Nutrición Hospitalaria

Nutr Hosp. 2013;28(3):1136-1139
ISSN 0212-1611 • CODEN NUHOEQ
S.V.R. 318

Original / *Pediatría*

Do calcium and vitamin D intake influence the effect of cycling on bone mass through adolescence?

A. Gómez-Bruton[1], A. González-Agüero[1,2], H. Olmedillas[3], A. Gómez-Cabello[1,2], A. Matute-Llorente[1], C. Julián-Almárcegui[1], J. A. Casajús[1,2] and G.Vicente-Rodríguez[1,2]

[1]GENUD "Growth, Exercise, Nutrition and Development" Research Group. University of Zaragoza. Spain. [2]Faculty of Health and Sport Science (FCSD). Department of Physiatry and Nursing. University of Zaragoza. Huesca. Spain. [3]Department of Functional Biology. Universidad de Oviedo. Asturias. Spain.

Abstract

Introduction: **Cycling has been associated with decreased bone mass during adolescence. Calcium (Ca) and vitamin D (VitD) intake are associated to bone mass and may be important confounders when studying bone mass.**

Aim: **To clarify the effect that Ca and VitD may have on bone mass in adolescent cyclists.**

Methods: **Bone mineral content (BMC) and density (BMD) of 39 male adolescents (20 cyclists) were measured. Ca and VitD intake were also registered. Different ANCOVA analyses were performed in order to evaluate the influence of Ca and VitD on BMC and BMD.**

Results: **Cyclists showed lower values of BMC and BMD than controls at several sites and when adjusting by Ca, Wards triangle BMD appeared also to be lower in cyclists than controls.**

Conclusion: **Nutritional aspects might partially explain differences regarding bone mass in adolescent cyclists and should be taken into account in bone mass analysis as important confounders.**

(*Nutr Hosp.* 2013;28:1136-1139)

DOI:10.3305/nh.2013.28.4.6490

Key words: *Bone. Cycling. Calcium. Vitamin D. Osteoporosis.*

¿INFLUYE LA INGESTA DE CALCIO Y VITAMINA D EN EL EFECTO DEL CICLISMO SOBRE LA MASA ÓSEA DURANTE LA ADOLESCENCIA?

Resumen

Introducción: **El ciclismo se ha asociado con un descenso de la masa ósea durante la adolescencia. La ingesta de calcio (Ca) y vitamina D (VitD) repercute sobre la masa ósea llegando a ser factores de confusión importantes al estudiarla.**

Objetivo: **Clarificar el efecto que el Ca y la VitD pueden tener sobre la masa ósea de ciclistas adolescentes. Métodos: se midió el contenido mineral óseo (CMO) y la densidad mineral ósea (DMO) de 39 varones adolescentes (20 ciclistas). También se registró la ingesta de Ca y VitD. Se realizaron distintos análisis ANCOVA para evaluar la influencia del Ca y la VitD sobre el CMO y la DMO.**

Resultados: **Los ciclistas mostraron menores valores de CMO y DMO que los controles en diversas zonas y, cuando se ajustó por Ca, la DMO del triángulo de Wards también pasó a ser menor en los ciclistas que en los controles.**

Conclusión: **Los aspectos nutricionales podrían explicar en parte las diferencias de masa ósea en ciclistas adolescentes y deberían tenerse en cuenta en el análisis de masa ósea como factores de confusión importantes.**

(*Nutr Hosp.* 2013;28:1136-1139)

DOI:10.3305/nh.2013.28.4.6490

Palabras clave: *Hueso. Ciclismo. Calcio. Vitamina D. Osteoporosis.*

Correspondence: Germán Vicente-Rodríguez.
E-mail: gervicen@unizar.es

Recibido: 9-II-2013.
Aceptado: 13-V-2013.

Introduction

Genes are principal determinants for bone mass. However environmental factors directly explain peak bone mass acquisition during growth. In addition to genetic predisposition and physiological factors, calcium (Ca) and vitamin D (VitD) intake have been described among the most important nutritional factors related to peak bone mass acquisition. Regarding lifestyle, physical activity and participation in sports during growth periods have been shown to be crucial for the acquisition of bone mass. However not all sports have the same osteogenic effect. Bone mineral content (BMC) and density (BMD) values vary among sports due to the inherent characteristics of each sport: high-impact sports such as gymnastics or basketball, and low-impact sports like swimming or cycling.

