EFFECTS OF LOW-VOLUME HIGH-INTENSITY TRAINING ON BONE MINERAL DENSITY AND HEALTH/FITNESS FACTORS IN OSTEOPENIC/OSTEOPOROTIC ADULTS

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Background

- Aging increases risk for **osteopenia and osteoporosis**, which can increase the risk of falls and fractures[1].
- Aging is also associated with sarcopenia (decreased muscle mass and function)[2].
- As muscle mass decreases, bone mineral density (BMD) tends to decrease[3].
- Muscles place large voluntary loads on the skeleton
  - **Wolff's Law:** bones remodel and adapt to the loads placed upon them[4]
  - **Utah Paradigm:** loads above or below a certain threshold impact activity of osteoblasts (bone-forming cells) and osteoclasts (bone-reabsorbing cells)[5]
- **Resistance training (RT)** has been shown to improve several health/fitness factors, including BMD
- **bioDensity™** is a low-volume, high-intensity mode of RT designed to load the skeleton up to multiples of body weight[6]
  - **High intensity** may be sufficient to induce positive bone adaptation
  - **Low volume** may be more appealing to older adults
- Due to the numerous health and fitness benefits associated with RT, bioDensity™ training could be a valuable intervention for people suffering from osteopenia and osteoporosis.

Purpose

To determine whether a 24-week bioDensity™ training intervention improves BMD and other health/fitness factors in osteopenic/osteoporotic adults.

Methods

9 postmenopausal females (59.8±5.0 years) without contraindications to exercise completed assessments at baseline and 24-weeks

- Body composition (BMI, waist circumference, %Fat, FFM, BMD, and bone mineral content (BMC) using DEXA
- Resting heart rate (RHR), systolic/diastolic blood pressure (SBP/DBP)
- Senior Fitness Test , Y-Balance Test, push-ups, sit-ups, and muscular power measurement (using force plates)

24-week Longitudinal bioDensity™ Training Intervention:

- Once per week; 4 exercises performed (5 seconds each) using maximum voluntary contractions (MCV) with limited range of motion
- Chest press (CP), Leg press (LP), and Vertical lift (VL) use ramping protocol (50% MVC followed by 100% MVC)
- Core pull (CORE) uses ballistic protocol (100% MVC immediately)

Statistical Analysis: Paired t-tests (baseline vs. 24-week assessment) were used for analysis (*$P<0.05$)

Results

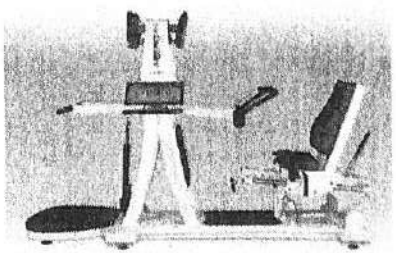

Figure 1: bioDensity equipment (CP, LP, and CORE = seated; VL = standing)

Table 1: Participant descriptors at baseline (N=9; post-menopausal females)

Descriptor	Mean ± S.D.
Age (years)	59.8 ± 5.04
BMI (kg/m²)	24.0±4.4
% Fat	39.3±7.1
FFM (kg)	39.8±3.8

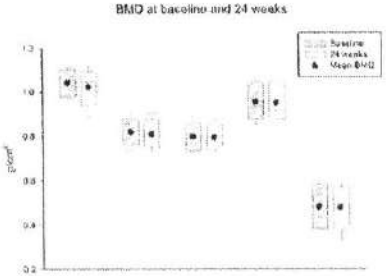

Figure 2: Bone mineral density at baseline and after 24 weeks of bioDensity™ training. (Box: line=median; box border=25/75% CI's; whiskers=max & min values)

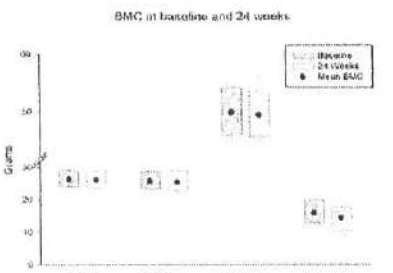

Figure 3: Bone mineral content at baseline and after 24 weeks of bioDensity™ training. (Box: line=median; box border=25/75% CI's; whiskers=max & min values)

Figure 4: Health, fitness, & functional independence measure; percent change baseline to 24 weeks (all significant at $P\leq0.05$) Mean ± S.D. PU=push up; YBT left=composite reach score for Y-Balance test on left leg; DBP=diastolic blood pressure.

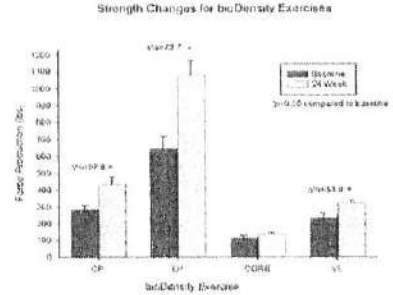

Figure 5: Strength changes for bioDensity™ exercises (CP=chest press; LP=leg press; CORE=core pull; VL=vertical lift)

Results Summary

- CP, LP, and VL strength increased significantly from baseline to 24-weeks
- BMD and BMC (total body, left hip, right hip, AP spine, and lateral spine sites) and body composition remained stable at 24 weeks
- Several fitness tests (chair stand, arm curl, Y-Balance Test, push-up max force) improved at 24 weeks
- DBP decreased from 71±5 to 66±6 mmHg; this level of reduction is associated with decreased cardiovascular disease risk and associated health care costs [7]
- Limitations: small sample size, lack of control group, lack of adequate assessment of physical activity, and study duration

Conclusions

- 24 weeks of bioDensity™ training resulted in maintenance but not improvement of BMD and BMC in postmenopausal females with low bone density. Other RCT's have shown decreases in BMD over a similar duration in control participants (no intervention).
- bioDensity™ training may be a valuable exercise intervention for older adults suffering from osteoporosis or osteopenia, and absence of improvement in BMD and BMC may be due to the relatively short observation period.
- Improvements in muscular strength, balance, and diastolic blood pressure are promising and directly related to reducing fall risk and increasing functional fitness and independence.
- The bioDensity™ low-volume approach may be appealing to older adults, and the high-intensity training produced clinically meaningful changes in health and fitness factors that impart fall and fracture risk reduction.

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