

Bone Density Issues in Aquatic Exercise

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Definitions

Osteoporosis (Google search = 27 definitions)

Simplest: A decrease in bone density. www.methodfitness.com

Most Complicated: (Wikipedia)

Osteoporosis is a disease of bone that leads to an increased risk of fracture. In osteoporosis the bone mineral density (BMD) is reduced, bone microarchitecture is disrupted, and the amount and variety of non-collagenous proteins in bone is altered. Osteoporosis is defined by the World Health Organization (WHO) in women as a bone mineral density 2.5 standard deviations below peak bone mass (20-year-old healthy female average) as measured by DXA; the term "established osteoporosis" includes the presence of a fragility fracture.[1]

Osteopenia (Wikipedia)

Osteopenia is a decrease in bone mineral density that can be a precursor condition to osteoporosis. However, not every person diagnosed with osteopenia will develop osteoporosis.

Facts and Figures (NIH)

- 44 million Americans (68% women) have osteoporosis (10 m) or osteopenia (34m)
- Each year 80,000 men have hip fracture and 1/3 die within a year
- Osteoporosis can strike at any age
- Osteoporosis and related fractures costs \$14 billion each year

Diagnosis

- X Ray Tests
- Bone Mineral Density Tests
- Bone Scans
- Laboratory Tests
 - Blood calcium levels / Blood vitamin D levels
 - Thyroid function / Parathyroid hormone levels
 - Estradiol levels to measure estrogen in women
 - Follicle stimulating hormone (FSH) test to establish menopause status
 - Testosterone levels in men
 - Osteocalcin levels to measure bone formation
 - Urine tests to measure calcium metabolism or the rate the bone is being broken down or resorbing

Treatment

- Healthy diet rich in calcium and vitamin D
- Physical exercise
- Healthy lifestyle (not smoking, avoid excessive alcohol use)
- Medication

Some prescription medications and chronic diseases can cause bone loss.

Aquatic Research

Bone Density Research specific to Aquatic Exercise: Typical format = Training Studies

- Divide in groups (exercise and control)
- Measure variables (pre test)
- Exercise Program
- Measure variables (post test)

Israel, 1994 (Wingate Institute)

One of the first studies to suggest using shallow water resistance as a bone loading activity

25 participants in land exercise group and 25 in water exercise group

Postmenopausal

5 month, 3xs/week exercise program

Bone density measurement in distal end of wrist, radius (Compton Scattering Technique)

Goals: compare the mean change in bone density between the two groups and compare the mean change in bone density within each group

Significant increases in bone density in both groups pre and post measurements

Water group showed significantly greater increases compared to the land group
Wrist measurement = first clue that water's resistance may play a factor in building bone density

Japan, 1994 (Japan Women's University)

Divided postmenopausal women into three groups:

- Veterans (35.2 months on average)
- Newcomers (began 3-4 weeks prior)
- Control (non-exercisers)

Veterans BMD was significantly higher than the newcomer and control groups

Rate of change in bone density of the lumbar spine:

- -0.92%/ year in control group (N=30)
- +1.55%/ year in the veteran group (N=20)

Questionnaires indicated an increased general awareness of health and fitness and daily life enhancement in veteran group

Results suggest that consistently participating in water exercise is an important factor in preventing bone loss
Appears to promote daily activity awareness, promote health, and improve daily life

Canada, 1997

Program designed for women with low bone mass

77 post menopausal women 50-70 years old with spinal or femoral bone density below the fracture threshold

Waist high water 60 minutes 3xs/ week for 12 months

Spinal and femoral BMD measured by dual-energy X-ray absorptiometry

Spinal BMD decreased significantly ($p < .001$)

No change in femoral neck BMD ($p = .90$)

Flexibility, agility, strength/ endurance, and CR endurance were affected positively ($p > .001$)

Psychological well-being improved significantly ($p > .001$)

Intervention successful in improving functional fitness and psychological well-being

Maintained BMD in femoral neck

Future studies needed to identify water exercises that are safe yet exert enough stress

Malliopoulis, et al 2000

12th European Congress of Physical Medicine and Rehabilitation Abstract Book. (not much information- secondary source)

"showed that aquatic exercise designed to improve flexibility, posture and muscular strength increased vertebral bone mass and decreased the risk of new fractures."

"They explained this positive effect by the strains applied through the bones by muscle contractions."

Turkey, 2003

Objective to discover whether moderate increased physical activity such as aquatic exercise has anabolic effects on bone

Anabolic effects = Synthesis, opposite of catabolic. Relating to, characterized by or promoting anabolism. (building up from smaller molecules)

Evaluated with quantitative ultrasound and hormonal variables

Postmenopausal sedentary women followed in a 6 mo aqua exercise program & a control group

Calcaneal bone was measured

No medications with calcium, relevant nutrients were standardized for all

All subjects received 1000mg calcium / day

None had previous fractures

Instructed to maintain sedentary lifestyle or do only aquatic exercise sessions

Intensity 10-13 on Borg scale / Walking, jumping and swaying

IGF-1 (Insulin-Like Growth Factor)

A growth hormone-dependent factor synthesized by multiple tissues including bone, cartilage and bone cells, which stimulates the production of bone tissue by osteoblasts.

Exercise group increased by 36% (sig) / Control group decreased by 2% (not sig)

GH (Growth Hormone)

A hormone produced in the anterior pituitary gland that may indirectly stimulate bone formation and may be useful in treating osteoporosis.

