1.4)	6.4 (1.2)	0.29	0.53	0.40
Feeling of	T1	6.0 (1.3)	6.1 (1.4)	-	-	-

(table continues)

Fullness						
	T3	5.8 (2.1)	6.5 (1.6)	-	-	-
	T4	5.8 (1.7)	7.0 (1.3)	0.13	0.59	0.37
Energy	T1	4.6 (1.1)	3.9 (1.8)	-	-	-
	T3	6.2 (1.4)	6.2 (1.9)	-	-	-
	T4	5.6 (1.4)	5.7 (1.9)	0.70	0.00*	0.35
Quality of Diet	T1	4.8 (1.7)	4.8 (1.9)	-	-	-
	T3	6.4 (1.7)	5.5 (1.6)	-	-	-
	T4	5.9 (1.6)	5.9 (1.2)	0.51	0.01*	0.40

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Quality of Life

Quality of life (QOL) statistics shown in Table 23 revealed statistically significant time effects for physical function (p=0.01), energy/fatigue (p=0.00), social functioning (p=0.01), and mental health (p=0.00). This implied the women participating in the Curves fitness and diet program experienced increases in physical function, energy/fatigue, social functioning, and mental health over the course of the study. There were no statistically significant group by time interactions between groups for the following QOL variables for the dietary supplement groups: physical functioning (p=0.92), general health perceptions (p=0.64), energy/fatigue (p=0.49), social functioning (p=0.39), and emotional well-being (p=0.61). Likewise, there were no statistically significant between group effects for physical functioning (p=0.69), general health perceptions (p=0.83), energy/fatigue (p=0.85), social functioning (p=1.00), and mental health (p=0.49). Thus, based on data collected we accept hypothesis H^4 stating there will be no differences between dietary supplement groups in psychometric assessments among women following the Curves fitness and diet program.

Blood Samples- Serum Chemistry Profiles

Table 24 summarizes the serum chemistry values observed throughout the study. The following variables were statistically significant for

Table 23

Quality of Life

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Physical Functioning	T1	48.1 (34.3)	40.8 (41.8)	-	-	-
	T3	56.5 (37.9)	54.2 (34.5)	-	-	-
	T4	71.2 (19.3)	69.6 (14.9)	0.69	0.01*	0.92
Role Limitations/Health Problems	T1	-100.0 (0)	-100.0 (0)	-	-	-
	T3	-100.0 (0)	-100.0 (0)	-	-	-
	T4	-100.0 (0)	-100.0 (0)	-	-	-
Bodily Pain	T1	-20.0 (0)	-20.0 (0)	-	-	-
	T3	-20.0 (0)	-20.0 (0)	-	-	-
	T4	-20.0 (0)	-20.0 (0)	-	-	-
General Health Perceptions	T1	15.0 (15.1)	11.5 (14.9)	-	-	-
	T3	14.2 (12.9)	16.2 (6.5)	-	-	-
	T4	16.9 (4.4)	16.5 (9.2)	0.83	0.48	0.64
Energy/Fatigue	T1	9.6 (12.7)	6.9 (11.1)	-	-	-
	T3	13.5 (10.9)	16.5 (8.3)	-	-	-
	T4	17.7 (5.6)	18.8 (9.2)	0.85	0.00*	0.49
Social Functioning	T1	21.2 (22.5)	15.4 (18.5)	-	-	-

(table continues)

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
	T3	25.0 (16.9)	27.9 (10.4)	-	-	-
	T4	28.9 (10.7)	31.7 (8.3)	1.00	0.01*	0.39
Role Limitations/Emotional Problems	T1	-100.0 (0)	-100.0 (0)	-	-	-
	T3	-100.0 (0)	-100.0 (0)	-	-	-
	T4	-100.0 (0)	-100.0 (0)	-	-	-
Emotional Well-Being	T1	12.0 (3.9)	11.4 (4.4)	-	-	-
	T3	13.1 (1.5)	13.9 (1.5)	-	-	-
	T4	8.9 (4.8)	10.4 (4.9)	0.49	0.00*	0.61

Note: All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

time effects: LDL (p=0.03), HDL (p=0.00), ALT (p=0.01), BUN (p=0.01), total bilirubin (p=0.00), creatinine (p=0.00), uric acid (p=0.04), total CK (p=0.00). Thus, based on the data collected we accept hypothesis H^{12} stating there will be time effects with no significant interactions between dietary supplement groups in blood profiles among women following the Curves fitness and diet program. There was one statistically significant between group variable for HDL (p=0.04). This implied that HDL cholesterol decreased in the active group over the course of the study. Although there were time effects, there was also one group x time effect for the variable ALT. There was a statistically significant interaction for ALT (p=0.05) for the dietary supplement groups. Statistical post hoc tests for the ALT significant interaction effect revealed that the significance is due to the Curves fitness and diet program. There were no statistically

significant between group effects for the following variables: triglycerides (p=0.75), total cholesterol (p=0.08), LDL (p=0.32), glucose (p=0.78), GGT (p=0.88), ALT (p=0.97), AST (p=0.99), total CK (p=0.90), total protein (p=0.13), albumin (p=0.54), BUN (p=0.74), total bilirubin (p=0.16), creatinine (p=0.79), BUN:creatinine (p=0.58), and calcium (p=0.94).

Table 24

Serum Chemistry

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
Triglycerides (mg/dl)	T1	147.2 (87.1)	156.3 (90.5)	-	-	-
	T3	135.2 (78.0)	146.9 (106.8)	-	-	-
	T4	138.0 (84.9)	150.4 (93.4)	0.75	0.62	0.99
Total Cholesterol (mg/dl)	T1	210.1 (45.1)	225.2 (29.1)	-	-	-
	T3	188.6 (30.6)	210.8 (26.8)	-	-	-
	T4	189.8 (41.2)	217.4 (47.3)	0.08	0.09	0.78
LDL Cholesterol (mg/dl)	T1	139.0 (34.0)	143.2 (28.3)	-	-	-
	T3	121.0 (22.9)	128.8 (20.1)	-	-	-
	T4	120.9 (29.9)	138.3 (37.7)	0.32	0.03*	0.11
HDL Cholesterol (mg/dl)	T1	50.5 (7.8)	57.1 (11.0)	-	-	-
	T3	43.3 (6.6)	52.1 (9.6)	-	-	-
	T4	45.1 (7.4)	51.3 (15.3)	0.04*	0.00*	0.78
Glucose	T1	107.7	106.3	-	-	-

(table continues)

