Effect of 12-weeks of bioDensity™ Training on Bone Mineral Density & Lean Muscle Quantity in Healthy & Osteo-penic/-portotic Adults

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Background

- Traditional ***resistance training (RT)*** using free weights or cable-pulley machines has well-documented ***sport-performance and health-promotion benefits***
  - e.g., prevention/attenuation of osteoporosis and sarcopenia, reduced fall risk, lower premature morbidity/mortality rates.
- ***bioDensity™ is a new (2009) form of high-intensity, low- volume RT*** that may overcome the often cited "lack of time" barrier to adopting and adhering to a RT program.
- Traditional RT typically requires 2-3 sessions per week of 6-10 different exercises in which 2-3 sets of 8-12 repetitions are performed (***40-60 minutes***).
- bioDensity™ uses proprietary technologies (machine and software) to elicit near ***total body maximal musculoskeletal loading*** with only 4 exercises that can be completed in **~5 minutes**.
- To date, the **strength changes and physiological adaptations** commonly reported with traditional RT **have not been reported for bioDensity™ training**.
- With high-intensity musculoskeletal loading there is **potential for improvement in bone mineral density**, however the time course for hypothesized changes is unknown due to the novelty of the bioDensity™ approach.

Purpose

To describe the bioDensity™ methodology/approach and measure clinical and functional outcomes after 12-weeks of bioDensity™ training. Focus is given to changes in strength and bone mineral density.

Methods

Description of bioDensity™ methodology and training approach

- See results section for details

Research Design and Measures:

- 1-year longitudinal study with assessments at: baseline, 12-, 24-, and 36-weeks. (Study is on-going with only 12-week results available)
- Participants (N=67) completed 1 bioDensity™ training session each week.
- Apparently healthy and osteo-penic/-portic adults 18-90 years recruited
- Body composition and bone mineral density (BMD) assessed by DEXA
- Functional muscular strength/endurance/power, agility, and hamstring flexibility assessed (fitness tests and force plate measures).
- Aerobic fitness (VO_2) estimated from a 3-minute step test
- Heart rate (HR) and blood pressure (BP) assessed
- Data were analyzed by two-way repeated measures ANOVA (session x sex) and paired t-tests. * $P<0.05$

Results

bioDensity™ Equipment and Strength Training Approach

- ***4 limited-range exercises*** performed ***once per week*** with direct supervision
- 3 seated exercises: ***Chest Press*** (CP), ***Leg Press*** (LP), ***Core Pull*** (Core)
- 1 standing exercise: ***Vertical Lift*** (VL)
- Exercises activate ***multiple*** large and small skeletal ***muscle groups*** across ***multiple joints*** → near total body musculoskeletal loading
- ***5-second maximal-voluntary contraction*** for each exercise
- ***CP, LP, VL*** employ ***ramping neuromuscular activation*** protocol
  - → progressively increase/ramp force application to submaximal level, inhale deeply, then ***immediately apply maximal force*** while exhaling
- ***Core*** performed using ***ballistic neuromuscular activation*** protocol
  - → inhale deeply, then ***exert maximal force*** from start of exercise while exhaling

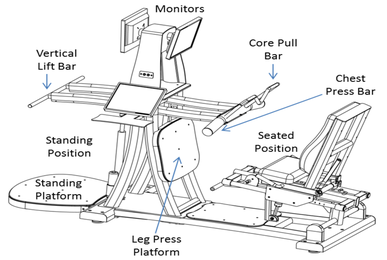

Figure 1. Change in CP, LP, Core Pull and VL force production across 12 bioDensity™ training sessions. Baseline (average of sessions 3 and 4). Mean±S.E.M.

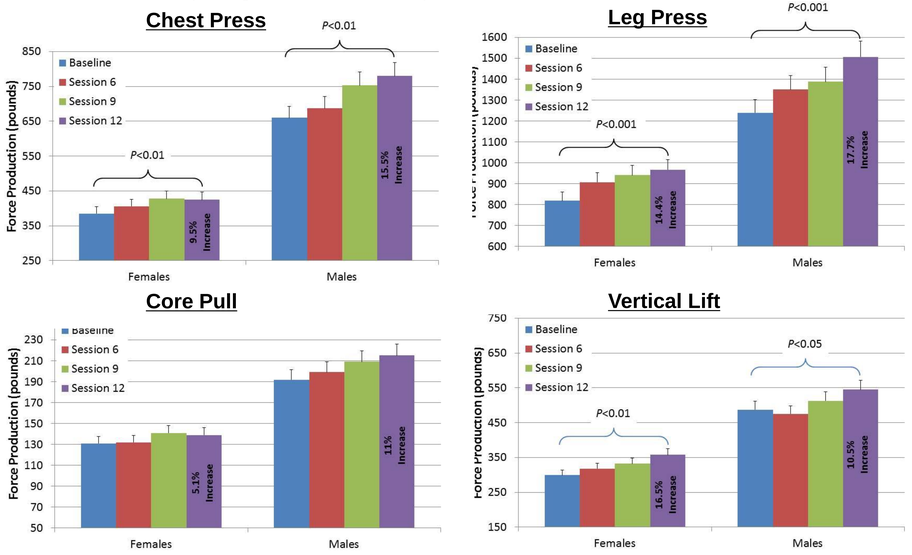

Table 1. Descriptive and physiological measures in participants at baseline and 12-weeks. Mean±S.E.M.

