THE EFFECTS OF RESISTANCE EXERCISE TRAINING ON BONE MINERAL DENSITY IN PREPUBESCENT YOUTH

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Abstract

PURPOSE: The purpose of this study was to evaluate bone mineral density and strength in prepubescent youth ages 8 to 10 years pre- and post-resistance exercise training (RET). **METHODS:** Twenty-nine healthy prepubescent male and females (14 females and 15 males; mean ± SD; age= 9.3 ± 0.9 years; height= 137.6 ± 8.5 cm; body mass = 34.8 ± 9.6 kg; maturation offset = -2.94 ± 0.64 years) were recruited and completed RET or served as a control (CON). Pre- and post-testing consisted of dual-energy x-ray absorptiometry (DXA) and 3-repetition maximum (3-RM) leg extension. DXA was used to obtain bone mineral density (TOT-BMD). In addition, BMD was analyzed separately for the left and right leg. Measurement of lower body strength was obtained with 3-RM leg extension. Participants in the RET group completed three whole-body sessions per week for 8 weeks (24 RET sessions total) that was focused on improving leg extensor strength. Each session included 4 lower (squats, step-ups, leg extension and flexion, etc.) and 2 upper body (bench press, rows, should press, lat pulldowns , etc.) exercises. Warm-ups included agility ladder and short hurdle drills. The RET program was based on a traditional linear periodization model with volume decreasing and loads increasing over the course of the program (i.e., week 1 = 3 sets, 8-12 repetitions; week 8: 5 sets, 3-5 repetitions). Separate two-way mixed factorial ANOVAs (group [RET vs. CON] x time [Pre vs. Post]) were used to examine potential changes for TOT-BMD and 3-RM. Separate three-way mixed factorial ANOVAs (group [RET vs. CON] x lower body [Left Leg vs. Right Leg] x time [Pre vs. Post]) were used to examine potential differences in BMD of the lower body._Partial eta (η_p^2) squared was calculated for each interaction with Cohen's *d* effect size (ES) used for follow-up t-tests **RESULTS:** There was a significant two-way interaction for 3-RM ($p<0.001$, $\eta_p^2=0.565$). There was a significant ($p<0.001$; $d=3.33$) increase in 3-RM from pre- (13.67±4.73 kg) to post-RET (28.77±7.15 kg) and no significant increase ($p=0.192$; $d=0.56$) for the CON. In addition, 3-RM was greater ($p=0.004$, $d=1.44$) for RET than CON at post-testing with no differences between groups at pre-testing ($p=0.200$, $d = 0.59$. For TOT-BMD, there were no significant time x group interactions ($p=0.529$) or main effects for group ($p=0.686$) or time ($p=0.051$). For lower body BMD, there was no three-way interaction ($p=0.314$), group x leg ($p=0.814$) or leg x time ($p=0.762$) two-way interactions, but there was a group x time interaction ($p=0.020$; $\eta_p^2=0.185$). Lower body BMD increased ($p=0.007$, $d=0.68$) from pre- (0.889±0.107 g/cm^2) to post-RET (0.906±0.110 g/cm^2), however, there was no significant change ($p=0.33$, $d=0.35$) in lower body BMD pre- and post-CON. **CONCLUSIONS:** Prepubescent who participated in a traditional linear periodization 8-week (3 days per week) RET program had increases in leg extension strength and BMD of the lower body. **PRACTICAL APPLICATIONS:** Resistance training is an effective exercise modality to improve maximal strength and bone mineral density in prepubescent youth. These results support efforts to increase opportunities for youth to participate in RET to improve muscular strength and decrease risk of bone fractures and, subsequently, improve sport performance and overall health.

Introduction

Exercise interventions for ten months or more increases bone mineral density (BMD) in prepubescent youth. However, it is unknown if a structured 8-week exercise program based on linear periodization will increase BMD in prepubescent youth as is seen in adults.

Purpose

To evaluate bone mineral density and strength in prepubescent youth ages 8 to 10 years pre- and post-resistance exercise training (RET).

Methods

Twenty-nine healthy prepubescent male and females (14 females and 15 males; mean ± SD; age= 9.3 ± 0.9 years; height= 137.6 ± 8.5 cm; body mass = 34.8 ± 9.6 kg; maturation offset = -2.94 ± 0.64 years) were recruited and completed RET or served as a control (CON).). Pre- and post-testing consisted of dual-energy x-ray absorptiometry (DXA) and 3-repetition maximum (3-RM) leg extension. DXA was used to obtain BMD (TOT-BMD) and separately for the left and right leg. Measurement of lower body strength was obtained with 3-RM leg extension. Participants in the RET group completed three whole-body sessions per week for 8 weeks (24 RET sessions total) that was focused on improving leg extensor strength.

Table 1: Age, height, body mass, three-repetition maximum (3-RM), and maturity offset pre- and post-resistance exercise training (RET) and control (CON) groups.

	RET		CON	
Variable	**Pre**	**Post**	**Pre**	**Post**
Age (years)	**9.37 ± 0.97**	**9.56 ± 0.96**	**9.1 ± 0.81**	**9.3 ± 0.83**
Height (cm)	**137.90 ± 9.20**	**139.53 ± 9.15^**	**137.06 ± 7.31**	**138.21 ± 7.50^**
Body Mass (kg)	**35.57 ± 10.12**	**37.65 ± 10.53^**	**33.17 ± 8.48**	**34.04 ± 8.26^**
3-RM (kg)	**13.67 ± 4.73**	**28.77 ± 7.15***	**16.38 ± 4.53**	**19.45 ± 5.69**
Maturity Offset (years)	**-2.87 ± 0.64**	**-2.71 ± 0.68^**	**-3.10 ± 0.66**	**-2.98 ± 0.67^**

*indicates significant increase pre- to post-RET.
^indicates significant increase from pre- to post-interventions (collapsed groups).

