PICO: In community-dwelling older adults (age 65+) with low bone density, can an exercise program improve bone mineral density?

Purpose	Title, Year, Design	Subjects	Outcome Measures	Intervention	Significant Results (p<0.05)	Conclusions	Comments/ Key points
Review of exercise interventions to improve bone density and decrease falls/fractures in individuals with low bone density	**de Kam et al.** 2009 Systematic Review	N= 28 RCTs focus on exercise intervention effect on fractures, falls, and risk factors in individuals with osteoporosis	Balance, Strength, BMD (DXA), Fall/fracture risk	Strength training: avg 2x/wk, 12 wk-30 mo but wide variability among trials	Improved BMD generally requires >1yr duration; most trials showed strengthening ex improved BMD or at least attenuated bone loss	Some exercise interventions are effective at improving bone mineral density in individuals w/osteoporosis, but results vary by study.	-There is a low number of RCTs specifically related to exercise interventions to address falls and fracture in osteoporosis. -Effective ex interventions avg 2x/wk, 3-12 mo. -Relationship among risk factors, falls, and fractures is uncertain. -Improved bone density requires ex >1 yr duration
Effect of high-intensity resistance training vs. agility training vs. stretching on bone mineral density at femur, tibia, and radius	**Liu-Ambrose et al.** 2004 RCT	N=98 Women, 75-85 yo, Osteoporosis or osteopenia, community-dwelling	BMD: DXA of proximal femur, pQCT (peripheral quantitative computed tomography) of radius and tibia	T1, T2, C: 50 min, 2x/wk, 25 wk T1: resistance training 12-16 reps at 75-85% 1RM T2: agility training for coord, balance, reaction time C: stretching and posture ed	pQCT T2>C of tibia, T1>T2 of radius; No change in DXA	Agility training improved cortical bone density at the tibia compared to stretching. Resistance training improved cortical bone density at the radius compared to agility training. Interventions did not create a change in DXA for hip BMD.	-A short duration exercise intervention may be able to improve BMD at localized areas of bone strain. -Lack of positive findings may indicate that duration of exercise training was not sufficient to induce changes in BMD.
Effect of long-term exercise on bone mass density in older women with osteoporosis	**Korpelainen et al.** 2006 RCT	N=133 Women, avg 72 yo, with osteoporosis	BMD and BMC: DXA of proximal femur and distal radius; falls: per report	T: 1 hr ex class of aerobics, balance, weight bearing strengthening, and impact exercises (jumps) and 20 min daily HEP, 30 mo C: no ex	No significant differences in BMD; Both groups lost BMC at trochanter but T<C; fewer falls T.	A long-term, primarily HEP was safe for elderly women with osteoporosis but did not significantly change BMD.	-Ex intensity may need to be increased to change BMD in individuals with osteoporosis.

