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The nutritional status in adolescent Spanish cyclists

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Abstract

Introduction: **Adolescence is an important period of nutritional vulnerability due to the increased dietary requirements.**

Objective: **To describe the nutritional status of adolescent cyclist and a group of normoactive controls.**

Methods: **The HELENA Dietary Assessment Tool was used to evaluate the nutritional intake of 20 adolescent cyclists and 17 controls. Total energy intake, resting energy expenditure (REE), total energy expenditure (TEE), macronutrients and several micronutrients were registered and compared with dietary guidelines.**

Results: **REE was lower and TEE higher in cyclists than in controls (both P < 0.01). Significant differences were observed in phosphorus and vitamin B1 being higher in cyclists (P < 0.05). Most participants, both cyclist and controls, did not reach the diet requirements for macronutrients, vitamins and minerals.**

Conclusion: **Nutritional status of adolescent cyclists and controls seems not to fulfil the requirements in quantity and quality. Possible implications for actual and future health especially in athlete adolescents need further research.**

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Key words: *Resting energy expenditure. Macronutrients. Energy intake. Body mass. BMI. Carbohydrates.*

ESTADO NUTRITIVO DE CICLISTAS ADOLESCENTES ESPAÑOLES

Resumen

Introducción: **La adolescencia es un periodo importante de vulnerabilidad nutricional dados las mayores demandas alimentarias.**

Objetivo: **Describir el estado nutritivo de ciclistas adolescentes y de un grupo de controles con actividad normal.**

Métodos: **Se utilizó la Herramienta de Evaluación Alimentaria HELENA para evaluar la ingesta nutricional de 20 ciclistas adolescentes y 17 controles. Se registraron la ingesta total de energía, el gasto de energía en reposo (GER), el gasto de energía total (GET), los macronutrientes y diversos micronutrientes y se compararon con las guías dietéticas.**

Resultados: **El GER fue menor y el GTE mayor en los ciclistas que en los controles (ambos P < 0,01). Se observaron diferencias significativas en el fósforo y la vitamina B1, siendo mayores en los ciclistas (P < 0,05). La mayor parte de los participantes, tanto ciclistas como controles, no alcanzó los requerimientos en macronutrientes, vitaminas ni minerales.**

Conclusión: **El estado nutritivo de los adolescentes ciclistas y de los controles parece no adecuarse a las recomendaciones de cantidad y calidad. Deberían investigarse las posibles implicaciones de la salud actual y futura, especialmente en los adolescentes atletas.**

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Palabras clave: *Consumo de energía en reposo. Macronutrientes. Ingesta de energía. Masa corporal. IMC. Hidratos de carbono.*

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Introduction

During adolescence, young people go through many changes as they move from childhood into physical maturity. This process is characterized by an accelerated growth rate associated with rapid muscular, skeletal and sexual development; it is, therefore an important period of nutritional vulnerability due to the increased dietary requirements for these changes.[1] However, most children and adolescents do not reach dietary guidelines/recommendations[2] and this behaviour may induce adverse metabolic effects, such as large losses in muscle mass, body mass and/or hormonal imbalances.[1] Moreover, it has been shown that a healthy diet during childhood and adolescence may reduce morbidity and mortality and prevent chronic diseases later in life.[3]

Athletic adolescents, especially those who take part in aerobic sports such as cycling, have special nutritional needs due to their higher caloric expenditure. Although a specific set of dietary recommendations does not exist for adolescents enrolled in sports, at least athletes need to consume a diet consistent with the recommendations for the general population for overall good health. It has been stated that carbohydrate-rich food must provide the majority of the energy provision in resistance trainings such as cycling,[4] and this higher carbohydrates intake should be compensated by a lower protein intake comparing to normoactive groups. In cyclists, calories should be settled according to their caloric expenditure and those calories should come from different dietary sources to ensure optimal results. To our knowledge, there is just one study that tested whether adolescent cyclists complied the macronutrients intake guidelines showing that cyclists did intake an excessive quantity of proteins and lipids in their diet; however, micronutrients and water intake that have a crucial roll in good development was not registred.[5] Therefore, the aim of this study was to describe the nutritional status of the adolescent cyclist compared to 1) normoactive adolescents peers, 2) energy requirements and 3) dietary requirements in macro and micronutrients.