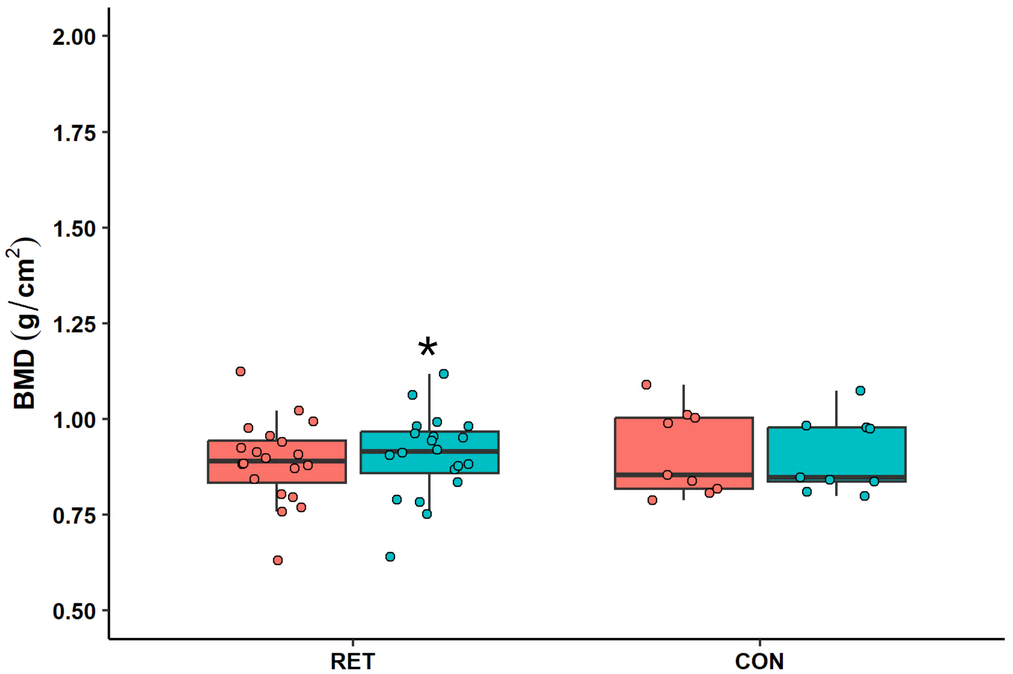

Figure 1: Plotted individual values and mean (standard deviation) lower body bone mineral density (BMD, g.cm2) pre- and post-intervention for the resistance exercise training (RET) and control (CON) groups.

*indicates significant increase pre- to post-RET.

Methods

Each session included 4 lower (squats, step-ups, leg extension and flexion, etc.) and 2 upper body (bench press, rows, should press, lat pulldowns , etc.) exercises. Warm-ups included agility ladder and short hurdle drills. The RET program was based on a traditional linear periodization model with volume decreasing and loads increasing over the course of the program (i.e., week 1 = 3 sets, 8-12 repetitions; week 8: 5 sets, 3-5 repetitions). Separate two-way mixed factorial ANOVAs (group [RET vs. CON] x time [Pre vs. Post]) were used to examine potential changes for TOT-BMD and 3-RM. Separate three-way mixed factorial ANOVAs (group [RET vs. CON] x lower body [Left Leg vs. Right Leg] x time [Pre vs. Post]) were used to examine potential differences in BMD of the lower body._Partial eta (η_p^2) squared was calculated for each interaction with Cohen's *d* effect size (ES) used for follow-up t-tests.

Results

There was a significant two-way interaction for 3-RM ($p<0.001$, $\eta_p^2=0.565$). There was a significant ($p<0.001$; $d=3.33$) increase in 3-RM from pre- (13.67±4.73 kg) to post-RET (28.77±7.15 kg) and no significant increase ($p=0.192$; $d=0.56$) for the CON. In addition, 3-RM was greater ($p=0.004$, $d=1.44$) for RET than CON at post-testing with no differences between groups at pre-testing ($p=0.200$, $d = 0.59$. For TOT-BMD, there were no significant time x group interactions ($p=0.529$) or main effects for group ($p=0.686$) or time ($p=0.051$). For lower body BMD, there was no three-way interaction ($p=0.314$), group x leg ($p=0.814$) or leg x time ($p=0.762$) two-way interactions, but there was a group x time interaction ($p=0.020$; $\eta_p^2=0.185$). Lower body BMD increased ($p=0.007$, $d=0.68$) from pre- (0.889±0.107 g/cm^2) to post-RET (0.906±0.110 g/cm^2), however, there was no significant change ($p=0.33$, $d=0.35$) in lower body BMD pre- and post-CON.

Conclusions

- Traditional linear periodization RET programs increased leg extension strength and BMD of the lower body.
- Resistance training is an effective exercise modality to improve maximal strength and lower body BMD in prepubescent youth
- These results support efforts to increase opportunities for youth to participate in RET to improve muscular strength and decrease risk of bone fractures and, subsequently, improve sport performance and overall health.

References

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