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
(mg/dl)		(16.2)	(14.9)			
	T3	101.0 (15.7)	104.3 (13.1)	-	-	-
	T4	98.3 (13.6)	100.8 (20.6)	0.78	0.09	0.75
GGT (U/L)	T1	46.5 (37.6)	36.5 (17.1)	-	-	-
	T3	38.1 (24.0)	43.8 (40.7)	-	-	-
	T4	44.8 (31.4)	55.0 (57.1)	0.88	0.22	0.19
ALT (U/L)	T1	22.9 (8.7)	27.4 (13.2)	-	-	-
	T3	19.2 (4.4)	19.5 (7.3)	-	-	-
	T4	23.7 (9.9)	19.3 (10.1)	0.97	0.01*	0.05*
AST (U/L)	T1	19.4 (6.1)	20.1 (7.1)	-	-	-
	T3	20.7 (3.6)	18.8 (5.6)	-	-	-
	T4	20.9 (4.7)	22.3 (11.1)	0.99	0.20	0.35
Total CK (mg/dl)	T1	58.1 (42.1)	56.6 (29.8)	-	-	-
	T3	89.1 (48.7)	82.8 (35.2)	-	-	-
	T4	81.3 (27.1)	93.5 (25.9)	0.90	0.00*	0.41
Total Protein (g/dl)	T1	7.5 (0.5)	7.0 (0.5)	-	-	-
	T3	7.2 (0.9)	6.8 (0.4)	-	-	-
	T4	7.2 (1.1)	6.8 (1.4)	0.13	0.36	0.98
Albumin (g/dl)	T1	4.4 (0.5)	4.2 (0.3)	-	-	-
	T3	4.2 (0.4)	4.0 (0.3)	-	-	-
	T4	4.1 (0.6)	4.1 (0.8)	0.54	0.17	0.87
BUN	T1	13.5	14.7	-	-	-

(table continues)

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
(mg/dl)		(3.0)	(4.7)			
	T3	13.2	13.8	-	-	-
		(3.3)	(4.4)			
	T4	12.4	12.0	0.74	0.01*	0.38
		(2.5)	(4.9)			
Total Bilirubin	T1	0.4	0.34	-	-	-
		(0.2)	(0.1)			
	T3	0.5	0.4	-	-	-
		(0.2)	(0.1)			
	T4	0.6	0.5	0.16	0.00*	0.89
		(0.3)	(0.2)			
Creatinine (mg/dl)	T1	0.8	0.8	-	-	-
		(0.2)	(0.1)			
	T3	0.8	0.87	-		
		(0.2)	(0.2)		-	-
	T4	0.7	0.7	0.79	0.00*	0.94
		(0.1)	(0.2)			
BUN: Creatinine	T1	16. 8	18.5	-	-	-
		(3.6)	(3.9)			
	T3	17.2	17.9	-	-	-
		(3.2)	(4.4)			
	T4	18.1	17.9	0.58	0.86	0.47
		(4.4)	(4.6)			
Calcium	T1	9.4	9.4	-	-	-
		(0.9)	(0.4)			
	T3	9.1	9.1	-	-	-
		(0.8)	(0.5)			
	T4	8.9	8.9	0.94	0.12	0.98
		(0.9)	(1.7)			

Note: Data represents serum metabolic/enzyme levels for the study. All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

Whole Blood Cell Analysis

Table 25 depicts the whole blood cell analysis during the study. There were no statistically significant group, time or group x time interaction effects for the following whole blood cell variables: WBC (p=0.96; p=0.60; p=0.30, respectively), neutrophils (p=0.71; p=0.62; p=0.06, respectively), lymphocytes (p=0.44; p=0.95; p=0.24,

respectively), monocytes (p=0.58; p=0.13; p=0.18, respectively), basophils (p=0.26; p=0.69; p=0.68, respectively), eosinophils (p=0.25; p=0.44; p=0.87; respectively), RBC (p=0.45; p=0.57; p=0.99, respectively), hemoglobin (p=0.65; p=0.57; p=0.99; respectively), and hematocrit (p=0.90; p=0.07, p=0.78, respectively).

Hormonal Responses

Table 26 reflects the hormonal blood markers indicating inflammation. Figure 12 displays changes in C-reactive protein (mg/dl) over the course of the study. A statistically significant time effect for C-reactive protein (p=0.03) was present. Figure 13 reflects changes in leptin (ng/ml) over the course of the study. A statistically significant time effect for leptin (p=0.01) was present.

Table 25

Whole Blood Cell Values

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
WBC (K/µl)	T1	6.0 (1.9)	5.5 (1.2)	-	-	-
	T3	5.7 (1.7)	5.9 (1.5)	-	-	-
	T4	5.4 (1.7)	5.7 (0.9)	0.96	0.60	0.30
Neutrophils (K/µl)	T1	60.9 (10.1)	56.5 (7.4)	-	-	-
	T3	57.4 (9.5)	57.8 (6.1)	-	-	-
	T4	57.6 (7.9)	58.1 (7.4)	0.71	0.62	0.06
Lymphocytes (K/µl)	T1	27.5 (8.2)	32.4 (6.2)	-	-	-
	T3	29.5 (8.8)	30.1 (9.3)	-	-	-
	T4	28.8	30.3	0.44	0.95	0.24

(table continues)

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
		(6.3)	(7.7)			
Monocytes (K/µl)	T1	7.7 (3.2)	7.8 (1.4)	-	-	-
	T3	8.9 (6.2)	7.2 (1.4)	-	-	-
	T4	9.3 (5.7)	8.2 (1.6)	0.58	0.13	0.18
Basophils (K/µl)	T1	5.1 (14.4)	1.2 (0.3)	-	-	-
	T3	8.8 (19.7)	1.1 (0.5)	-	-	-
	T4	5.7 (16.5)	1.0 (0.4)	0.26	0.69	0.68
Eosinophils (K/µl)	T1	2.6 (1.4)	2.2 (1.1)	-	-	-
	T3	2.8 (1.5)	2.2 (0.9)	-	-	-
	T4	2.9 (1.4)	2.3 (0.9)	0.25	0.44	0.87
RBC (M/µl)	T1	4.7 (0.4)	4.5 (0.4)	-	-	-
	T3	4.7 (0.4)	4.6 (0.3)	-	-	-
	T4	4.7 (0.6)	4.6 (0.5)	0.45	0.60	0.30
Hemoglobin (g/dl)	T1	13.5 (1.6)	13.3 (1.5)	-	-	-
	T3	13.4 (1.1)	13.2 (0.9)	-	-	-
	T4	13.3 (0.9)	13.1 (1.5)	0.65	0.57	0.99
Hematocrit (%)	T1	40.9 (3.0)	40.3 (4.4)	-	-	-
	T3	41.7 (3.0)	41.6 (2.4)	-	-	-
	T4	42.0 (2.6)	42.3 (3.9)	0.90	0.07	0.78

