



Ten Minutes of Capoeira Plus Jumping Thrice Weekly Improves Bone and Reduces Fat in Primary School Children: The CAPO Kids Trial

Beck, BR^{1,2}, Weeks, BK^{1,2}, and Nogueira, RC^{1,2}

¹School of Allied Health Sciences, ²Menzies Health Institute Queensland, Griffith University, Gold Coast, Australia



Background

Physical inactivity and inappropriate nutrition in childhood is associated with the development of obesity and lifetime chronic disease^{1,2}. Similarly, sedentary behaviour in youth curtails optimal development of bone. In fact, the increasing prevalence of obesity parallels growing rates of osteoporotic fracture. Physical activity is an effective strategy to reduce overweight *and* optimise musculoskeletal health^{3,4}; however, exercise recommendations for the two outcomes typically differ. Bone responds to brief bouts of high impact activity, whereas traditionally, low-to-moderate intensity prolonged aerobic exercise is recommended to reduce fat⁵. The efficacy of an exercise program for children that targets both the musculoskeletal and metabolic systems has not previously been examined.

Aim

To determine the efficacy of a brief, novel, fun and feasible, school-based exercise program to enhance the musculoskeletal and cardio-metabolic health of pre- and peri-pubertal children.

Methods

Design: cluster-randomised controlled exercise intervention

Participants: 9-11 year old primary school children

Intervention (EX): 9-month, in-school program of 10 min/day, 3 days/week combined *capoeira* (Brazilian sport) and jumping, plus usual school physical education

Control (CON): Usual school physical education

Measures (at baseline and 9 months):

- Anthropometrics (height, sitting height, weight, waist circumference [WC])
- Bone variables
 - BUA, SOS, and SI (QUS, Achilles Insight, GE Lunar)
 - Whole body, lumbar spine and proximal femur BMC, aBMD and bone area (DXA, XR800, Norland, Cooper Surgical)
 - Radius and tibia vBMD and parameters of bone geometry (pQCT, XCT3000, Stratec)
- Body composition (DXA, XR800) (lean [LM] and fat mass [FM])
- Cardiovascular parameters (resting HR, BP, VO₂max)
- Functional performance (vertical jump [VJ])
- Physical activity (PA) participation (BPAQ⁶)
- Dietary calcium (ACAES⁷)
- Skeletal maturity (YAPHV⁸)
- Exercise intensity (Energy expenditure (SenseWear, BodyMedia, PA) and ground reaction forces (Advanced Mechanical Technology, MA, & Matlab, MathWorks, MA))

Statistical analysis: One-way ANOVA to compare baseline characteristics; repeated measures ANCOVA to examine treatment effects; multiple regression analyses to determine variance predictors

