

Canadian Academy of Sport and Exercise Medicine Position Statement: Osteoporosis and Exercise

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Abstract: The purpose of this paper is to look at the effects of exercise in the treatment and prevention of osteoporosis in athletes of all age groups. Recommendations for exercise programs will be discussed as a tool to improve bone health. Medical management of osteoporosis will be reviewed mainly as it pertains to postmenopausal women.

Key Words: osteoporosis, bone mineral density, fragility fracture

(*Clin J Sport Med* 2013;23:333–338)

INTRODUCTION

Osteoporosis has become an important health issue in North America for women of all ages, but especially those individuals in the postmenopausal age group and female endurance athletes.¹ We need appropriate recommendations and relevant information for the prevention and treatment of osteoporosis for recreational and high level athletes.

Data from Statistics Canada notes that, in the fiscal year 2003/2004, patients aged 60 or older requiring treatment at an acute care hospital for hip fracture totaled 23 621. Annual costs to Medicare for treatment of hip fractures are estimated at \$650 million.² Leslie et al have shown that age adjusted hip fracture rates in Canada have decreased in men and women since 1985.³ However, the absolute number of hip fractures continues to increase.

Osteoporosis is a chronic progressive disease characterized by decreased bone strength, low bone mass, and microarchitectural bone deterioration leading to increased risk of fracture. Primary osteoporosis is due to age-related bone loss. The rate of activation of skeletal bone remodeling units is normal in primary osteoporosis, but the filling of the bone resorption pits by osteoblasts is incomplete. Remodeling of bone is a natural occurrence throughout life and involves the coupled action of osteoclasts and osteoblasts.^{4,5}

Secondary osteoporosis results from chronic medical conditions, nutritional deficiencies, and medications. The secondary causes are outlined in Appendix A. The rate of activation of skeletal bone remodeling units is increased

initially so that an increased proportion of the skeleton is being remodeled at any one time.⁴

World Health Organization definitions of osteopenia and osteoporosis are listed below:

<u>Normal</u>	Hip bone mineral density (BMD) > 1.0 SD below the young adult female reference mean (<i>T</i> score above -1.0)
<u>Osteopenia</u>	Hip BMD between 1.0 and 2.5 SDs below the young adult female reference mean (<i>T</i> score between -1.0 and -2.5)
<u>Osteoporosis</u>	Hip BMD = or >2.5 SDs below the young adult female reference mean (<i>T</i> score at or below -2.5)
<u>Severe Osteoporosis</u>	Hip BMD = or >2.5 SDs below the young adult female reference mean in the presence of 1 or more fragility fractures

A low impact fracture is a fracture that results after a fall from standing height or less. A fragility fracture occurs from no trauma such as cough, sneeze, or sudden movement.⁴ Fragility fractures represent 80% of all fractures in women over 50 years of age.⁶

The purpose of this paper is to look at the effects of exercise in the treatment and prevention of osteoporosis in athletes of all age groups. Recommendations for exercise programs will be discussed as a tool to improve bone health. Medical management of osteoporosis will be reviewed mainly as it pertains to postmenopausal women. This paper will not specifically discuss the management of stress fractures.

METHODOLOGY

The exercise recommendations discussed in this paper for the prevention and treatment of osteoporosis reflect a review of the published literature as of May 2012. The most recent clinical practice guidelines for the medical management of osteoporosis by the Scientific Advisory Council of Osteoporosis Canada 2010 have been reviewed and utilized for the discussion of recommendations.⁶

INFLUENCE OF EXERCISE IN CHILDREN AND YOUNG ADULT WOMEN

The early adult years are the most important for achieving high BMD, as peak bone mass is thought to be attained by the

Submitted for publication June 9, 2013; accepted July 19, 2013.

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This position statement was prepared by the CASEM Women's Issues In Sport Medicine Committee.

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end of the third decade.⁷ However, 95% of peak bone mass is achieved by age 17 years in girls and 20 years in boys.⁸ Approximately 26% of total adult bone mass is achieved in a 2-year period during peak bone gain that begins at 12.5 years in girls and 14.1 years in boys.⁹ Foley et al showed, in their 20-year prospective study of Australian school children age 7 to 15 years, that increased childhood fitness levels, especially in females, leads to an increase in peak bone mass independent of current loading.¹⁰

Athletes aged 18 to 24 years have shown increased bone mineral density when compared with young women who were more sedentary. The sports participated in included soccer, rugby, and distance running. Rugby showed the greatest BMD at the femoral neck and lumbar spine.^{11,12} Younger athletes involved in weight-bearing sports showed significantly higher bone mass than less active peers or those not involved in weight-bearing sports.⁹