Note: Data represents differential white blood cell levels for the study. All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

There were statistically significant time effects for C-reactive protein (p=.03) and leptin (p=.01). Changes in C-reactive protein (mg/dl) mean time differences over the course of the study were 0.3±0.7 for the active group and 0.1±0.4 for the placebo group. Changes in leptin (ng/ml) mean time differences over the course of the study were -24.3±79.7 for the active group and -32.2±54.5 for the placebo group. This implied the women participating in the Curves fitness and diet program had an increase in C-reactive protein and a decrease in leptin. It is assumed that less leptin resistance lowers high levels in obese people. There were no statistically significant group, time, or group x time interactions for any of the following hormonal blood markers: IL-6 (p=0.42; p=0.95; p=0.49, respectively), TNF-α (p=0.88; p=0.96; p=0.95, respectively), cortisol (p=0.97; p=0.93; p=0.11, respectively), and insulin (p=0.11; p=0.86; p=0.82, respectively). Statistical analysis revealed a huge effect size (d=1.55) for TNF-α, and medium effect sizes (d=0.46; d=0.46; d=0.45, respectively) for C-reactive protein, IL-6, and cortisol. A small effect size (d=0.19) was found for leptin. Therefore, a larger sample size would have increased the power of the study and the likelihood of statistical significance for TNF-α, C-reactive protein, IL-6, and cortisol.

There were no statistically significant group or group x time interactions for C-reactive protein (p=0.54; p=0.59, respectively) and leptin (p=0.62; p=0.62, respectively).

Table 26

Hormones

Variable	Testing Session	Active Group (±SD)	Placebo Group (±SD)	Group p-value	Time Effect p-value	Group x Time p-value
C-Reactive Protein (mg/dl)	T1	0.5 (0.4)	0.5 (0.5)	-	-	-
	T3	0.6 (0.4)	0.4 (0.5)	-	-	-
	T4	0.9 (0.8)	0.6 (0.5)	0.54	0.03*	0.59
IL-6 (pg/ml)	T1	4.0 (4.3)	2.9 (3.8)	-	-	-
	T3	3.4 (4.8)	3.4 (4.0)	-	-	-
	T4	4.5 (6.9)	2.1 (2.8)	0.42	0.95	0.49
TNF-α (pg/ml)	T1	0.5 (3.0)	0.5 (3.1)	-	-	-
	T3	0.8 (2.9)	0.6 (4.3)	-	-	-
	T4	0.6 (3.9)	1.0 (2.9)	0.88	0.96	0.95
Cortisol (µg/dl)	T1	32.6 (41.7)	24.4 (13.5)	-	-	-
	T3	33.0 (31.4)	24.1 (8.7)	-	-	-
	T4	22.6 (17.8)	38.7 (48.4)	0.97	0.93	0.11
Insulin (micIU/ml)	T1	7.8 (3.3)	16.9 (17.9)	-	-	-
	T3	8.8 (6.3)	16.9 (19.4)	-	-	-
	T4	7.6 (4.4)	17.0 (19.7)	0.11	0.86	0.82
Leptin (ng/ml)	T1	142.1 (93.0)	167.3 (75.0)	-	-	-
	T3	119.1 (98.9)	123.2 (49.6)	-	-	-
	T4	117.8 (124.2)	135.1 (49.6)	0.62	0.01*	0.62

Note: Data represents hormonal variables for the study. All data represented as means (±SD). Significant group, time and/or group x time interactions are depicted with an asterisk.

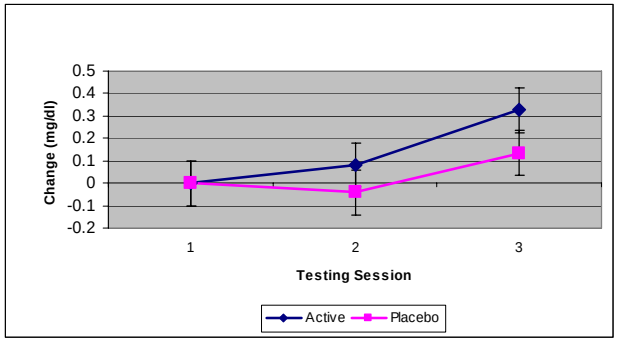

Figure 12. Changes in C-reactive protein (mg/dl) over the course of the study. A statistically significant time effect for C-reactive protein (p=0.03) was present.

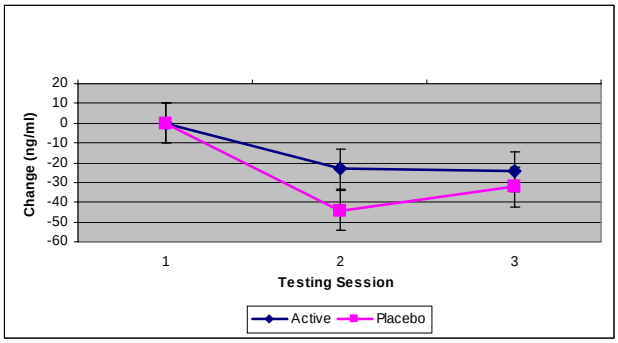

Figure 13. Changes in leptin (ng/ml) over the course of the study. A statistically significant time effect for leptin (p=0.01) was present.

Summary

Since many of the variables were statistically significant for time effects, there were many training adaptations for women with knee osteoarthritis (OA) participating in the Curves program. These adaptations included decreased weight loss, decreased fat mass, decreased body fat, increased 1 repetition maximal muscular strength, increased aerobic capacity, increased isokinetic strength, decreased knee pain, stiffness, physical function, improved quality of life variables of physical functioning, energy/fatigue, and mental health, as well as decreased appetite and hunger states. The research indicated that women with OA can benefit from the Curves fitness and diet program. In addition,

strong effect sizes from the statistical data revealed that knee pain could potentially decrease with a larger sample size. Glucosamine and chondroitan supplementation tended to decrease perceptions of pain, with no statistically significant improvement in strength, or functional status. More research using a larger population and longer time period is needed to examine the effect of glucosamine and chondroitan supplementation on training outcomes with OA patients.

CHAPTER FIVE

Discussion

General Summary

The purpose of this study was to determine whether participation in the Curves fitness and weight loss program and/or ingesting a commercially available glucosamine and chondroitan joint support dietary supplement affects knee pain and function, body composition, heart rate, blood pressure, blood profiles, maximal cardiopulmonary exercise capacity, knee flexion, knee circumference, and knee strength in sedentary, overweight (BMI > 27) women with knee osteoarthritis.