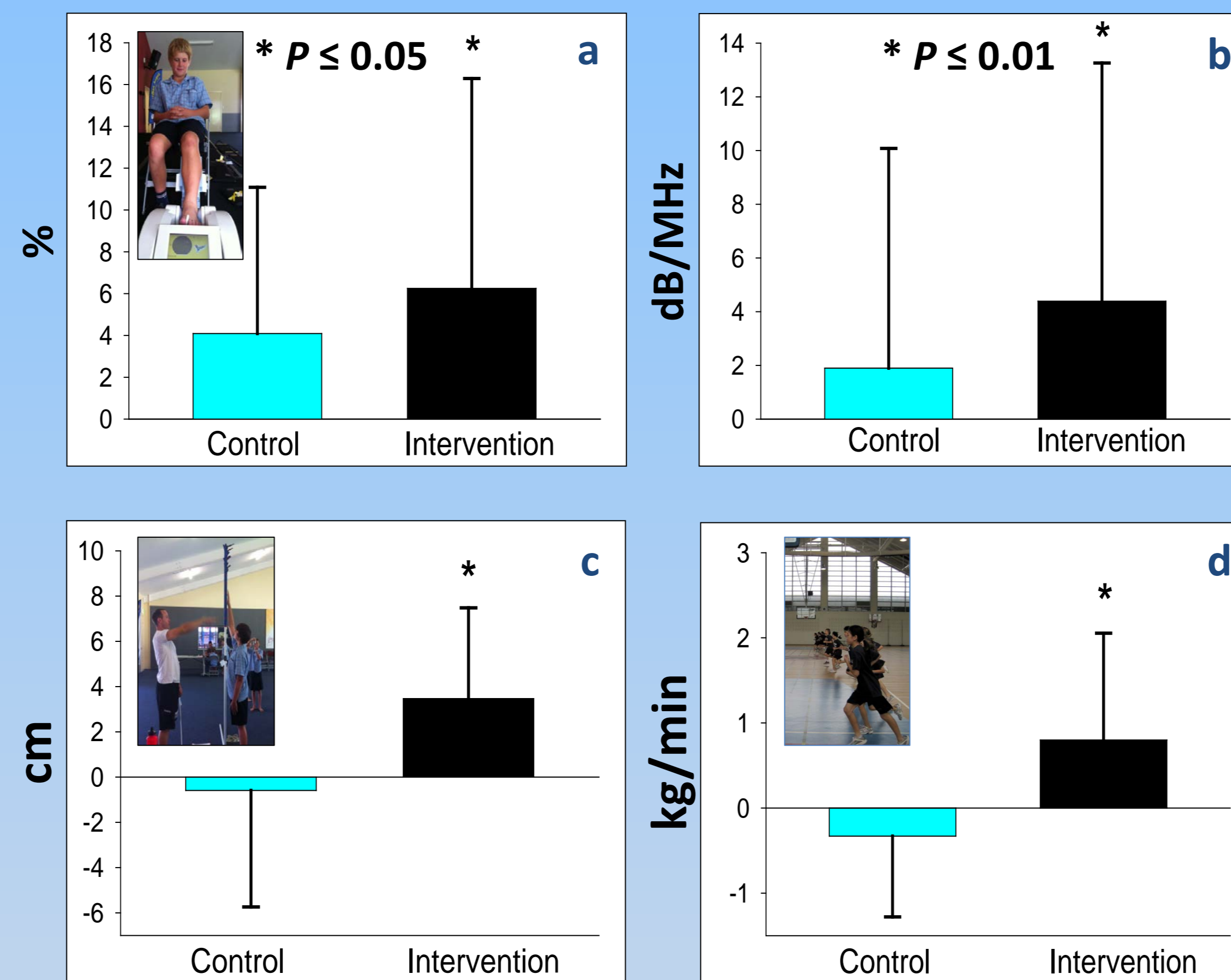


Figure 1. 9-month absolute change in a. calcaneal stiffness index, b. BUA; c. maximal jump height, and d. estimated VO₂ max (n = 294, *P ≤ 0.001)

Table 1. Baseline characteristics of CON and EX groups

Parameters	Control (n = 130)	Exercise (n = 164)	P
Age (years)	10.7 ± 0.6	10.5 ± 0.5	0.02
YAPHV (years)	-2.0 ± 0.92	-2.2 ± 0.99	0.10
Weight (kg)	38.4 ± 8.6	38.9 ± 9.3	0.60
Height (cm)	1.431 ± 0.68	1.442 ± 0.71	0.20
Fat mass (kg)	15.07 ± 7.0	14.06 ± 6.5	0.66
Lean mass (kg)	25.84 ± 5.9	25.02 ± 4.5	0.63
BPAQ (score)	34.2 ± 34.0	26.1 ± 27.49	0.04
Calcium (mg)	1148.8 ± 647.5	1068.1 ± 620.4	0.30

YAPHV, years to age of peak height velocity; BPAQ, bone-specific physical activity questionnaire