Materials and methods

Subjects

Thirty-seven healthy male adolescents agreed to participate in the study. To be included, subjects had to be below 21 years of age, healthy, without any chronic disease and free of musculoskeletal conditions, bone fractures, medications or habits affecting bone development. Twenty adolescent male road cyclists (16.9 ± 1.1 years old) were recruited from different cycling teams of Aragón and Cataluña (Spain). All cyclists participated in regional competitions and training sessions a mean of 13.8 hours per week for a minimum of 2 and a maximum of 7 years prior to the study. Seventeen controls, normoactive males, were recruited among high schools and sports sciences university grade. Control subjects (17.0 ± 2.0 years old) were enrolled in recreational sports (rugby, tennis, handball, soccer) 2 hours a week with occasional match at the weekend but none cycled more than 1 hour per week. The complete methodology of this project has been described elsewhere.[6]

Parents and adolescents signed a written informed consent. Data collection was conducted in 2010. The study was performed following the ethical guidelines of the Declaration of Helsinki 1961 (revised in Edinburgh, 2000) and was approved by the Research Ethics Committee of the Government of Aragon (CEICA; Spain).

Assessment of dietary intake and energy expenditure

A 24-h recall, the HELENA-DIAT (Dietary Assessment Tool),[7] was carried out to assess dietary intake (macronutrients and several micronutrients). Resting energy expenditure (REE) was calculated by using Schoenfield-W equation, as it has been demonstrated as the most accurate prediction equations in adolescents.[8] Total energy expenditure (TEE) was estimated as REE plus the physical activity level of each participant expressed by the metabolic equivalent value[9] (MET; the ratio of the associated metabolic rate for the specific activity to the resting metabolic rate) plus the thermogenic effect of food.[10]

The recommended macronutrients intake for the cyclists has been calculated by using different tools. Protein requirement was settled at 1.5 g/kg body weight^{-1} day^{-1} because during stable training periods, protein intake greater than 1.7 g/kg body weight^{-1} · day has been shown to lead to increased protein oxidation.[4] Fat was recommended at less than 30% of energy[4] and carbohydrates was calculated to complete the amount of energy required. The specific Spanish requirements of macronutrients for the general population have been applied to the controls: carbohydrates 50-55%, fats 30-35% and proteins 10-15% of the total energy intake,[11] mean value of this range was used.

The requirements of the American Institute of Medicine (AIM)[12] were used to compare the intake of micronutrients for both groups. No requirements for potassium or sodium were showed, because the AIM just showed the mean values for the American population.

Statistics

Mean and standard deviation (SD) are given as descriptive statistics. Kolmogorov-Smirnov tests were carried out to test the normality in the distribution of the studied variables. To determine the differences between controls and cyclists, non-parametric test (Mann-Whitney) was applied for all the studied variables. Chi-square was performed to calculate the differences in the percentage of participants who followed the nutrients requirements. All the analyses were carried out with the Statistical Package for the Social Sciences (SPSS) Windows software, version 15.0. Significance was set at P-value < 0.05.

Results

There were no differences in age and height between groups. However, cyclists had lower body mass (63.81 ± 9.17 *vs.* 73.82 ± 18.79) and BMI (20.39 ± 2.29 *vs.* 23.69 ± 5.37) than controls (both P < 0.05).

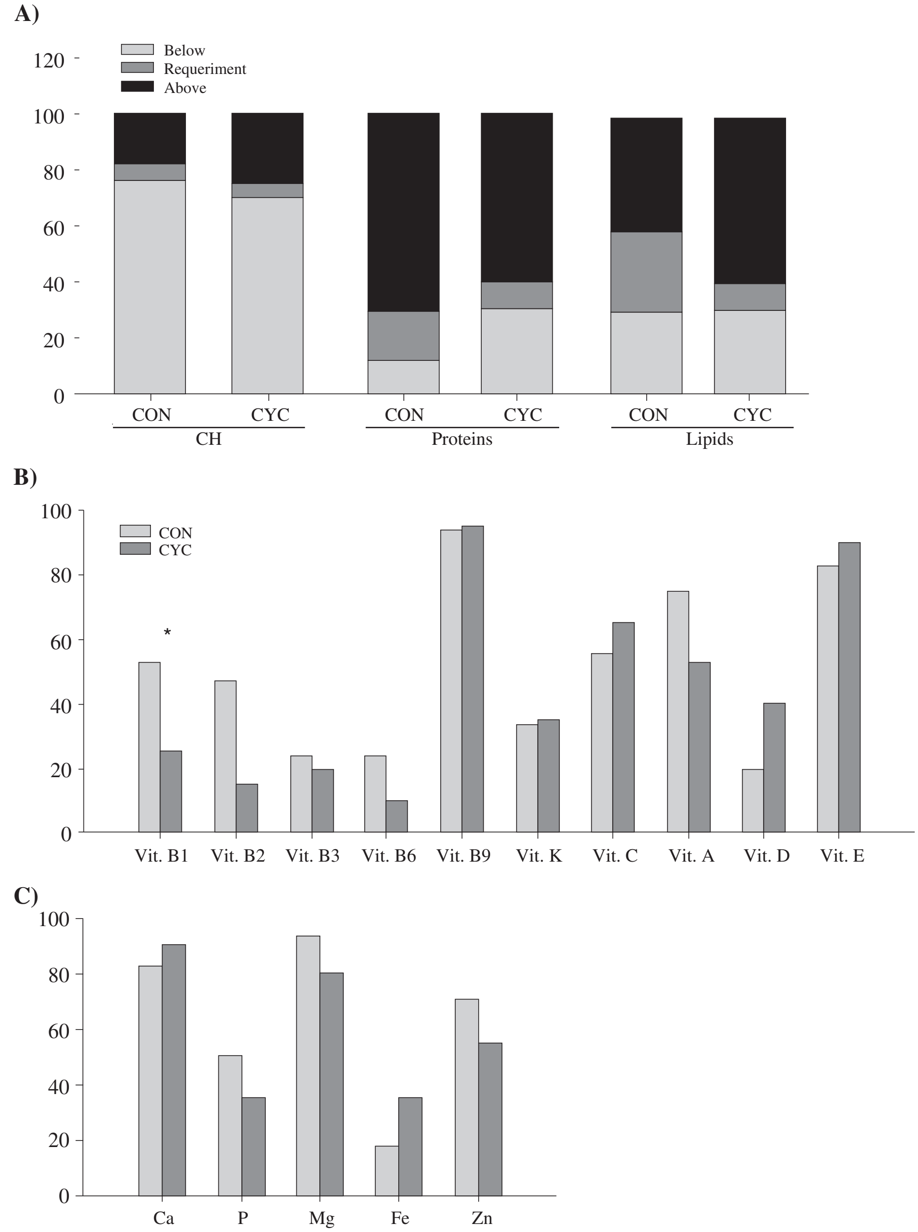
The average energy intake was similar for controls and cyclists. REE was 7.99% lower and TEE 11,81% higher for cyclists compared to controls (both P < 0.05).