Results of the study indicated many positive training adaptations for women with knee osteoarthritis (OA) participating in the Curves program. These adaptations included decreased weight loss (3%±4), decreased fat mass (6%±8), decreased body fat (4%±3), increased 1 repetition maximal muscular strength (11%±12), increased muscular endurance (13%±12), increased isokinetic strength (ranging from 10-25%±4), decreased knee pain (112%±317), stiffness (70%±234), and limitations in physical function (96%±1356), improved quality of life variables of physical functioning (37%±52), energy/fatigue (55%±69), social functioning (40%±76), mental health (22%±84), appetite (13%±36), hunger (17%±34), increased energy (24%±35), and quality of diet (19%±38). In addition, strong effect sizes (d=1.1) from the statistical data revealed that VAS knee pain could potentially decrease with a larger sample size. Glucosamine chondroitan supplementation tended to decrease perceptions of pain, with no statistically significant

improvement in strength, or functional status. However, moderate effect sizes were observed in WOMAC^{TM} pain (d=0.4), left knee flexion (d=0.53), 1 repetition max (d=0.53), total work (d=0.72), maximal systolic blood pressure (d=0.69), and cortisol (d=0.45). These findings suggest that glucosamine and chondroitan supplementation during a weight loss and fitness program may have therapeutic benefits for women with OA. The magnitude of these gains may have over-ridden many effects of the glucosamine and chondroitan supplementation. The research indicated that women with OA can benefit from the Curves fitness and diet program.

Changes in Body Composition

During this 14-week study, the active and placebo groups experienced statistically significant decreases over time in weight (p=0.00), fat mass (p=0.00) and body fat % (p=0.00). This represented an overall decrease in weight (3%±4), fat mass (6%±8), and percent body fat (4%±3). This indicated that all participants significantly reduced their body weight, fat mass, and body fat percentage over the course of the study due to the Curves fitness and diet program. Another important finding was that both groups maintained their fat free mass, which generally decreases during weight loss. There were no statistically significant group x time interactions for fat mass (p=0.73) and percent body fat (p=0.44). There were also no statistically significant time or group x time interaction effects for lean body mass (p=0.26; p=0.34, respectively) or fat free mass (p=0.30; p=0.45, respectively). A small effect size (d=0.37) existed for lean body mass group x time interaction. Results indicated that women with OA who participated in the Curves fitness and weight loss program can significantly lose weight and improve their body composition.

In relation to previous research findings conducted by Kersick, et al. (2004) and Magráns, et al. (2005), our data supports the Curves fitness and diet program for promoting decreases in weight loss, fat mass, and percent body fat in OA patients. The weight loss demonstrated by Kersick, et al. (2004) was a decrease of 4 to 6 kg. Our data reflects a weight loss of 2 to 4 kg. In addition, our data supports a 3 to 5% reduction in body fat, which coincides with that found by Magráns, et al. (2005). Our data also supports the research of Messier, et al. (2004) indicating that overweight OA patients can decrease their body weight with physical activity. Messier, et al. (2000) also studied the effects of exercise and weight loss in obese adults with knee OA. This research found that the exercise and diet group lost 8.5 kg over a six month period compared with 1.8 kg in the exercise only group. Research by Madsen et al. (1997) on body composition in women with OA demonstrated that body weight, body mass index, fat mass, and body fat were 15% higher in patients needing knee replacement ($p<0.001$). Although this study was only 14-weeks, the data supported these research findings and demonstrated that OA patients can lose weight.

In relation to the non-significant interaction effects observed on body composition variables, there may be one main reason why this study did not find statistical significance in lean body mass, and fat free mass. The reason is that the sample size ($n=26$) was small, in relation to past studies conducted by Kreider, et al. (2005) with a sample size of $n=200$ and Messier, et al. (2004) with a sample size of $n=252$. A larger sample size would have increased the power of the study and the likelihood of statistical significance. Additionally, all the women participated in the same exercise and diet program, regardless of whether they experienced greater reductions in perception of knee

pain and/or improvements in functional capacity with dietary supplementation of glucosamine and chondroitan. Therefore, although significant time effects were observed, one would not expect greater weight loss with the supplement intervention studied.

Changes in Anthropometric Procedures of the Knee

Anthropometric procedures of the knee indicated a statistically significant time effect for the left knee circumference ($p=0.05$). There were no statistically significant differences between groups ($p=0.99$). This revealed that increases in the left knee circumference of 4%±9 occurred over time due to the women participating in the Curves fitness and diet program. This was most likely due to measurement error, but further research is needed. There were no statistically significant time or group x time interaction effects for the right knee circumference ($p=0.35$, $p=0.91$, respectively) and no statistically significant interaction effects for the left knee circumference ($p=0.90$) for the dietary supplement groups. Our data supports the findings of King, et al. (2005) stating that inactivity has been reported to hasten the symptoms and progression of OA: muscle weakness, atrophy, decreased flexibility and cardiorespiratory fitness, osteoporosis, depression, and lowered pain threshold. In addition, improvements in knee function were demonstrated by Messier, et al. (2004) in overweight and obese adults. This study indicated that weight loss plus exercise provided improvements in self-reported measures of knee pain and function among older overweight and obese adults with knee OA.

Changes in Performance Variables- Cardiopulmonary Exercise Tests

Minor, et al. (1993) and O'Reilly, et al. (1999) reported that aerobic exercise and strength-training programs improve the functional capacity in OA patients by 3 to 5% of VO_{2max}. Therefore, regular physical activity can improve the health and physical functioning for OA patients and inactivity leads to disabilities (O'Reilly, Muir, & Doherty, 1999). It is well known that the basic components of an exercise program are to improve strength, flexibility, and endurance (Balady, Berra, Golding, et al.,2000). The following exercise recommendations for OA patients are based on the American College of Sports Medicine (ACSM) guidelines (Balady, Berra, Golding, et al.,2000). Aerobic endurance exercises should include intensities of low to moderate (40%-60% of VO_{2max}/HR_{max}) for a daily total of 20-30 minutes performed 3-5 times per week. The type of aerobic activity for an OA patient is dependent upon the patient's current disease status, joint stability, and interest level (Pollock, Mengelkoch, Graves, et al., 1997).

Rasmussen, et al. (2004); Wilborn, et al. (2005); and Campbell, et al. (2005) demonstrated the Curves fitness and diet program enhanced maximal aerobic capacity by 10%. In addition, biomechanical and energy expenditures analysis performed on the Curves fitness and program indicated that exercise intensity of 65% of VO_{2max} support the ACSM guidelines (La Bounty., et al. 2006). Women new to exercise can burn approximately 164-238 kcals during a 30-minute Curves workout (Farris, et al., 2006). Highly trained women can burn 238-522 kcals/30 minute-workout at 65% VO_{2max} (Farris, et al., 2006). As a result, the research has shown that the Curves program is highly effective in improving fitness.