Dual energy X-ray absorptiometry (DXA) has been often used for evaluating bone mass for its precision at the individual level; however, it is a two dimensional measure influenced by several factors such as body size or height. It therefore seems necessary, when comparing different groups of persons, to adjust by different confounders to minimize those individual differences. Some variables like height or lean mass are often entered into the analyses to adjust the data; however other variables may also affect bone mass like the above described Ca and VitD intake. Therefore, the main aim of the present study was to compare BMC and BMD of male adolescent road cyclists (CYC) to age-matched controls (CON) and to evaluate the influence of Ca and VitD intake on these variables.

Material and methods

Subjects

Thirty-nine healthy male adolescents (see table I for descriptive data) participated in the study. To be included in the study, subjects had to be under the age of 21, healthy, without any chronic disease and free of musculoskeletal conditions, bone fractures, medications or habits affecting bone development. Twenty CYC were recruited from different cycling teams, all being regular participants in regional competitions and participating in training sessions and competitions a mean of 10 hours per week for a minimum of 2 years prior to the study. Nineteen age-matched CON, physically-active boys were recruited among high school and university. The CON were enrolled in recreational sports 2 h per week with occasional match at the weekend but none cycled more than 1 h per week. None of the subjects that participated in the study were taking Ca or VitD supplements at the time.

Table I
Descriptive characteristics and nutrients intake of the participants

Variable	*Cyclists (n = 20)*	*Controls (n = 19)*
Age (years)	16.49 ± 1.14	16.77 ± 2.25
Height (cm)	173.78 ± 5.77	175.63 ± 9.26
Weight (kg)	62.19 ± 8.08*	73.18 ± 17.80
BMI	20.35 ± 2.54*	23.62 ±4.86
Calcium intake (g/day)	763.81 ± 389.56	823.11 ± 519.34
Vitamin D intake (µg)	3.91 ± 7.1	4.82 ± 11.26

Values as mean and SD.
*P ≤ 0.05; BMI = Body mass index.

Ethical issues

Written informed consent was obtained from parents and adolescents. The study was performed following the ethical guidelines of the Declaration of Helsinki 1961 (revision of Edinburgh 2000). The protocol study was approved by the Ethics Committee of Clinical Research from the Government of Aragón (CEICA; Spain).

Experimental design

All participants were asked to come for one visit to complete the testing that took place in April 2011. All the tests and questionnaires were performed by qualified researchers from the University of Zaragoza.

Bone mass

Subjects were scanned using DXA (paediatric version of the software QDR-Explorer, Hologic Corp., Software version 12.4, Bedford, MA, USA) in order to obtain BMC and BMD data of the whole body, hip (and subregions) and lumbar spine. Additionally lean mass [body mass – (fat mass + bone mass)] was measured and regional analyses of the limbs were performed from the whole body. DXA equipment was calibrated as recommended by the manufacturer. Area was determined from the scan analyses. Once soft tissue was removed from scan data, the result was computed BMD through the following equation: BMD = BMD bone segment [(Qbone-D0)/D0], were Q is derived from the ratio between the low and high energy attenuation; then three Qs are calculated, for bone, air and tissue. D0 is the difference Q air-Q bone. BMC was derived from both BMD and area, using the following equation: BMC=(BMD)(Bone area). Bone mineral apparent density (BMAD) was calculated using the formula: Whole body BMAD = Whole body BMC/(Whole body area^2/body height). All DXA scans were completed with the same device and software and performed by the same technician who had been fully trained in the operation of the scanner, the positioning of subjects, and the analysis of results, according to the manufacturer's guidelines. The coefficients of variation of the DXA in our lab are published elsewhere.

Nutritional status

A 24 hour recall was performed to measure daily Ca and VitD intake by using the Helena Dietary Assessment Tool (YANA-C) computer programme, previously validated on adolescents. This Tool was designed for adolescents aged 11 and over, and consists of a single 24-h recall structured according to six meal occasions (breakfast, mid-morning snack, midday meal, afternoon snack, evening meal and evening snack). For every meal occasion, participants were invited to select all food items eaten at each occasion and could choose within more than 400 food items, hierarchically organized in 18 food groups. Items not listed in the menus could be added by clicking a 19th group labeled "items not found". The EFCOSUM project considers 24-h recalls as the best method to get population mean intakes and distributions for participants aged 10 years and over in different European countries.