Data of nutritional variables are presented in table I. No significant differences were observed in none of the diet components, with the exception of phosphorus and vitamin B1 being significantly higher in cyclists compared to controls (P < 0.05). Data for nutrient requirements are presented in figure 1. In general, neither controls nor cyclists reached the macronutrients requirements. Both groups consumed more fats and proteins and less carbohydrates than the established requirements. In relation to the micronutrients intake, 17.6% to 93.8% of the participants did not reach

Table I
Energy and nutrient intake of the participants

	Controls *Mean ± SD*	*Cyclists* *Mean ± SD*	*P*
Energy intake (kcal)	2,296.04 ± 1,552.13	2,321.38 ± 995.51	0.428
Resting energy expenditure (kcal)	1,682.31 ± 251.77	1,548.05 ± 122.88	**0.043**
Total energy expenditure (kcal)	2,101.97 ± 334.21	2,383.47 ± 231.46	**0.005**
Carbohydrates[a] (g)	251.09 ± 236.81	195.95±67.02	0.855
Simple sugars[a] (g)	148.56 ± 223.85	101.89 ± 36.85	0.201
Polysaccharides (g)	98.64 ± 60.13	94.01 ± 49.71	0.761
Total fiber[a] (g)	20.69 ± 27.35	15.06 ± 11.55	0.648
Lipids (g)	97.16 ± 69.16	113.47 ± 82.15	0.361
Monounsaturated fatty acids (g)	38.03 ± 27.65	44.48 ± 34.01	0.465
Polyunsaturated fatty acids (g)	15.15 ± 12.73	17.07 ± 10.81	0.503
Saturated fatty acids (g)	34.02 ± 27.06	42.14 ± 36.04	0.286
Cholesterol (mg)	469.56 ± 333.76	460.89 ± 263.75	0.849
Proteins (g)	103.32 ± 65.19	128.18 ± 57.34	0.198
Animal Protein (g)	123.88 ± 150.63	105.49 ± 56.98	0.484
Vegetable Protein[a] (g)	23.83 ± 14.95	26.95 ± 25.39	1.000
Water (ml)	1,984.09 ± 718.29	2,019.64 ± 639.82	0.443
Calcium (g)	681.88 ± 453.16	751.10 ± 393.65	0.369
Phosphorus (mg)	1,105.17 ± 642.27	1,691.91 ± 678.69	**0.012**
Sodium (mg)	3,355.34 ± 2,312.68	3,442.95 ± 2,405.43	0.976
Potassium[a] (mg)	3,364.24 ± 2,612.51	2,766.89 ± 913.49	0.714
Iron[a] (mg)	41.64 ± 81.73	16.97 ± 12.42	0.737
Zinc (mg)	10.46 ± 10.37	10.48 ± 4.88	0.259
Magnesium (mg)	250.05 ± 177.65	313.54 ± 155.75	0.161
Vitamin B1 (mg)	1.36 ± 0.91	1.76 ± 0.72	**0.041**
Vitamin B2[a] (mg)	2.18 ± 2.43	2.16 ± 1.16	0.113
Vitamin B3 (mg)	40.61 ± 46.88	31.01 ± 15.08	0.807
Vitamin B6 (mg)	2.38 ± 1.88	2.68 ± 0.98	0.094
Vitamin B9[a] (μg)	264.72 ± 334.46	246.24 ± 114.78	0.259
Vitamin B12 (μg)	7.15 ± 10.04	7.24 ± 8.61	0.571
Vitamin C (mg)	96.51 ± 80.63	81.28 ± 92.06	0.315
Vitamin A (μg)	626.16 ± 528.06	551.93 ± 494.86	0.524
Retinoids (μg)	250.85 ± 199.93	278.83 ± 277.44	0.969
Carotenoids[a] (μg)	1,578.32 ± 1,625.72	1,643.58 ± 2,047.72	0.411
Vitamin D[a] (μg)	2.55 ± 2.43	3.91 ± 7.13	0.949
Vitamin E[a] (mg)	9.78 ± 13.50	7.58 ± 6.52	0.715

