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**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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A thesis presented in partial fulfilment of the  
requirements for the degree of

Master of Science  
in  
Nutrition and Dietetics

At Massey University, Albany, 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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## 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.

## Table of Contents

<b>Abstract</b> .....	<b>I</b>
<b>Acknowledgements</b> .....	<b>III</b>
<b>Contributions</b> .....	<b>IV</b>
<b>List of tables</b> .....	<b>VIII</b>
<b>List of figures</b> .....	<b>IX</b>
<b>Abbreviations</b> .....	<b>XI</b>
<b>Terms</b> .....	<b>XII</b>
<b>1.0 Introduction</b> .....	<b>1</b>
<b>1.1 Background</b> .....	<b>2</b>
<b>1.2 Justification</b> .....	<b>3</b>
<b>1.3 Aim and Objectives</b> .....	<b>3</b>
1.3.1 Aim .....	3
1.3.2 Objectives .....	3
<b>1.4 Hypotheses</b> .....	<b>4</b>
<b>2.0 Review of the literature</b> .....	<b>5</b>
<b>2.1</b> .....	<b>6</b>
<b>Introduction</b> .....	<b>6</b>
<b>2.1 Food sources of vitamin D</b> .....	<b>7</b>
<b>2.2 Chemistry and physiology</b> .....	<b>8</b>
2.2.1 Metabolism of vitamin D .....	8
<b>2.3 Vitamin D in New Zealand</b> .....	<b>9</b>
2.3.1 Vitamin D recommendations .....	9
2.3.2 Vitamin D status .....	10
2.3.3 Seasonal variation of vitamin D .....	10
2.3.4 The effect of latitude on vitamin D status .....	12
<b>2.4 The relationship between serum vitamin D, parathyroid hormone and calcium</b> .....	<b>12</b>
<b>2</b> .....	<b>14</b>
2.5.1 Protein .....	15
2.5.2 Calcium .....	17
2.5.3 Energy intake .....	19
<b>2.6 Peak bone mass</b> .....	<b>20</b>
2.6.1 The achievement of peak bone mass .....	20
<b>2.7 Bone mineral measures</b> .....	<b>22</b>
<b>2.8 Physical activity and bone mineral density including loading</b> .....	<b>22</b>
<b>2.9 Sex hormones and bone mineralisation</b> .....	<b>27</b>
2.9.1 Oligomenorrhoea .....	32
2.9.2 Gynaecological age (GA) .....	32
<b>2.10 Characteristics of ballet dancers and gymnasts</b> .....	<b>32</b>
<b>2.11 Dancers, gymnasts and diet</b> .....	<b>34</b>
<b>2.12 Vitamin D status of ballet dancers</b> .....	<b>35</b>
<b>2.13 Sex steroids and issues in this population</b> .....	<b>36</b>
<b>2.14 Summary</b> .....	<b>37</b>

<b>3.0 Methods</b> .....	<b>38</b>
3.1 Primary Aim .....	39
3.2 Ethical Approval .....	39
3.3 Study Design .....	39
3.4 Subject Recruitment.....	40
3.5 Screening .....	40
3.6 Procedures .....	41
3.7 Funding.....	42
3.8 Vitamin D supplementation protocol.....	42
3.9 Compliance.....	42
3.10 Laboratory measurements.....	42
3.11 Bone measures .....	43
3.12 Anthropometric measurements .....	45
3.13 Questionnaires .....	46
3.14 Dietary survey procedure.....	46
3.15 Analysis of the 4-day estimated food records.....	46
3.16 Assessment of physical activity .....	46
3.17 Statistical methods.....	47
3.18 Data storage and handling.....	48
<b>4.0 Results</b> .....	<b>49</b>
<b>4.1 Study participants</b> .....	<b>50</b>
4.1.1 Attrition rates .....	50
<b>4.2 Results Section 1 Baseline Characteristics of participants in the randomised controlled trial</b> .....	<b>52</b>
4.2.1 Serum vitamin D and other biomarkers .....	52
4.2.2 Bone mineral measures at baseline .....	53
4.2.3 Anthropometric characteristics at baseline .....	54
4.2.4 Analysis of the 4-day estimated food records .....	55
<b>4.3 Change in parameters over 12 months – differences between intervention and control groups</b> .....	<b>56</b>
4.3.1 Change in vitamin D and other serum markers over 12 months.....	56
4.3.2 Intact PTH.....	57
4.3.3 Oestradiol.....	57
4.3.4 Change in bone mineral measures over 12 months .....	58
4.3.5 Changes in anthropometry .....	60
<b>4.4 Results Section 2 Baseline Data Investigations</b> .....	<b>62</b>
4.4.1 Predictors of bone mineral at baseline.....	62
4.4.2 Total body bone mineral density .....	62
4.4.3 Total body bone mineral content.....	63
4.4.4 Age groups and bone .....	64
4.4.5 Age of menarche.....	64
4.4.6 Gynaecological Age.....	65
4.4.7 Oligomenorrhoea .....	66
4.4.8 Physical training volume .....	66
4.4.9 Change by age group .....	67
<b>5.0 Discussion</b> .....	<b>68</b>
<b>5.1 Summary of outcomes</b> .....	<b>69</b>
Section 1 Outcomes from the randomised controlled trial.....	69
Section 2 Outcomes from the baseline data .....	69
<b>5.2 Primary outcome</b> .....	<b>70</b>
5.2.1 Vitamin D status at baseline .....	70
5.2.2 Vitamin D supplement dosage.....	73