Statistics

The Statistical Package for the Social Sciences (SPSS, version 15.0 for Windows) was used to conduct statistical analyses. The normality in the distribution of the variables was established by using Kolmogorov-Smirnov tests. Student t tests for independent samples were performed to evaluate differences between groups. One-way analysis of covariance (ANCOVA) with Bonferroni post-hoc was used to evaluate differences between groups, including as covariates in all the analysis (except for head and BMAD): height, subtotal lean and age (Model 1). Further, Ca (Model 2) and VitD (Model 3), and both Ca and VitD (Model 4) were also included in the analyses in order to view the combined influence of nutritional variables. Statistical significance was set at $p \leq 0.05$.

Results

Descriptive characteristics of participants by group are summarized in table I. CYC and CON were comparable in age and height. CYC were lighter and presented lower BMI than CON (table I; both $p \leq 0.05$).

Bone mass

The adjusted values of BMC and BMD by different confounders are shown in table II. For BMD; left leg,

Table II
Bone mineral density, content and apparent density adjusted by age, height and subtotal lean

Variable	*Cyclists*	*Controls*	*Model 1* *p*	*Model 2* *p*	*Model 3* *p*	*Model 4* *p*
BMD (g·cm^{-2})						
R. Leg	1.208 ± 0.12	1.285 ± 0.12	0.051*	0.039*	0.048*	0.041*
L. Leg	1.200 ± 0.12	1.302 ± 0.12	0.015	0.013	0.014	0.014
R. Arm	0.728 ± 0.06	0.753 ± 0.07	0.246	0.233	0.239	0.236
L. Arm	0.724 ± 0.06	0.749 ± 0.06	0.233*	0.214*	0.222*	0.216
Total LSP	0.890 ± 0.12	0.963 ± 0.12	0.078	0.062*	0.082	0.068*
Pelvis	1.036 ± 0.16	1.219 ± 0.16	0.002*	0.001*	0.002*	0.002
Wards	0.815 ± 0.15	0.910 ± 0.15	0.060	0.050	0.062	0.054*
Troch.	0.755 ± 0.09	0.870 ± 0.10	0.001*	0.001*	0.001*	0.001
Head	1.926 ± 0.29	1.982 ± 0.29	0.542	0.597	0.546	0.541*
Subtotal	0.963 ± 0.09	1.039 ± 0.09	0.015	0.012	0.016	0.013
BMAD	0.091 ± 0.01	0.094 ± 0.01	0.329	0.282	0.298	0.275
BMC (g)						
R. Leg	453.2 ± 75.97	500.9 ± 76.09	0.030*	0.029*	0.032*	0.032*
L. Leg	459.8 ± 80.84	514.9 ± 117.7	0.035	0.034	0.036	0.037
R. Arm	148.8 ± 29.33	156.7 ± 29.38	0.455	0.433	0.452	0.442
L. Arm	145.2 ± 29.38	157.1 ± 29.42	0.230*	0.218*	0.241*	0.230
Total LSP	55.36 ± 10.68	60.94 ± 10.69	0.123	0.116	0.132	0.123*
Pelvis	247.1 ± 55.15	298.3 ± 55.24	0.008*	0.008*	0.009*	0.009*
Wards	0.949 ± 0.19	1.039 ± 0.19	0.168	0.141	0.166	0.149
Troch.	9.155 ± 1.83	10.46 ± 1.84	0.038	0.035	0.040	0.038
Head	465.8 ± 85.10	476.9 ± 85.13	0.688*	0.686*	0.686*	0.687*
Subtotal	1,784.8 ± 258.9	1,988.8 ± 286.2	0.038	0.035	0.041	0.039

BMAD = Bone mineral apparent density; BMC = Bone mineral content; BMD = Bone mineral density; L = Left; R = Right; LSP = Lumbar Spine; Troch = Trochanter.
Values as mean and SD. *P ≤ 0.05.
Model 1 adjusted by age, height and subtotal lean.
Model 2 adjusted by Model 1 + Calcium intake.
Model 3 adjusted by Model 1 + Vitamin D intake.
Model 4 adjusted by Model 1 + Calcium intake + Vitamin D intake.
Head in model 1 only adjusted by age.
BMAD in model 1 adjusted by age whole body total lean and height.

pelvis, trochanter and subtotal were lower in CYC than in CON in Model 1 (table II, all $p \leq 0.05$) and remained similar in the rest of the models. However right leg and Wards triangle were similar among groups in Model 1, but became significantly lower in CYC than CON once adjusted by Ca (Wards triangle, Model 2, table II, $p \leq 0.05$) or the combined effect of Ca and VitD (Right leg, Model 4, table II, $p \leq 0.05$).