Variable	Combined (N=67)		Females (N=47)		Males (N=20)	
	Baseline	12-weeks	Baseline	12-weeks	Baseline	12-weeks
Age (yrs)	48.9±5.2	--	49.7±6.3	--	47.1±3.7	--
Osteopenia/-porosis (%)	20	--	23	--	10	--
Weight (kg)	73.6±2.2	73.5±2.1	71.3±2.1	71.1±2.5	79.0±3.9	79.3±3.8
BMI (kg/m^2)	26.6±0.8	26.5±0.8	27.0±0.9	26.8±0.9	25.6±1.4	25.7±1.4
Waist Circumference (cm)	88.1±1.9	87.9±1.8	87.0±2.2	86.7±2.1	91.0±3.5	90.7±3.3
Body Fat (%)	34.1±1.5	34.4±1.5	38.5±1.5 †	38.7±1.5 †	23.7±2.3	24.4±2.2
Lean Muscle Mass (%)	65.8±1.5	65.5±1.5	61.4±1.5 †	61.3±1.4 †	76.3±2.2	75.6±2.3
Total BMD (g/cm^2)	1.16±0.01	1.16±0.01	1.14±0.01 †	1.14±0.01 †	1.22±0.02	1.22±0.02
Total BMC (g)	2598±63	2610±62	2,376±57 †	2,397±58 †	3,122±84	3,111±87
Lt. Hip BMD (g/cm^2)	1.00±0.02	1.00±0.02	0.98±0.02	0.98±0.02	1.05±0.4	1.06±0.04
Lt. Hip BMC (g)	33.1±0.9	33.0±0.9	30.7±0.9 †	30.6±1.0 †	38.8±1.4	38.8±1.4
Rt. Hip BMD (g/cm^2)	0.99±0.02	0.99±0.02	0.97±0.02	0.97±0.02	1.0±0.4	1.0±0.4
Rt. Hip BMC (g)	32.8±0.9	32.8±0.9	30.3±0.9 †	30.2±0.9 †	38.6±1.4	39.0±1.4
Spine L_{1-5} BMD (g/cm^2)	1.17±0.02	1.17±0.02	1.15±0.02	1.15±0.02	1.22±0.03	1.23±0.03
Spine L_{1-5} BMC (g)	65.1±1.7	64.8±1.7	60.3±1.6	60.0±1.5	76.3±2.4	77.2±2.5
Steps/day	8,785±418	9,047±508	8,330±458	9,005±536	9,787±859	*9,561±1,279* *
Systolic BP (mmHg)	121±2	120±2	121±2	119±2	124±3	122±3
Diastolic BP (mmHg)	76±1	*72±1* *	76±1	*71±2* *	79±2	*74±2* *
Resting HR	67±1	*69±2* *	69±2	*72±2* * †	63±3	65±3
Estimated VO_2 (ml/kg/min)	42.3±1.6	*44.9±1.8* *	36.2±0.6 †	*38.4±0.8* * †	52.5±2.5	56.1±2.8
Shuttle Run (seconds)	13.7±0.3	*13.3±0.3* *	14.4±0.4 †	*14.0±0.4* * †	12.5±0.4	12.1±0.4
Push-ups (#)	31±2	*36±2* *	27±2 †	*33±2* * †	38±4	*42±5* *
Sit-ups (#)	25±2	*27±2* *	23±2 †	*26±2* * †	29±4	*32±4* *
Hamstring Flexibility	45.3±1.5	*47.7±1.4* *	47.9±1.6 †	*50.2±1.5* * †	39.1±2.9	*42±2.8* *
Vertical Jump (cm)	20.0±1.2	20.6±1.2	16.3±0.9 †	17.0±0.9 †	28.2±2.1	27.6±2.4
Push-up Force (N)	496±24	492±28	415±18	398±17	653±38	657±47

* = $P<0.05$ compared to baseline within group (combined, females or males); † = $P<0.05$ *compared* to males at baseline or 12-weeks. BMI = body mass index; Lt. = left; Rt. = right; BP = blood pressure; Steps/day measured by pedometer Omron HJ720-ITC; Estimated VO_2 in males *P=0.09*. Shuttle Run in males *P=0.1*. Push-up Force in males *P=0.08*.

Conclusions

- bioDensity™ is currently in 154 national and 9 international locations with a 200% increase in installations over the past 24 months. With increasing use and application, it is critical that this novel RT methodology be accurately reported to the clinical/scientific communities to support future validation.
- Our findings indicate that 12 bioDensity™ training sessions produce significant and functionally/clinically meaningful increases in chest press, leg press, and vertical lift strength.
- It is not surprising that this high-intensity musculoskeletal loading has not yet impacted bone mineral density at 12-weeks as most adaptations to bone density occur at or after 6-months of training. Sub-group analyses for only osteo-penic/-porotic adults (20% of the sample) were similar and did not show improvements in bone mineral density at any site.
- The improvement in clinical (VO_2 and diastolic BP) and functional measures (agility, muscular endurance, hamstring flexibility) are promising and warrant further investigation.

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