Effect of self-selected exercise intensity program on bone density in osteoporotic women	**Bergstrom et al.** 2008 RCT	N=92 45-65 yo women with osteoporosis or osteopenia and a forearm fx.	BMD: DXA hip and lumbar spine; LE strength: 10x sit-to-stand for time	T: 30 min walk x3/wk and 60 min strength training x2/wk at self-selected intensity, 12 mo. C: no ex All: Calcium and Vit D supplement	BMD hip T>C at 1 yr (T incr, C decr for 1% diff btw gr); T improved sit-to-stand performance	Walking and strengthening program 5x/wk was able to improve BMD at hip and functional LE strength	-Indv who set own training intensity with general instructions to progress as able achieved an improvement in functional LE strength and a slight improvement in hip BMD. -A more rigorous training program may be able to elicit a greater effect.
Effect of general exercise program on lumbar BMD in osteoporotic women	**Iwamoto et al.** 1998 RCT	N=35 53-77 yo women with osteoporosis	BMD: DXA L2-4	T: daily walking and gymnastic training (low-mod intensity), 12 mo. C: no ex All: Calcium and Vit D supplement	Increased BMD T; Attenuated BMD loss C	Walking and gymnastic exercise was sufficient to improve lumbar spine BMD over the course of 1 year; Calcium and Vit D supplement was sufficient to prevent bone loss in control.	-Small population of study and unclear exercise intervention limit the ability to generalize findings. -There is potential for an exercise program to improve BMD of the lumbar spine.
Effect of long-term exercise on fracture risk and BMD in women with osteopenia	**Kemmler et al.** 2011 RCT	N=85 48-60 yo women with osteopenia	Fracture risk; BMD: DXA hip and lumbar spine	T: 60 min group ex 2x/wk, 20 min HEP 2x/wk; resistance training, jumping, aerobic ex; progressed q 12 wk; 12 years total duration C: no ex program All: Calcium and Vit D supplement	BMD T>C in spine and hip; T had loss of BMD at hip but less than C; stable BMD spine in T but loss in C; no significant difference in "overall" fracture risk	Long-term exercise maintained BMD of the spine and slowed the decrease in hip compared to no exercise; fewer fx after long-term exercise program but not statistically different	-Regular exercise over years can help prevent bone loss at key skeleton sites and may decrease fracture risk. -No measure of decrease falls vs. decrease of fx -Potential bias from group selection over long duration intervention ("control" who want to ex or "exercise" who don't continue)

Review of high-intensity resistance training effect on post-menopausal bone loss	**Martyn-St. James and Carroll** 2006 Systematic review	N=25 RCT (14 spine, 11 hip)	BMD: DXA	Avg 2-3x/wk, 6 mo-2 yr duration of high-intensity strengthening programs	Small but statistically sig improvement in lumbar spine BMD; inconsistent change hip/femoral neck BMD; Calcium supplementation had improved BMD changes at the hip	High-resistance training may improve BMD at the lumbar spine and hip areas in older adults; Calcium may be a beneficial addition to effect BMD.	-High-intensity resistance training may not be tolerated by all older adults -This type of training may have benefits of strength even if BMD do not change.
Effect of two year progressive strengthening program on BMD in older women	**Kerr et al.** 2001 RCT	N=126 55-65 yo women	BMD: DXA hip, lumbar spine, forearm, whole body	T1: strengthening 30 min, 3x/wk with load progression, 2 yr T2: same ex as T1 without load progression, rather increased bicycle time C: no ex All: Calcium	T1>T2,C for BMD at hip; BMD at T1 increased while T2,C decreased; no difference in lumbar spine or whole body	A 2 year progressive strengthening program made a significant difference in BMD of the hip but not of the lumbar spine or whole body; an exercise program without progressive loading was no different than no exercise	-Progressive strengthening can improve bone density/prevent bone loss of the hip over 2 years. -Non-progressive strengthening does not have the same benefit on bone density. -This intervention did not improve BMD of the spine or whole body
Effect of high and low intensity resistance training at 2 and 3 times per week frequency on BMD in older adults	**Bemben and Bemben** 2011 RCT	N=124 55-74 yo men and women	BMD: DXA hip, spine, whole body	T1(2HI): 80% 1RM, 2x/wk T2(2LI): 40% 1RM, 2x/wk T3(3HI): 80% 1RM, 3x/wk T4(3LI): 40% 1 RM, 3x/wk 40 weeks, 1RM assessed q5 wk.	Hip and lumbar BMD improved in all groups; whole body did not improve; hip changes similar between men and women; spine changes tended to be greater in men	After 40 weeks of high or low resistance training 2 or 3x/wk, BMD of the hip and spine was significantly better compared to baseline; whole body BMD did not change; Men responded slightly better than women for BMD of the spine	-High and low intensity strengthening 2-3x/wk for 40 weeks improved BMD of the hip and spine in older adults. -Whole body BMD was not affected -Older men may have a better bone response to exercise than older women

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