

Does high-impact exercise in the prepubertal period have an osteogenic effect in females?

Trial: Van Langendonck L, Claessens AL, Vlietinck R, et al. Influence of weight bearing exercises on bone acquisition in prepubertal monozygotic female twins: a randomised controlled prospective study. *Calcif Tissue Int* 2003; 72: 666-674.

Question

Does high-impact exercise in the prepubertal period have an osteogenic effect in females?

Trial details

Design: Randomised, partially blinded clinical trial.

Participants: 21 monozygotic twin pairs of prepubertal girls aged 7–10 years; 15 pairs recruited through a twin registry and 6 pairs recruited from local schools. Twin pairs were randomly allocated, one to the intervention group and one to the control group.

Intervention: The twin in the intervention group engaged in 10 minutes of impact exercise on three occasions each week for 9 months, supervised by a teacher at school. The twin in the control group received no extra contact with teachers or researchers.

Main outcome measures: Adipose tissue measured by skinfold measurements; body weight, lean tissue mass, relative fat mass (%fat) and bone mineral content (BMC) measured by dual-energy x-ray absorptiometry.

Main results: At 9 months, girls in the impact exercise group had reduced adipose tissue compared with those in the control group (5.6% reduction v 0.6% increase in skinfold measurements [$P < 0.05$] and a 3.7% reduction v 1.5% reduction in %fat [$P < 0.05$]), but no difference in body weight or lean tissue mass. In a post-hoc analysis of 12 pairs of twins who were not undertaking impact activities outside the intervention program, there was a higher proximal femur BMC in the intervention v control group (11.9% v 9.4% increase [$P < 0.001$]).

Conclusion: The authors conclude that a high-impact exercise intervention results in an additive osteogenic bone response in prepubertal girls not undertaking other impact activity, but has no effect on bone status in girls already involved in high-impact sports.

Commentary

Rationale for the trial

To prevent osteoporosis, it is important to maximise bone mineral accrual in early life and minimise bone loss in later life. It is thought that high-impact exercise in premenarchal years may influence the accrual component of this process, although the most effective exercise regimen remains unknown.

Trial methods

Monozygotic twins were selected to assure inherent control of genetic confounders, such as prepubertal status, rate of maturation and body dimension and, to some extent, environmental confounders, such as diet. Twins were not selected on any basis of perceived need, such as low bone mass or low involvement in impact activities.

The trial's methods of randomising twin-pairs to intervention and control groups and group allocation concealment from the radiographer are not described, but would be needed for inclusion of this trial's findings in a systematic review.

Major outcome measurements were based on dual-energy x-ray absorptiometry, a non-invasive, objective test for measuring bone and body composition which was read by a radiographer blinded to group status. The primary outcome was bone mineral content (BMC), a mass measurement that can be estimated with more precision than bone mineral density (BMD). It is unclear whether those measuring physical characteristics or analysing the data were blinded. No measurement of dietary intake was reported, and physical activity was not monitored objectively before or during the study.

One girl from each twin-pair was randomly assigned to an impact exercise program, while the other received no intervention. The effect of confounders, which has been problematic in many non-randomised studies of bone health in childhood, was minimised to some extent, but bias may have resulted from parents', teachers' and participants' awareness of group status. Chances for contamination between groups were high, with twins cohabiting and attending the same school. The trial design could have been strengthened by the control group receiving a low-impact exercise program or a placebo intervention such as health education.

The success of the intervention would have depended on sustainability of program goals and intensity and motivation provided by teachers, and any differences in teachers' ability to provide these would influence the nature of the intervention. Effects often overlooked are that more efficient skill execution over time reduces workload and that well trained muscles can attenuate bone load. Load is difficult to measure, but would be an essential component of future trials of physical activity in children. A commentary on compliance from the participants' perspective would also have been useful to inform future studies.

The conclusion that the intervention was more effective in girls not undertaking impact activity outside the intervention is not reflected in the summary statistics. In the 21 girls in the high-impact exercise group, BMC increased by 11.96%, compared with 11.90% in the subgroup of 12 girls inactive outside the intervention. Without further information, it is difficult to understand the large difference in t values between the two analyses ($t=0.78$ for the whole group v $t=2.97$ for the otherwise inactive subgroup) and why a small effect size was significant in 12 twin-pairs. A mean-versus-differences plot would have shown if the effect was greater in girls with low BMC, and additional statistics,

such as 95% confidence intervals and number needed to treat (say, to improve BMC by 5%), would help to clarify the clinical importance of the results.

New information

Results of musculoskeletal gains should be interpreted cautiously, as groups improved their bone mass equally, and so the role of exercise in the acquisition and maintenance of peak bone mass remains unclear. Further studies are needed, because many public health recommendations are being made even though there is little evidence supporting them.



Implications for clinical practice

Intervention activities were developmentally appropriate and the simplicity of the program, with only 10 minutes of exercise on three occasions each week, could be attractive for public health interventions and inclusion in planning and policy documents. However, it is important to ascertain if certain subgroups, such as inactive children or those with low bone mass, benefit most. Family-based activities to target such groups may be more efficient than wider school-based activities that involve many children who may not benefit.

To reliably measure the effects of impact exercise on early bone health, larger studies with a more generalisable population will be needed, with stratified random allocation to groups for greater control of potential confounders, and with more attention paid to issues of quality program delivery. Although large trials are a challenge to conduct, they are essential for increasing confidence in their clinical implications. Risk versus benefit must also be considered. In programs for prepubertal children, it is essential that teachers and parents have the expertise to ensure safe landings from jumps and safe increases in workload.

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Competing interests

None identified.

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