For BMC, both legs, pelvis, and subtotal were lower in CYC than CON in all the models (table II, all $p \leq 0.05$).

Discussion

Although previous studies have shown lower levels of bone mass in CYC, and some others studied Ca or VitD intake in that population; this is, to our knowledge, the first study taking into account Ca and VitD intake for studying their influence in bone mass in a sample of male adolescent CYC. The main finding of this study is that Ca and VitD have an influence on bone mass at several regions of the body in this population. These results contradict previous findings that showed no relation between Ca intake and BMD in adult cyclists adding novel information on the exercise-nutrition interaction on bone mass. The differences among findings may be due to the age of participants, as the previous were in adults and our sample is composed of adolescents. It is well known that bone growth takes place mainly during adolescence and therefore Ca intake may be more important for bone formation in these stages of life. Also the inclusion of VitD intake might be important in this regard, as this is the first study taking into account this micronutrient, closely related with the regulation of Ca, in adolescent cyclists.

Overall BMD and BMC were lower in CYC than in CON independently of the statistical model used. Low-impact sports have been previously described as less osteogenic than high impact sports. Our results regarding bone mass are in the line of previous, as seen in a recent review that cycling participation seems to have a neutral or even deleterious effect in terms of BMD acquisition at several sites of the body and confirm the influence of nutritional variables.

Ca is fundamental to bone mass and its supply through diet is crucial. According to recommended dietary allowance (RDA) guidelines the CYC included in the study, who consumed an average of 763.81 mg/day, were far from these RDA established for their age group (1,300 mg/day), being the CON also slightly under the RDA (823 mg/day). Similar findings were obtained for VitD (RDA 15 μg/day), with CYC having 3.91 μg/day and CON having 4.82 μg/day. These low intakes are concerning, especially in CYC, and might partially explain the differences observed in bone mass. The low Ca and VitD intake observed, are in line with previous studies in Spanish children living in the same latitude.

Some studies performed with DXA in adolescents suggest that BMC is more accurate and reliable than BMD for assessing bone acquisition in early stages of sexual development. Therefore the lower values of BMC found in CYC compared with CON in subtotal body, both legs and pelvis are findings of great relevance. The same study confirmed that if BMD is adjusted by several confounders, it can also be a reasonable parameter for assessing bone acquisition. Despite of this, some studies performed with DXA do not use any corrections; it seems therefore necessary to adjust by age, height and/or lean due to the characteristics of DXA. It has been showed in this study that nutritional variables like Ca and VitD intake modify final BMD values and therefore comparisons among groups. Hence, nutritional variables that affect bone should be taken into account in further studies.

The values observed at Ward s triangle, a highly trabecular area, seem to be different between groups in the model that included Ca as covariate. Ward s triangle has been previously described as a sensitive indicator of osteoporosis, particularly in men, and has been recommended as an adequate area to identify patients at increased risk for osteoporosis-related fractures. Therefore, the lower values of BMD observed at Ward s in the CYC compared with CON are extremely important, and make Ca intake a key confounder to be included in the statistical analysis.

We would like to state that these findings may be specific to our small group of athletes and need to be confirmed in future bigger studies. Furthermore, and because of the cross-sectional nature of this study, we cannot ensure that the observed differences in the bone measurements are the result of the sport or self-selection bias.

Conclusion

VitD and specially Ca intake should be taken into account when comparing bone mass in populations of adolescent CYC, as observed that when those were included in the analyses, differences between groups became significant in some important regions regarding osteoporosis such as Ward s triangle.

The combination of non-osteogenic sport participation and low intake of some important nutrients may produce deleterious effects in bone development during growth; more research is needed on the exercise-nutrition interaction in bone mass.

Acknowledgements

This study was supported by a grant from Ministerio de Ciencia e Innovación, Instituto de Salud Carlos III (DPS2008-06999) and Presidencia del Gobierno de España, Consejo Superior de Deportes (21/UPB20/10) and Fondo Europeo de Desarrollo Regional (MICINN-FEDER). We gratefully acknowledge all participating adolescents, their parents and coaches for their collaboration.