Exercise group increased by 75% (sig) / Control group decreased by 61% (sig)

PTH (Parathormone)

A hormone secreted by the parathyroid gland. PTH regulates the level of calcium in the blood by adjusting the activity of bone cells (osteoblasts and osteoclasts) and kidney cells. Through the action of PTH and vitamin D, the body maintains a constant level of calcium in the blood.

Exercise group decreased by 31% / Control group = no significant increase

CT (Calcitonin)

A hormone secreted by the thyroid gland which inhibits bone resorption. It is used to slow the bone resorption rate in osteoporotic patients.

Exercise group increased by 54% (sig) / Control group decreased by 20% (not sig)

BUA (Broadband Ultrasound Attenuation)

Attenuation in ultrasound is the reduction in amplitude of the ultrasound beam as a function of distance through the imaging medium. Indicates bone structure and mineral content.

Exercise group increased by 19% (sig) / Control group decreased slightly (not sig)

SOS (Speed of Sound)

Accepted as an indicator of bone elasticity.

Exercise group increased 63% (sig) / Exercise groups not statistically significant

Study Limitations:

- Number of subjects
- Use of ultrasound as opposed to dual X-ray absorptiometry measurement
- 6 month study- longer same results?

Difficult for elderly people to do weight bearing exercises. Aquatic exercise is a good alternative.

Turkey, 2005

Looked at the effects of weight bearing and aquatic exercises on the calcaneal ultrasonic scores of postmenopausal sedentary women

Very similar to previous study with the addition of a land group- did similar exercises on land as in the water

Calcaneal BUA

- Aquatic exercise increased 3.1%
- Land exercise group increased 4.2%
- Control group decreased 1.3%
- Changes statistically significant for both exercise groups.
- No statistically significant differences in the comparison of the aquatic and weight-bearing (land) exercise groups

Concluded that aquatic and weight-bearing (land) exercises are both determined to increase ultrasound scores for calcaneal bone

If postmenopausal women cannot exercise on land, there is value to aquatic exercise

Israel, 2004 (University of Haifa)

Can water exercise delay bone density loss for post menopausal women?

One hour water exercise class 3xs / week for seven months

Measured DEXA and QUS (equipment) in four areas:

1. Vertebrae L-1 to L-4
2. Neck of hip bone on both legs
3. Proximal radius
4. Midshaft Tibia

Results indicated that water exercise had a positive effect on bone density and allowed women in the experimental group to preserve and even increase their bone density, in comparison to the control group which registered a loss.

Oregon State University, 2004

12 month shallow water exercise program on bone mineral density and physical function in post menopausal women

Measured BMD spine, total hip, femoral neck by dual x-ray absorptiometry

Measured leg power, arm endurance, CR fitness, flexibility

Exercise group 45 minute shallow water class 3xs / week for 12 months

Control group maintained initial activity levels

Over 12 month femoral neck BMD decreased 1.7% in the control group but did not change in the exercise group

Study provides preliminary evidence that shallow water exercise maintains femoral neck BMD in postmenopausal women

Effective for maintaining and improving physical function

Poland, 2007

Effect of long term deep water training on bone mineral density

Pre-menopausal group and post menopausal group

Forearm BMD was measured DXA

The mean values of BMD in both groups of postmenopausal women (exercisers and control group) were contained in the range of changes recognized as the progressive physiological process.

Diet not controlled / Several risk factors and dietary deficiencies identified

Exercise Program Variables (Wasserman, 2005)

Israel, Oregon, and both Turkey studies used exercise protocols considered to be “average” or “typical” following basic guidelines set by AEA and ACSM

A direct comparison of actual movements and additional variables such as water depth, state of BMD at study onset, initial physical conditioning, etc would provide additional insight into forming a “general” exercise protocol that would optimize bone health in shallow water.

Indications in land research:

- Cells respond to ion fluid flow from impact exercise (current)
- Fluid vanishes after two strikes
- Four strikes should be target- then allow a 10 second gap
 - 14 Times greater Gains
 - American College of Sports Medicine 2004
 - Fluid flow communication
 - Allow non-impact time ~15 – 20 seconds
- Provide Objective to class
- Apply force quickly (Impact)
- Impact various directions
- Allow recovery time (be active)

Class Planning Factors (Wasserman, 2005)

Consider incorporating the following examples into your class structure:

- 4 jumping jacks followed by 20 seconds of jacks at level 2
- Walk for 20 seconds, stop and cross country ski 4 times
- Side step 4 right and 4 left, do 4 tuck jumps driving legs down
- Knee swing 3 bounce center R then L, double knees up- out- in- down

Summary

- Research indicates that shallow water exercise maintains and even builds BMD.
- Shallow water provides the anabolic stimulus needed to maintain and build BMD
- Program must be appropriate.
- Need more research and comparison of variables to determine the best type of exercise to build BMD in the water.

2011 Update

- Ongoing study and data collection being conducted by Dr. Kim Beason, University of Mississippi.

Dr. Kim Beason: “I do know that the older adults that participate in aquatic exercise are more likely to continue their active lifestyles out of the water. Therefore, water exercise, if not a direct BMD influence, allows participants the ability to ambulate on dry land and THAT does maintain BMD in older adults, especially my group with MEAN 77 years old.”

- Study just completed in Brazil by Linda Moreira Pfrimer. Preliminary results look favorable for aquatic exercise and maintaining/building bone density.