DO CALCIUM AND VITAMIN D INTAKE INFLUENCE THE EFFECT OF CYCLING ON BONE MASS THROUGH ADOLESCENCE?

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

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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.

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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 des censo 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.

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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>
<thead>
<tr>
<th>Table I</th>
<th>Descriptive characteristics and nutrients intake of the participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Cyclists (n = 20)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>16.49 ± 1.14</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>173.78 ± 5.77</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>62.19 ± 8.08*</td>
</tr>
<tr>
<td>BMI</td>
<td>20.35 ± 2.54*</td>
</tr>
<tr>
<td>Calcium intake (g/day)</td>
<td>763.81 ± 389.56</td>
</tr>
<tr>
<td>Vitamin D intake (μg)</td>
<td>3.91 ± 7.1</td>
</tr>
</tbody>
</table>

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 (pediatric 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/body height). All DXA scans were performed 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,
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 Ward’s 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 osteoporosis such as Ward’s triangle. 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.

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.

**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.

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