5.2.3 Vitamin D and leanness.....	75
5.2.4 Supplement compliance.....	76
<b>5.3 Further investigation of baseline data.....</b>	<b>78</b>
5.3.1 Skeletal development and growth.....	78
5.3.2 Predictors of bone mineral density at baseline .....	78
5.3.3 Lean mass.....	78
5.3.4 Calcium.....	79
<b>5.4 Change in bone mineral over 12 months .....</b>	<b>80</b>
<b>5.5 Weight-bearing and non-weight bearing sports .....</b>	<b>80</b>
<b>5.6 Age-related bone mineral accrual.....</b>	<b>80</b>
<b>5.7 Bone mineral density at the femoral neck .....</b>	<b>81</b>
<b>5.8 Menstrual function .....</b>	<b>81</b>
5.8.1 Age of menarche.....	81
5.8.2 Oligomenorrhoea .....	82
<b>5.9 Strengths and limitations .....</b>	<b>82</b>
5.9.1 Population.....	82
5.9.2 Study design .....	82
5.9.3 Range of ages .....	83
<b>6.1 Key findings.....</b>	<b>85</b>
6.1.1 Bone.....	85
6.1.2 Vitamin D.....	85
6.1.3 Age-related changes in bone.....	86
6.1.4 Menstruation and bone .....	86
6.1.5 Summary.....	87
<b>6.2 Recommendations .....</b>	<b>88</b>
6.2.1 Future research .....	88
<b>7.0 References .....</b>	<b>89</b>
<b>8.0 Appendices .....</b>	<b>107</b>
<b>Appendix A .....</b>	<b>107</b>
<b>Appendix B .....</b>	<b>107</b>
<b>Appendix C.....</b>	<b>107</b>
Appendix A.....	108
Appendix B.....	109
Appendix C.....	115

## List of tables

<b>Chapter 3</b>	<b>Description</b>	<b>Page</b>
<b>Table 1.</b>	Bone measures analysed by DXA scan at baseline and 12 months.	45
<b>Chapter 4</b>		
<b>Table 2.</b>	Serum blood results at baseline for gymnasts and dancers.	54
<b>Table 3.</b>	Bone mineral measurements at baseline for dancers and gymnasts.	55
<b>Table 4</b>	Baseline demographic and anthropometric characteristics of ballet dancers and gymnasts	56
<b>Table 5.</b>	Change in serum measures from baseline, six months and endpoint, between and within intervention and control groups.	58
<b>Table 6.</b>	Change in bone mineral measures from baseline to endpoint within and between intervention and control groups	60
<b>Table 7.</b>	Changes from baseline to endpoint in anthropometry within and between intervention and control groups	62
<b>Table 8.</b>	Predictors of total body bone mineral density at baseline	64
<b>Table 9.</b>	Predictors of total body bone mineral content at baseline	64
<b>Table 10.</b>	Differences between variables in dancers and gymnasts who had experienced menarche and those who had not experienced menarche at baseline	66
<b>Table 11.</b>	Gynaecological age of participants at baseline.	66
<b>Table 12.</b>	Regular vs irregular periods and bone measures at baseline.	67
<b>Table 13.</b>	Differences in mean change over 12 months in bone variables and height.	68

## List of figures

<b>Chapter 2</b>	<b>Description</b>	<b>Page</b>
<b>Figure 1.</b>	Vitamin D metabolism.	9
<b>Figure 2.</b>	The hormonal control of blood calcium in the body by parathyroid hormone and calcitonin.	14
<b>Figure 3.</b>	Dietary protein intakes, IGF-I, and calcium-phosphate homeostasis. IGF-I influences bone growth, bone mass accumulation and mineral homeostasis	28
<b>Figure 4.</b>	The interaction of energy availability, menstrual dysfunction and bone mineral density noted in The Female Athlete Triad	29
<b>Chapter 3</b>		
<b>Figure 5.</b>	Diagrammatic representation of phases of the study design.	39
<b>Figure 6.</b>	An example of a DXA scan of the lumbar spine, showing the vertebrae L1-L4.	44
<b>Figure 7.</b>	An example of a DXA scan of the hip showing the femoral neck.	44
<b>Chapter 4</b>		
<b>Figure 8.</b>	Diagram of sporting codes included in this study	52
<b>Figure 9.</b>	Diagram of selection process from assessment for eligibility in study through to analysis of results.	52
<b>Figure 10.</b>	Change in serum 25(OH)D in the intervention and control groups over 12 months.	57
<b>Figure 11.</b>	Differences in mean bone mineral density at 4 age groups. The age groups were 12-13 years, 14 years, 15 years and 16-18 years.	65

**Figure 12** Serum 25(OH)D in relation to BMI (kg/m<sup>2</sup>) showing response to vitamin D supplementation 75

## Abbreviations

1,25(OH) <sub>2</sub> D <sub>3</sub>	α,25-dihydroxyvitami D <sub>3</sub> or calcitriol
25(OH)D <sub>3</sub>	25-hydroxyvitamin D <sub>3</sub>
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<sup>2</sup>.

**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<sup>2</sup>):** 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<sup>2</sup>).

**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).