A 2010 randomized control study from Japan compared office-based brief high-impact exercise of vertical jumps and stretching versus stretching alone in a group of healthy premenopausal women. There was a significant difference in the change in femoral neck BMD between the groups in favor of the high-impact exercise group.¹³

A jumping intervention 3 times per day over 8 months showed a significant increase in BMD in school children. This pilot study, called “Bounce at the Bell”, involved children jumping for approximately 1 minute 3 times per day over a period of 8 months. This is a simple program that could be implemented in any school by any teacher.¹⁴

FEMALE ATHLETE TRIAD

Osteoporosis in a younger, premenopausal female athlete immediately alerts the physician to be vigilant in investigating the athlete for signs of the Female Athlete Triad. Clinical manifestations include low energy availability, disordered eating and eating disorders, menstrual disturbances or amenorrhea, and osteopenia or osteoporosis.¹⁵ These athletes may present with signs and symptoms of a stress fracture. Improving bone health in women with Female Athlete Triad is a completely different entity from the management of osteoporosis and fragility fractures in perimenopausal and postmenopausal women.

Preparticipation history and physical exam are an important time in which to determine if there is a problem and implement prevention and/or treatment. The Female Athlete Triad Coalition has preparticipation history, physical, and investigation recommendations on their Web site developed by Mountjoy, Cruz, Lebrun, and Hutchinson (Appendix B).

Prevention strategies are aimed at improving nutritional status with Vitamin D (800 IU/day), calcium supplements (1200 mg/day), and education. Prevention also includes improving policies and procedures of governing sports bodies to cease harmful weight loss practices.

POSTMENOPAUSAL WOMEN

The 2009 Cochrane Review by Bonaiuti et al about the effects of exercise as a treatment of osteoporosis showed that

exercise is effective in slowing bone loss after 1 year or longer. Specifically aerobic, weight-bearing, and resistance exercises are all effective on the BMD of the spine in postmenopausal women.¹⁶

The 2011 Cochrane Review by a group from the Scottish Centre for Evidence Based Care of Older People in Glasgow examined the effectiveness of exercise interventions in preventing bone loss and fractures in postmenopausal women.¹⁷ They reviewed 43 randomized controlled trials (RCTs) and concluded that the most effective type of exercise intervention for femoral neck BMD is progressive resistance exercise for the lower limbs while the BMD of the spine improved with weight bearing and resistance training.

The Bone, Estrogen, Strength Training (BEST) Study was a randomized controlled trial that examined the effects of exercise on BMD in 2 populations of postmenopausal women, those using Hormone Replacement Therapy (HRT) and those not using HRT. This community-based osteoporosis prevention exercise program showed significant increase in femoral BMD with exercise and HRT compared to women on HRT who did not exercise. Exercise without HRT prevented loss of BMD in the lumbar spine.¹⁸

An RCT looked at the effect of a community-based exercise program on the risk of falls in inactive osteoporotic 65- to 75-year-old women between 1996 and 2000. The study compared 2 groups of women who were randomized to either an exercise intervention or no exercise intervention. Improvement in dynamic balance and strength was found to be significant in the group who had the exercise intervention.¹⁹ This type of study confirms our commonsense knowledge that exercise will aid in injury prevention.

An RCT by Nelson et al showed that, in postmenopausal women, high-intensity resistance training 2 days per week results in a gain of 1% BMD of the femoral neck and lumbar spine, while the group that did not exercise lost 2.5% and 1.8% at the same bone sites. Beneficial gains in the exercise group showed significant increases in strength, dynamic balance, and total body lean mass, as well as becoming more active overall, with a 27% increase in physical activity unrelated to the intervention.²⁰

Iwanmoto et al showed the necessity of maintaining an exercise program in postmenopausal women. This study placed women in 3 different groups with similar baseline BMD. The groups were randomly assigned to a control group, a 2-year exercise training group, and a 1-year exercise training plus 1-year detraining group. Exercise training involved brisk walking and gymnastic training. All groups were prescribed Vitamin D and calcium daily. The mean percent change in BMD was significant in the 2 exercise groups at 1 year, but the detraining group had similar BMD to the control group after 1-year detraining.²¹

The Erglan Fitness Osteoporosis Prevention Study from the University of Erglan, Germany, in 2004 showed that high-intensity exercise over a 26-month period significantly improved strength and endurance, with reduction in bone loss and back pain in postmenopausal women. Isometric trunk flexor and trunk extensor strength was significantly increased from baseline. Both the control and exercise groups took 1500 mg of calcium and 500 IU of Vitamin D. There

were significant differences between the control group and the exercise group with respect to BMD of the spine and femur.²²

This review of the literature revealed a lack of good RCTs. Many trials failed to specifically utilize subject groups with diagnosed osteoporosis for study of exercise intervention. The most important clinical end-point in perimenopausal and postmenopausal women is a fragility fracture. The following recommendations are tools in the prevention of osteoporosis and fragility fractures in these women.