Statistically significant time effects existed for VO_2 (ml/kg/min) (p=0.01), and maximal ventilation (L/min) (p=0.00). The overall mean results represented a 6%±9 increase in VO_2 (ml/kg/min) and a 15%±16 increase in maximal ventilation (L/min). This data approaches the research findings of Rasmussen, et al. (2004); Wilborn, et al. (2005); and Campbell, et al. (2006) supporting an increase in aerobic capacity and surpasses those findings by Minor, et al. (1993) and O'Reilly, et al. (1999) with 3-5% VO_{2max}.

A statistically significant group x time interaction existed for maximal systolic blood pressure (mmHg) (p=0.03). Statistical post hoc tests for maximal systolic blood pressure significant interaction revealed that the significance is due to the Curves fitness and diet program. Maximal systolic blood pressure changes over time further imply that a trend exists in the active group. This indicated that the active supplement group had a lower maximal systolic blood pressure versus the placebo group.

One possible explanation for an improved maximal systolic blood pressure is that the active supplement contained rutin. Rutin is a bioflavinoid (Ahmadu, Haruna, Garba, et al. 2004). Bioflavinoids help to maintain the resistance of capillary walls for permeation, pressure changes, and provide synergistic antioxidant effects with vitamin C. Ahmada, et al. (2004) evaluated the effects on pressure changes when ingesting 50 mg/day of rutin. Consequently, it is possible that ingestion of rutin for our study may have enhanced blood pressure (Ahmadu, Haruna, Garba, et al. 2004). It is difficult to distinguish this without further research, since the amount of rutin found in the supplement is only 10 mg/two tablets.

In relation to previous research findings conducted by Rasmussen, et al. (2004); La Bounty, et al. (2006); and Farris, et al. (2006), the data supports previous findings that the Curves fitness and diet program promotes aerobic exercise capacity. Our data also agrees with the guidelines set by ACSM (Balady, Berra, Golding, et al.,2000) for patients with OA indicating that functional capacity can be enhanced with consistent aerobic activity for the lessening of symptoms associated with OA.

In relation to the non-significant findings on cardiopulmonary variables, there may be one main reason why our study did not find statistical group x time interaction significance in VO_2 (L/min) ($p=0.42$), VO_2 (ml/kg/min) ($p=0.49$), maximal minute ventilation ($p=0.33$), peak heart rate ($p=0.23$), and maximal diastolic blood pressure ($p=0.34$). There was no physiological reason that a difference should be found in these variables with glucosamine and chondroitan supplementation, unless the supplementation could have allowed the participant to exercise significantly longer without pain. However, since all participants completed the same exercise program, one would not expect to see differences particularly since the study only had a sample size of 30. A larger sample size would have increased the power of the study and the likelihood of statistical significance.

Isotonic Bench Press

Researchers reported that reduced strength in relative terms to body weight, can promote the development of OA (Slemenda, Heilman, Brandt, et al., 1998). As a result, it is believed that interventions to strengthen muscularity, joint stability, and reduce body fat may reduce pain and enhance daily physical function for people affected by OA.

Research on the Curves fitness program demonstrated the strength training components of the program indicated a 50-75% of 1RM with an average of 15-20 repetitions performed per 30-second time frame (Rasmussen, et al. 2004, Wilborn, et al. 2005, Campbell, et al., 2005). This research demonstrated an increase of 10-15% in muscular strength and endurance for the participants. As a result, the research has shown that the Curves program is highly effective in muscular strength and endurance.

Statistical data collected for the study indicated significant time effects for 1 repetition maximum ($p=0.00$), 70% of 1 repetition maximum ($p=0.00$), and total work ($p=0.05$). This demonstrated that women participating in the study improved their muscular strength by 11%±12, muscular endurance by 13%±12, and total work by 12%±65 over the course of the study. Therefore, our research supports those found by Campbell, et al. (2005) with a 10-15% increase in muscular strength and endurance. The research also supports the guidelines set forth by ACSM for OA patients. A medium effect size ($d=0.72$) existed for between groups for the total work. An implication exists that this could lead to statistical significance with a larger sample size. There were no statistically significant group x time interaction effects for 1 repetition maximum ($p=0.58$), 70% of 1 repetition maximum ($p=0.99$), 70% of 1 repetition maximum repetitions ($p=0.30$), and total work ($p=0.22$).

Range of Motion

Exercise benefits for OA patients include the reduction in pain, swelling, enhancement of joint range of motion, muscle weakness, and postural instability. Collectively, studies such as Xing, et al (1998) and Reginster, et al. (2000) suggest that

glucosamine chondroitan supplementation may have therapeutic benefits for patients with knee osteoarthritis.

Although the study did not measure mean joint spaces as did the research findings of Reginster, et al. (2001), statistical data collected indicated significant time effects left knee flexion (p=0.00). There was a statistically significant interaction for right knee flexion of p=0.05 due to the Curves fitness and diet program. An increase of 4% for the left knee flexion and 5% for the right knee flexion was present in the active group. This implied that the participants were able to better flex their left knee due to the Curves fitness and diet program. There were no statistically significant group x time interaction effects for right knee extension (p=0.49). However, statistical analysis revealed a small group x time interaction effect size (d=0.2) for right knee extension and a medium effect (d=1.0) for left knee flexion. This leads the researcher to believe that statistical significance due to an interaction effect could be achieved with a larger sample size. Thus, the glucosamine and chondroitan supplement may be helpful. The researcher also believes that there may be a correlation between the anthropometric statistically significant time effect for the left knee circumference (p=0.05), and left knee flexion (p=0.00). All of these statistically significant time effects could be related to better range of motion due to the Curves fitness and diet program as a result of enhanced left knee functional improvements, but further research is needed to determine if the results were due to measurement error.

Equitest Procedures

Muscle weakness and reduced joint proprioception are risk factors for developing OA. It is common to see weakness in the quadriceps for patients with knee OA due to

reduced joint stability and lack of shock absorbing capacity (Hurley, 1999). Quadricep muscle weakness also leads to inactivity and disability (Harries, & Bassey, 1990). Research has also demonstrated that joint proprioception or diminished position sense declines with age (Pai, Rymer, Chang, et al., 1997). However, those patients with knee OA had decreased knee propcrioception when compared to those without knee OA (Pai, Rymer, Chang, et al., 1997).

