Vitamin D Supplementation In Adolescent Female Ballet Dancers And Gymnasts in a 12 Month Randomised Controlled Trial In Auckland, New Zealand

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Abstract

Aim: To examine the effects of vitamin D supplementation on the bone health of female adolescent ballet dancers and gymnasts.

Method: Adolescent female ballet dancers and gymnasts from Auckland, New Zealand were recruited to a 12 month randomised double-blind trial. Participants were supplemented with cholecalciferol 50,000 IU per month or a placebo. At baseline detailed dietary intake was collected by a four day food record; at baseline and 12 months bone mineral density (BMD) and content were recorded by DXA as well as bone-free, fat-free, lean body mass, percentage body fat, height and weight. At baseline, six months and 12 months serum markers for vitamin D (oestradiol and parathyroid hormone) were collected.

Results: A total of 61 adolescent girls were recruited at baseline, BMD and content by DXA was completed in 45 girls and 41 provided vitamin D serum samples. Serum vitamin D concentration was recorded for 41 female ballet dancers and gymnasts aged 12 to 18 years was 72 nmol/L and remained adequate (>50 nmol/L) in both intervention and control groups for the 12 month duration. There was no significant difference between intervention and control groups in bone mineral density and content at any bone site at 12 months. The significant predictors of increased bone mineral density at baseline were older age (P=0.002) higher bone-free, fat-free, lean body mass (P=0.001) and higher calcium intake (P=0.005). For higher bone mineral content the significant predictors at baseline were older age (P=0.01) and higher bone-free, fat-free, lean body mass (P=0.001). In all participants (n=48) bone mineral density and content increased significantly at 12 months (total body BMD and content, areal BMD, total hip BMD and content, femoral neck BMD and content and lumbar spine BMD and content).

Discussion: More than adequate baseline serum vitamin D levels in this adolescent group may explain the lack of significant difference in any of the bone measures between intervention and control groups. As the age range of the adolescent girls varied markedly and older age predicted both an increase in BMD and content, it is likely that there was also bone accrual due to growth. The nil effect of vitamin D supplementation on bone measures was also limited by the small sample size.

Conclusion: In this study vitamin D supplementation had no effect on the bone mineral density and content of female adolescent ballet dancers and gymnasts.

Further investigations are needed to examine vitamin D supplementation on bone measures in a large group of adolescent girls.

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Finally, to my friends and family, thanks for your love and support during this project.

Contributions

Masters student and author: Wendy Jessup

Responsible for half of this study in conjunction with Masters student Sarah Mitchell and Research assistant Owen Mugridge. Responsible for serum preparation at endpoint and DXA scans at endpoint and assisted with monitoring of training diaries. Compiled and documented bone mineral measures, anthropometric values and serum data and performed all statistical analysis.

Masters student: Sarah Mitchell

Sarah was involved in the application for ethical approval and recruitment of participants. She collected baseline and six months anthropometric data and monitored supplement compliance.

Research assistant: Owen Mugridge

Coordinated data collection appointments and performed phlebotomy.

DXA management and operation: Dr Pamela von Hurst and Wendy Jessup

Dr von Hurst provided training and supervision throughout.

Laboratory manager: PC Tong

Prepared the serum for analysis of intact PTH, oestradiol and 25(OH)D.

Performed DXA QC for scans and conducted bone mineral analysis from scan reports.

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Abbreviations

$1,25(OH)_2D_3$	α,25-dihydroxyvitami D_3 or calcitriol
$25(OH)D_3$	25-hydroxyvitamin D_3
aBMD	Areal bone mineral density
BFFFLBM	Bone free, fat free, lean body mass
BMC	Bone mineral content
BMCLS	Bone mineral content lumbar spine
BMCTH	Bone mineral content total hip
BMDLS	Bone mineral density lumbar spine
BMDTH	Bone mineral density total hip
GA	Gynaecological age
GH	Growth hormone
IGF-1	Insulin like growth factor 1
PBM	Peak bone mass
PBMAS	Saskatchewan Paediatric Bone Mineral Accrual Study
PHV	Peak height velocity

Terms

The following terms are used in this thesis:

Amenorrhoea: no menstrual cycles for >90 days, in women of reproductive age (Birmingham, 2004).

Anthropometrics: refers to the measurement of the human individual, in this thesis including bodyweight (kg), height (m) and BMI /m^2.

Areal bone mineral density: bone mineral density per surface area (Zemel et al., 2011).

Bone free, fat free, lean body mass (kg): Lean mass measured by DXA less bone mineral content.

Bone mineral density (g/cm^2): refers to grams of bone mineral per unit of bone area scanned (Kalkwarf et al., 2007).

Bone mineral content (g): refers to grams of bone within a specific area (Zemel et al., 2011).

Body mass index: the ratio of weight to height squared (BMI= kg/m^2).

Body composition: includes lean body mass body fat percentage and bone.

Dual Energy X-Ray Absorptiometry: based on the decrease in photon energy of the photon beam as it passes through bone and non-mineralized soft tissue (Bachrach, 2000).

Eumenhorrea: Normal cycles of menstruation.

Hypogonadism: hypothalamic disruption due to insufficient energy intake relative to energy expenditure (Rothman & Wierman, 2008)).

Gynaecological age: (GA) can be defined as the difference between chronologic age and menarchal age. It is the reference criterion for biological maturity (Stevens-Simon, Forbes, Kreipe, & McAnarney, 1986).

Oligomenorrhoea: irregular menstrual periods, <9 menstrual periods over 12 months (Birmingham, 2004; Thein-Nissenbaum & Carr, 2011).

Osteoporosis: a skeletal disease characterised by low density and general deterioration of bone tissue.

Peak bone mass: highest bone mineral content during adulthood (Heaney et al., 2000).

Peak height velocity: Period in adolescence when growth is at maximum rate.

Primary amenorrhoea: a delay in menarche past 15 years due to the late commencement of puberty (Barrack, Rauh, & Nichols, 2008; Birmingham, 2004).

Secondary amenorrhoea: the absence of menstruation, post-menarche, lasting three months (Birmingham, 2004).