RECOMMENDATIONS

Exercise Prescription for Optimizing Bone Development in Youth

To optimize bone health, all youth should accumulate a minimum of 60 minutes of weight-bearing activity daily. Forty minutes of moderate to vigorous physical activity daily is necessary to build hip strength and bone structure. This can include 15 minutes of jumping 3 times per week. Sports participation throughout childhood is essential in optimizing bone health and should be advocated.²³ The American College of Sports Medicine recommends 10 to 20 minutes of impact activities 3 days per week including plyometrics, jumping, moderate intensity resistance training, and participation in sports that involve jumping and running.⁷

Exercise Prescription for Preservation of Bone Health During Adulthood

Moderate to high intensity weight-bearing endurance activities, resistance activities, and jumping activities are recommended 3 times per week for 30 to 60 minutes to preserve bone health.^{1,7} Activities that have shown outcomes favorable to bone health in premenopausal women include jogging, strength training, jumping exercises, and aerobics.²⁴ Explosive muscle contractions have shown the greatest osteogenic stimulus but must be progressively achieved from the start of the training program.¹

Recommendations Regarding the Female Athlete Triad

Triad athletes that need Bone Mineral Density Testing are those athletes who have:

1. Amenorrhea, oligomenorrhea, disordered eating, or an eating disorder for 6 months or more.
2. Stress fractures or fractures from minimal trauma.¹⁵

Results of bone mineral density testing must be interpreted differently in Triad athletes. A low normal result (*t* score -1.0 to -2.5) or osteopenia should be considered as osteoporosis in these young women.¹⁵

Management of the Female Athlete Triad requires a team approach consisting of medical, psychiatric, and nutritional specialists.²⁵ Treatment for Triad athletes incorporates nutritional counseling that may include psychotherapy. The goal of restoring the female athlete to a eumenorrhic state can

be achieved by increasing energy intake to 30kcal/kg fat free mass/day.²⁵

Bisphosphonates are not recommended in this age group. Oral contraceptives are not endorsed by the Triad Coalition for this problem. Underlying medical conditions should be addressed if discovered during investigations.

Exercise Recommendations for Postmenopausal Women

An innovative community-based program was designed by the staff of the British Columbia Women's Hospital Centre Osteoporosis Program in Vancouver to improve functional ability and decrease risk of falls.²⁴ The outline of this program is seen in Appendix C. A study looking at the efficacy of this program in women age 65 to 85 revealed that individuals who completed this program showed increased general health, decreased fear of falling, decreased back pain, and increased ability to undertake activities of daily living.¹⁹

High-impact exercises have not shown major gains in BMD in postmenopausal women, but weight-bearing endurance exercise (30–60 minutes) 3 to 5 times per week is more beneficial. Strength training to load the spine and hip area is recommended 3 days per week. These weightlifting exercises could include leg press, leg extension, leg curl, squats, loaded back extensions with shoulder, and arm exercises.¹

SUPPLEMENTATION FOR OSTEOPOROSIS

The consensus by various health institutes suggests that supplementation in the prevention of osteoporosis in premenopausal women should include a daily intake of elemental calcium of 1000 mg per day until menopause with an increase to 1200 mg per day thereafter. If this cannot be obtained through diet, then calcium carbonate or calcium citrate can be taken as a supplement. Calcium citrate is preferred for patients who have history of kidney stones or are hypochlorhydric (including persons on gastric acid inhibiting drugs).

Vitamin D supplementation should include 400 IU for all healthy adults. For adults over age 50 at moderate risk of Vitamin D deficiency (this may include the elderly, chronically ill, housebound, or institutionalized persons), the daily recommended intake is 800 to 1000 IU daily. In some cases, daily doses of 1000 to 2000 IU may be required to achieve optimum blood levels of greater than or equal to 75 nmol/L.⁴

PHARMACOLOGICAL THERAPY

The integrated approach to management of patients at risk for fragility fracture is shown in Appendix D as outlined by Osteoporosis Canada.⁶

The 2010 clinical practice guidelines from Osteoporosis Canada recommend the following:

1. First-line therapies for prevention of hip, vertebral, and nonvertebral fractures in menopausal women requiring treatment of osteoporosis include alendronate, risendronate, zoledronic acid, and denosumab.
2. Raloxifene can be used as first-line therapy for prevention of vertebral fractures in menopausal women.