In an effort to measure knee function, balance, and mobility, data were collected on postural balance and mobility. Statistical results revealed no statistically significant time or group x time interaction effects for the following sit-to-stand balance tests: weight transfer ($p=0.71$, $p=0.77$, respectively), rising index ($p=0.99$, $p=0.08$, respectively), or sway velocity ($p=0.59$, $p=0.84$, respectively). These research findings support those demonstrated by Bennell, et al. (2005) showing no statistical significance in standing balance in healthy older individuals induced with knee pain. This implied that balance impairments associated with knee OA may be due to other factors other than knee pain (Bennell, et al. 2005). Further research is also needed to evaluate changes in quadriceps strength for women participating in the study.

Statistical data for the step up and over knee function test revealed significant time effects for the following tests: lift up index on the right and left leg ($p=0.01$, $p=0.00$, respectively), impact index on the right leg only ($p=0.03$), and movement time on the right and left leg ($p=0.00$, $p=0.00$, respectively). This represented a 7%±15 and an 11%±17 increase in the step up and over lift index for the right and left legs, respectively. A decrease of 2%±19 existed for the impact index of the right leg and an increase of 10.5%±17 was demonstrated for left leg. Additionally, decreases of 18%±17 and

21%±26 were present for movement times for the right and left legs, respectively. These results implied that women participating in the Curves fitness and diet program had decreases in both legs with the amount of force that was applied concentrically to lift themselves up and over the box. The women also experienced decreases in their movement time to step-up-and-over the box. Movement time was influenced by losing weight, gaining strength, and improving balance. There were no statistically significant time effects for impact index on the left leg ($p=0.40$). There were no statistically significant group x time interaction effects for lift up index on the right and left leg ($p=0.16$; $p=0.31$, respectively), movement time ($p=0.26$; $p=0.26$, respectively), and impact index ($p=0.31$; $p=0.38$, respectively).

Statistical data for the forward lunge tests revealed statistically significant time effects for distance on the right and left leg ($p=0.00$; $p=0.00$, respectively), contact time on the right and left leg ($p=0.00$; $p=0.00$, respectively), and force impulse on the right and left leg ($p=0.00$; $p=0.00$, respectively). This represented an increase of 7%±9 and 8%±9 for the right and left legs, respectively on the forward lunge distance, a decrease of -173.7%±217.6 and an increase of 144.9±794.2% for the impact index on the right and left legs, respectively, and a 1%±5 increase for the force impulse on the left leg. Additionally, there were decreases of 22%±23 and 24%±28 in contact time for the right and left legs, respectively, and a decrease in the force impulse for the right leg of 21%±23. This data indicated that women participating in the Curves fitness and diet program are better able to step further with each leg when performing a forward lunge. An assumption exists that the joint may be improving to allow for this to occur, but further research is needed. In addition, the women participating in the Curves fitness and

diet program had decreased contact times when performing a forward lunge, which indicates the amount of foot contact before returning to the starting position was less due to losing weight, gaining strength, and improving balance. Lastly, the women participating in the Curves fitness and diet program had decreases in their force impulse while performing a forward lunge. This is the percentage of body weight per second, which is the impact distance with contact time. It is assumed that since the women lost weight and their joints improved, the force impulse also improved. However, further research is needed. There were no statistically significant time effects for impact index on the right and left leg (p=0.60; p=0.08). This indicated the women participating in the Curves fitness and diet program did not have improvements in balance when performing this test. There were no statistically significant interactions for either leg for the following variables: distance (p=0.53; p=0.91, respectively), impact index (p=0.73; p=0.90, respectively), contact time (p=0.98; p=0.96, respectively), and force impulse (p=0.87; p=0.95, respectively). Therefore, results from the present study indicated that glucosamine and chondroitan supplementation did not affect the balance of the women participating in the study, but did positively affect the knee joint as a result of the Curves fitness and diet program.

Isokinetic Procedures

Based on the data collected, statistics revealed significant time effects for the following isokinetic variables at 60 degrees/second: left leg peak torque extension (p=0.01), right leg peak torque flexion (p=0.00), left leg peak torque flexion (p=0.00), left leg peak torque/body weight extension (p=0.01), right leg peak torque/body weight flexion (p=0.00), left leg peak torque/body weight flexion (p=0.00), right leg work

fatigue flexion (p=0.02). Although there were no statistically significant differences between groups, there were time differences. These results implied the women were able to increase their peak torque knee strength, similar to performing a 1 repetition maximum, peak torque/body weight, and work fatigue, similar to muscular endurance test over the course of the study for the above specified legs when performed at a slower speed of 60 degrees/second. It is assumed there will be less work fatigue as muscular strength and endurance improves. It is also assumed that the knees are stronger, because the women are participating in an exercise and diet program and so they are working harder. This implied that knee strength and work fatigue improved. However, further research is needed. There were no statistically significant interaction effects for the dietary supplement groups.

There were statistically significant time effects for the following isokinetic variables at 180 degrees/second: left peak torque extension (p=0.00), right peak torque extension (p=0.04), left peak torque flexion (p=0.00), right peak torque flexion (p=0.00), right peak torque/body weight extension (p=0.00), left peak torque/body weight extension (p=0.00), right peak torque/body weight flexion (p=0.00), left peak torque/body weight flexion (p=0.00), left work fatigue extension (p=0.04). Although there were no statistically significant differences between groups, there were time differences. These results implied the women were able to increase their peak torque knee strength, similar to performing a 1 repetition maximum, peak torque/body weight, and work fatigue, similar to muscular endurance test over the course of the study for the above specified legs when performed at a faster speed of 180 degrees/second. It is assumed there will be less work fatigue as muscular strength and endurance improves. It is also assumed the

knees are stronger, because the women are participating in an exercise and diet program and so they are working harder. This implied that knee strength and work fatigue improved over the course of the study for the above specified legs when performed at 180 degrees/second. However, further research is needed. There were no statistically significant interaction effects for the dietary supplement groups.

Statistical results revealed isokinetic knee strength 300 degrees/second for the following time effect variables were significant: right peak torque extension ($p=0.04$), left peak torque extension ($p=0.00$), right peak torque flexion ($p=0.00$), left peak torque flexion ($p=0.00$), right peak torque/body weight extension ($p=0.04$), left peak torque/body weight extension ($p=0.00$), right peak torque/body weight flexion ($p=0.00$), and left peak torque/body weight flexion ($p=0.00$). Although there were no statistically significant differences between groups, there were time differences. These results implied the women were able to increase their peak torque knee strength, similar to performing a 1 repetition maximum, peak torque/body weight, and work fatigue, similar to muscular endurance test over the course of the study for the above specified legs when performed at a faster speed of 300 degrees/second. It is assumed that there will be less work fatigue as muscular strength and endurance improves. It is also assumed that the knees are stronger, because the women are participating in an exercise and diet program and so they are working harder. This implies that knee strength and work fatigue improves. However, further research is needed. There were no statistically significant interaction effects for the dietary supplement groups.