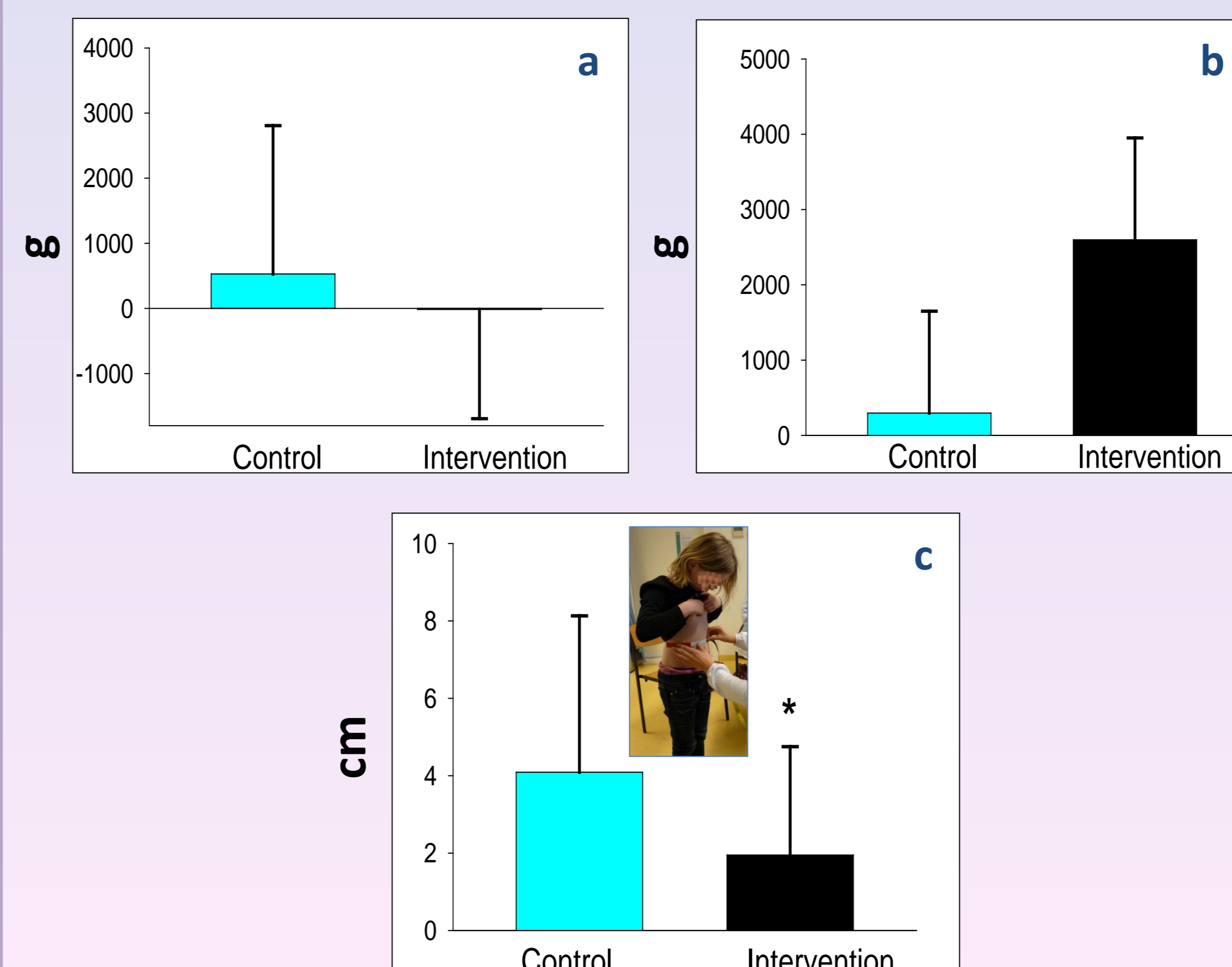


Figure 2. 9-month absolute change in a. fat mass (n=54), b. lean mass (n = 54), and c. waist circumference (n = 294, *P ≤ 0.001)



Figure 3. a. BP measure, b. CAPO Kids session in progress, c. pQCT tibial scan, d. DXA whole body scan

Results

339 children volunteered to participate. There were no differences between CON and EX groups at baseline, except age (EX: 10.5 ± 0.5; CON 10.7 ± 0.6; P = 0.02) and previous PA (EX: 26.1 ± 27.49; CON 34.2 ± 34.0; P = 0.04).

EX improved calcaneal BUA (EX: 3.99 ± 9.06 dB/MHz; CON: 1.33 ± 8.3 dB/MHz; P ≤ 0.01), SI (EX: 6.25 ± 10.04%; CON: 4.09 ± 6.99%; P ≤ 0.05), WC (EX: 1.95 ± 2.82 cm; CON: 4.09 ± 4.05 cm; P ≤ 0.001), HR (EX: -4.11 ± 3.35 BPM; CON: 0.22 ± 3.8 BPM; P ≤ 0.001), VJ (EX: 3.47 ± 4.01; CON: -0.59 ± 5.16; P ≤ 0.001) and estimated VO₂ max (EX: 2.68 ± 3.96; CON: -0.20 ± 3.38 ml/kg/min; P ≤ 0.001) more than control.

Sex-specific results largely mirrored the combined analyses but EX boys improved LS stiffness (+14.2% vs. +1.5%, P = 0.04) and radius periosteal circumference at 66% (+9.2% vs. +4.8%, P = 0.03); and EX girls improved LS index of bending strength (+24.4% vs. +12.0%, P = 0.006) more than CON.

Baseline BUA and maturity predicted 32.2% of the variance in BUA change (P ≤ 0.001) for boys; while BMI and baseline BUA accounted for 16.4% of the variance in BUA change (P = 0.006) for girls.

Average energy expenditure for a 10 minute session was 39.7 ± 9.3 kcal (mean 4 kcal/min). Exercise intensity was 'vigorous' to 'very vigorous' for 34% of the session. Vertical ground reaction forces of the CAPO Kids manoeuvres ranged from 1.3 ± 0.2 BW (cartwheels) to 5.4 ± 2.3 BW (360° jump).

Conclusion

Ten minutes, 3 times a week of capoeira and jumping improved metabolic and musculoskeletal health in pre- and peri-pubertal boys and girls. The exercise program was safe, enjoyable and easily incorporated into a primary school schedule.

Acknowledgments

We thank the staff and students of Guardian Angels Primary and Saint Kevin's Catholic Schools (Gold Coast) for their participation; *Timezone*, *Charlies 24 Hour Restaurant* and *Ripley's Believe it Or Not* (Gold Coast) for incentive gifts, and the Centre for Musculoskeletal Research for funding support.

References:

1. Pekkinen, M., Viljakainen, H. et al. (2012) *PloS one*, 7(7): p. e40090
2. WHO *Global status report on noncommunicable diseases 2010*. Geneva: World Health Organisation, 2011
3. Andersen L.B., Harro, M. et al. (2006) *The Lancet*, 368(9532); 299-304
4. Mountjoy, M., Andersen, L.B. et al. (2011) *Brit J Sports Med*, 45(11); 839-848
5. Weeks, B. K., Beck, B. R. (2010). *J Osteoporosis*, 1-9
6. Weeks, B. K. Beck, B. R. (2008) *Osteoporosis Int*, 19(11); 1567-1577
7. Watson, J. F., Collins, C. E. et al. (2009) *Int J Behav Nutr Phys Activity* 6(1); 1-17
8. Mirwald, R.L., Baxter-Jones, A.D.G., et al. (2002) *MSSE*, 34(4); 689-694