- Hormone treatment can be used as first-line treatment in menopausal women who require treatment of vasomotor symptoms and osteoporosis.
- Menopausal women intolerant of first-line therapies can be treated with calcitonin or etidronate. (The long-term use of calcitonin is currently under review by Health Canada.)
- First-line treatment for men with osteoporosis includes alendronate, risedronate, and zoledronic acid.
- Testosterone is not recommended for the treatment of osteoporosis in men.

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APPENDIX A

Secondary Causes Of Osteoporosis

Endocrine disorders

- Cushing syndrome
- Hypogonadism
- Hyperthyroidism
- Primary hyperparathyroidism

Rheumatological disorders

- Rheumatoid arthritis
- Systemic lupus erythematosus
- Ankylosing spondylitis
- Juvenile polyarticular arthritis

Malignancy

- Multiple myeloma

Pharmacotherapy

- Glucocorticoid excess
- L-thyroxine overreplacement
- Anticonvulsants
- Lithium, aluminum
- Cytotoxic drugs, immunosuppressants
- Heparin (long term)
- Drugs causing hypogonadism

Gastrointestinal disease

- Chronic liver disease
- Inflammatory bowel disease
- Celiac disease
- Gastric bypass or gastrectomy

Renal insufficiency or failure

Miscellaneous causes

- Vitamin D deficiency
- Alcohol abuse
- Anorexia nervosa, malnutrition
- Movement disorders (Parkinson disease)
- Amyloidosis
- AIDS, HIV
- Chronic obstructive pulmonary disease
- Cerebrovascular accident
- Multiple sclerosis
- Prolonged bed rest or wheelchair bound from any cause

APPENDIX B

Female Athlete Triad Screening Questionnaire (To Identify Those Female Athletes At Risk)

- Do you worry about your weight or body composition?
- Do you limit or carefully control the foods you eat?

3. Do you try to lose weight to meet weight or image/appearance requirements in your sport?
4. Does your weight affect the way you feel about yourself?
5. Do you worry that you have lost control over how much you eat?
6. Do you make yourself vomit, use diuretics or laxatives after you eat?
7. Do you currently or have you ever suffered from an eating disorder?
8. Do you ever eat in secret?
9. What age was your first menstrual period?
10. Do you have monthly menstrual cycles?
11. How many menstrual cycles have you had in the last year?
12. Have you ever had a stress fracture?
14. Do you worry if you have missed a workout?
15. Do you exercise or are you physically active as well as training for your sport?
16. Do you have stress in your life outside sport? What are these stresses?
17. Are you able to cope with stress? How?
18. What is your family structure?
19. Do you use or have you used these ways to lose weight?
 - a. Laxatives
 - b. Diuretics
 - c. Vomiting
 - d. Diet pills
 - e. Saunas
 - f. Plastic bags or wrap during training
 - g. Other methods (please state)

In-Depth Evaluation Of Athletes Identified As High Risk For The Triad By The Screening Questionnaire

Detailed History

Please circle the response that best matches your situation. Never=1 Rarely=2 Occasionally=3 More often than not=4 Regularly=5 Always =6

1. Do you want to weigh more or less than you do?
2. Do you lose weight regularly to meet weight requirements for your sport? How do you do it?
3. Is weight/body composition an issue for you?
4. Are you satisfied with your eating habits?
5. Do you think your performance is directly affected by your weight? If so, how?
6. Do you have forbidden foods?
7. Are you a vegetarian? Since what age?
8. Do you miss meals? If so, how often? For what reason?
9. Do you have rapid increases or decreases in your body weight?
10. What do you consider your ideal competitive weight?
11. Has anyone ever suggested you lose weight or change your eating habits?
12. Has a coach, judge, or family member ever called you fat?
13. What do you do to control your weight?

APPENDIX C

Osteofit Program (www.osteofit.org)

Warm-up: Gentle range of motion exercises for the major joints performed either seated or standing for 10 to 15 minutes. The warm-up ends with walking and simple dance routines with tempos of 110 to 126 beats per minute.

Workout: The workout includes strengthening and stretching exercises for the improvement of postural problems of thoracic kyphosis, chin protrusion, and medially rotated shoulders. Exercises to improve coordination and balance that include heel raises, 2-legged heel-toe rock, and progressing to tandem walks and obstacle courses. Hip stabilization-focused exercises with leg and balance exercises. Trunk stabilization is focused with upper extremity strengthening in the standing position. Functional ability exercises include getting up from a chair and the floor. Repetitions are from 8 to 16 and weights are light. Upper and lower extremity exercises are alternated to prevent injury. Stretches are included at the end of the workout.

Relaxation: Deep breathing and relaxation exercises to soft music or nature sounds.

APPENDIX D REVIEW SYSTEM