The research supports those findings of Jan et al. (1991), which indicated improvements in peak torque for female patients with knee OA. Our research also

supports Carter, et al. (1997), which indicated peak torque improvement by 198.5 Nm, which represents an increase of approximately 10%. Further research is needed using a larger sample size for possible statistical group x time interaction effects. In addition, it would be interesting to determine changes in quadriceps strength over the course of the study to evaluate a correlation between knee strength and knee functional balance tests.

Changes in Psychometric Questionnaires-Pain Scale

Based on the data collected for our study, statistical results for knee pain revealed significant time effects (p=0.00) and a trend toward a significant interaction (p=0.20) for the dietary supplement groups. This represented a 123%± improvement in knee pain for women with OA participating in the study. Although there were no statistically significant changes between groups, there were time effect differences due to the Curves fitness and diet program. This implied that women participating in the Curves fitness and diet program had decreases in knee pain over the course of the study. Similarly to the study conducted by Braham, et al (2003), there were no statistically significant group x time interactions (p=0.20) with knee pain. However, statistical analysis revealed a very large group x time interaction effect size (d=1.1) for knee pain, indicating that significance may be reached with a larger sample size. This indicated a potentially positive outcome for future research studies using a larger outcome for an increase in power and the likelihood of a statistically significant group x time interaction effect for knee pain based on the visual analog scale. The results of having a statistically significant interaction for this type of study if performed with a larger sample size would be profound and warrant further research to distinguish if the active ingredients of the

supplement, such as MSM, zinc, boswellia serrata extract play an integral role in decreasing knee pain, in combination with the glucosamine and chondroitan.

The research also supports the findings of Pavelka, et al. (2002) indicating an improvement in knee pain. Many of the research studies discussed in chapter 2 evaluated pain using various tests. The pain scores for these studies were all found to be significant. However, the studies involved much larger sample sizes (Pavelka, et al. 2002; n=202; Usha, et al., n=118; Kulkami, et al., 1991; n=42) over an extended period of time of up to three years. Thus, extending the length of our study would warrant further research for evaluating knee pain.

WOMAC^{TM} 3.1 Index

Based on the data collected for our study, there were statistically significant time effects for pain (p=0.00), stiffness (p=0.00), and limitations in physical function (p=0.00). The overall results of the study represented a 112%±317 decrease in knee pain, 70%±234 reduction in knee stiffness and 96%±1356 decrease in physical function limitations. Although, there were no between group differences, there were time differences in knee pain, stiffness, and physical function as related to the WOMAC^{TM} Index for women participating in the Curves fitness and diet program. Again, it is assumed that knee pain, stiffness, and physical function limitations will decrease due to the women participating in an exercise and diet program. There were no statistically significant interactions for the dietary supplement groups for pain (p=0.43), stiffness (p=0.74), and physical function (p=0.91). Statistical analysis revealed a medium effect size (d=0.4) for pain, which could lead to significance with a larger sample size. A negligible (d=0.11) and small effect (d=0.22) size was demonstrated for stiffness and physical function limitations,

respectively. A larger sample size would have increased the power of the study and the likelihood of statistical significance.

This data supports the findings of Reginster (2001) in that the treatment group had decreases in OA symptoms. The data supports Pavelka et al. (2002) which indicated the treatment group had improvements of 20-25% and significant differences occurred on the WOMAC™ scales (Pavelka, Gatterova, Olejarova, et al., 2002). We also agree with Chrubasik, et al. (2000) which indicated a 14% reduction in the WOMAC™ pain scores for the treatment, when compared to a 2% increase in pain for the placebo group. In addition, the results of having a statistically significant interaction for this type study if performed with a larger sample size would be profound and warrant further research to distinguish if the active ingredients of the supplement, such as white willow bark extract plays an integral role in decreasing knee pain in combination with the glucosamine and chondroitan.

Eating Satisfaction

Statistical data for our study revealed significant time effects for appetite ($p=0.04$), hunger ($p=0.02$), energy ($p=0.00$), and quality of diet ($p=0.00$) for the dietary supplement groups. This indicated a decrease in appetite of 13%±36, hunger 17%±34, increase in energy of 24%±35, and improvement in the quality of diet of 19%±38 for women with OA. This implied that women following the Curves fitness and diet program experienced a decrease in appetite and hunger, increase in energy and quality of diet while losing weight. This result is a very positive outcome for allowing women with knee OA know they can experience decreases in appetite and hunger and still lose weight. There were no statistically significant group x time interactions for appetite

(p=0.07). There were no time or group x time interaction effects for satisfaction of food (p=0.53; p=0.40, respectively), and feeling of fullness (p=0.59; p=0.37, respectively). Likewise, there were no statistically significant between group effects for appetite (p=0.75), hunger (p=0.97), satisfaction of food (p=0.29), feeling of fullness (p=0.13), energy (p=0.70), and quality of diet (p=0.51). There were no other research studies found to compare eating satisfactions in women with OA.

Quality of Life

Statistically significant time effects were observed for physical function (p=0.01), energy/fatigue (p=0.00), social function (p=0.01), and mental health (p=0.00). This indicated an increase in physical function of 37%±52, energy/fatigue 55%±69, social function 40%±76, and mental health 22%±84. This implied the women participating in the Curves fitness and diet program experienced increases in physical function, energy/fatigue, social function, and mental health over the course of the study. The results indicated the women experienced better health-related quality of life (HRQOL) by having higher scores for physical function, energy/fatigue, and emotional well-being.

Our data supports Bowden, et al. (2004), which demonstrated that women following the Curves fitness and diet program had increases in quality of life. In review of the Brenda et al. (2001) study and those performed by Bowden, et al. (2004), the significant time effect items of our study may have played a role in the women adhering to the Curves program and following the study protocol, but further research is suggested. Our data also supports Sliwinski et al. (2006) indicating an increase in the QOL physical function ($p<0.001$) for older adults. Similarly, our data supports the findings of Baird, et al. (2006) indicating improvements in QOL for older adults with OA. This study found

that HRQOL significantly increased after 12 weeks for intervention group as opposed to the control group.

Changes in Blood Samples- Serum Chemistry Profiles

Research performed by Rasmussen, et al. (2004), and Slonaker, et al. (2004) on serum chemistry profiles for women participating in the Curves fitness and diet program have been very favorable. While total cholesterol decreased by 4%, LDL decreased by 3%, and triglycerides decreased by 12% (Rasmussen, et al. 2004).

The following variables were statistically significant for time effects: LDL ($p=0.03$), HDL ($p=0.00$), ALT ($p=0.01$), BUN ($p=0.01$), total bilirubin ($p=0.00$), creatinine ($p=0.00$), uric acid ($p=0.04$), total CK ($p=0.00$). There was one statistically significant between group variable for HDL ($p=0.04$). This represented a decrease in LDL, HDL, and triglycerides for the active group of -15%, -12%, and -7%, respectively. The placebo group had decreases in LDL, HDL, and triglycerides of -4%, -11%, and -4%, respectively. This implied that HDL and LDL cholesterol decreased in the active group over the course of the study. These research findings support those determined by Rasmussen, et al. (2004), and Slonaker, et al. (2004). Although there were time effects, there was also one group x time effect for the variable ALT. There was a statistically significant interaction for ALT ($p=0.05$) for the dietary supplement groups. Statistical post hoc tests for the ALT significant interaction effect revealed that the significance is due to both the active treatment and Curves fitness and diet program. Although some hematological variables decreased over time, there were no clinically significant interactions observed in remaining hematological markers. Based on the data collected, the Curves fitness and diet program improved blood lipid profiles without adversely

affecting the general markers of clinical status. The serum chemistry blood analysis was used for clinical safety and assessment of some health parameters.

Whole Blood Cell Values

There were no statistically significant group, time or group x time interaction effects for the following whole blood cell variables: WBC (p=0.72; p=0.61; p=0.58, respectively), neutrophils (p=0.98; p=0.67; p=0.10, respectively), lymphocytes (p=0.76; p=0.84; p=0.35, respectively), monocytes (p=0.62; p=0.10; p=0.62, respectively), basophils (p=0.36; p=0.49; p=0.41, respectively), eosinophils (p=0.24; p=0.59; p=0.91; respectively), RBC (p=0.96; p=0.88; p=0.90, respectively), hemoglobin (p=0.74; p=0.14; p=0.76; respectively), and hematocrit (p=0.93; p=0.10, p=0.59, respectively). Based on the data collected, it does not appear that the Curves fitness and diet program and/or combination of the glucosamine and chondroitan supplement affects whole blood cell values. However, further research can be conducted based on a larger sample size to better determine this analysis.

Hormonal Responses

Vacanti, et al. (2004) and Mulligan, et al. (2004) evaluated hormonal responses in women participating in the Curves fitness and diet program. The results demonstrated that leptin was reduced overall by 17% (Vacant, et al. 2004). In addition, fasting insulin was reduced by 15% overall, while insulin sensitivity improved by 19% (Mulligan, et al. 2004).

The goal of measuring hormonal blood markers for our study was to indicate inflammation and determine whether weight loss induced by diet, exercise, and/or

glucosamine and chondroitan supplementation influenced obesity markers. There were statistically significant time effects for C-reactive protein (p=.03) and leptin (p=.01). This represented an overall increase for C-reactive of 39%±89 and a reduction of 21%±26 in leptin. This implied that the women participating in the Curves fitness and diet program had an increase in C-reactive protein and a decrease in leptin. It is assumed that less leptin resistance lowers high levels in obese people (Vacanti, et al., 2004). There were no statistically significant group, time, or group x time interactions for any of the following hormonal blood markers: IL-6 (p=0.42; p=0.95; p=0.49, respectively), TNF-α (p=0.88; p=0.96; p=0.95, respectively), cortisol (p=0.97; p=0.93; p=0.11, respectively), and insulin (p=0.11; p=0.86; p=0.82, respectively). However, statistical analysis revealed a medium group x time effect size (d=.45) for cortisol. There were no statistically significant group or group x time interactions for C-reactive protein (p=0.54; p=0.59, respectively) and leptin (p=0.62; p=0.62, respectively). Although our data for C-reactive protein, TNF-α, and IL-6 do not currently agree with the findings of Penninx, et al (2004) who evaluated inflammatory markers in 274 patients with OA participating in and exercise and nutrition intervention, the effect sizes for our study warrant further research. Statistical analysis revealed a huge effect size (d=1.55) for TNF-α, medium effect sizes (d=0.46; d=0.46, respectively) for C-reactive protein and IL-6, and a small effect size (d=0.19) for leptin. Therefore, a larger sample size would have increased the power of the study and the likelihood of statistical significance for TNF-α, C-reactive protein, and IL-6.

Conclusions

In conclusion, the Curves fitness and diet program benefits women with knee osteoarthritis (OA). There were many positive training adaptations for women with knee osteoarthritis participating in the Curves program. These adaptations included decreased weight loss (3%±4), decreased fat mass (6%±8), decreased percent body fat (4%±3), increased 1 repetition maximal muscular strength (11%±12), increased muscular endurance (13%±12), increased isokinetic strength (ranging from 10-25%±4), decreased knee pain (112%±317), stiffness (70%±234), limitations in physical function (96%±1356), improved quality of life variables of physical functioning (37%±52), energy/fatigue (55%±69), social functioning (40%±76), mental health (22%±84), appetite (13%±36), hunger (17%±34), increased energy (24%±35), and quality of diet (19%±38). In addition, strong effect sizes (d=1.1) from the statistical data revealed that VAS knee pain could potentially decrease with a larger sample size. Glucosamine chondroitan supplementation tended to decrease perceptions of pain, with no statistically significant improvement in strength, or functional status. However, strong/moderate effect sizes were observed in WOMAC^{TM} pain (d=0.4), left knee flexion (d=0.53), 1 repetition max (d=0.53), total work (d=0.72), maximal systolic blood pressure (d=0.69), TNF-α (d=1.55), C-reactive protein (d=0.46), IL-6 (d=0.46), and cortisol (d=0.45). These findings suggest that glucosamine and chondroitan supplementation during a weight loss and fitness program may have therapeutic benefits for women with OA.

This study is the first of its type evaluating the benefits of the Curves fitness and diet program in combination with the use of a glucosamine and chondroitan commercially available supplement in women with knee OA. However, more research

using a larger population and longer time period is needed to examine the effect of glucosamine and chondroitan supplementation on training outcomes with OA patients. Many of the research performed on OA patients involved only a supplementation intervention and/or no supplementation and an exercise intervention. Some of the studies performed on OA patients involving exercise interventions used general fitness field tests, (i.e. 6-minute walk test, stair-climb test) to evaluate aerobic capacity. Our study used more scientifically detailed testing methods to determine exercise capacity. Therefore, it was difficult to compare the results of these studies based on the methods used with the results. Additional research evaluating a non-exercise and exercise intervention with glucosamine and chondroitan supplementation using scientifically detailed testing procedures would be beneficial for evaluating the symptoms associated with OA.

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