[a]Non-parametric test (Mann-Whitney).
Statistical differences between groups in bold letters.



CYC: Cyclists; CON: Controls; CH: Carbohydrates; Vit: Vitamin; Ca: Calcium; P: Phosphorus; Mg: Magnesium; Fe: Iron; Zn: Zinc.
*Significant differences between groups.

Fig. 1.—a) Percentage of participants who are below, above or reaching the requirements of macronutrients; b) percentage of participants who not reach the vitamins requirements; c) percentage of participants who not reach the minerals requirements.

the mineral requirements being calcium, magnesium and zinc the less consumed. Vitamins were also not reached by the 15-95% of the participants being vit B9, A and E the less consumed. Percentage of cyclists that did not reach the recommended vitamin B1 intake was lower than in controls. Water intake recommendation was not reached by controls nor cyclists.

Discussion

The main finding of this study was that most of the participants did not reach the American dietary reference intakes for minerals and vitamins, and the macronutrients proportions were not properly distributed (fig. 1). A second major finding was that controls presented higher values of REE and lower values of TEE comparing to cyclists, but the average energy intake was similar for both. The fact that cyclists had significantly lower body mass and BMI than controls, it may be partially explained by the physical activity level. Cyclists practiced more than ten hours of physical activity per week and the control group performed a maximum of two. Then, we could consider that cyclists had higher total energy requirements than the control group.

Controls and cyclists consumed more proteins and lipids and less carbohydrates than the Spanish dietary references. These results agree with the information found by Sanchez-Benito et al.[5] and it could affect the health of these adolescents and the performance of the cyclists. Controls and cyclists should take into account that an excessive amount of proteins could lead to the excretion of the protein nitrogen which implies the lost of increased quantities of calcium and, in the long term, may be a factor of risk for osteoporosis.[5] As well, high quantities of fat may be a factor risk of cardiovascular diseases for controls and cyclists.[13] According to the performance of cyclists, adequate amounts of energy must be consumed to support the training volume and intensity. Several studies support that a high carbohydrates diet is needed and recommended in all athletes in order to enable the training load.[14] Therefore, dietary planning for controls and cyclists must include enough carbohydrate on a moderate energy budget, while also meeting protein needs.[4]

On the other hand, both groups mostly present low percentages of people who reach the vitamins and minerals requirements. Cyclists and controls have mostly a deficit in vitamin B9, vitamin A and vitamin E; and in calcium, magnesium and zinc. Vitamin B9, A, E and zinc are recognized to boost both cell-mediated and humoral immune defences of the body.[15] Ca and vitamin A are required to maintain the integrity and mineralization of bones. Moreover, zinc is also important to ensure sexual maturation and a correct neuromotor development in adolescence.[15] We have reported significant differences in phosphorous and vitamin B1 intake between groups. Phosphorous has an important role in bone health. Vitamin B1 takes part in the metabolism of carbohydrates.[15] Even if cyclists have a higher intake of these micronutrients, in general, they do not reach the requirements at relative terms.

Cycling is an endurance exercise and training sessions are usually long making hydration an important issue to take into account to avoid progressive dehydration and loss of electrolytes, such as potassium, magnesium, calcium or sodium.[14] In the post-exercise period, replacement of fluids and electrolytes can usually be achieved through the normal dietary intake. Water intake should be proportional to the energy intake, at a minimum, 1 ml per kcal.[12] However, none of the groups reach this recommendation being the hydratation of controls and especially the cyclists compromised.

Therefore, an implementation of a healthy nutrition programme should be encouraged through the adolescence in order to guarantee a good health status especially in athlete adolescents.

Some limitations of this study deserve comment. First at all, the 24 h recall was performed once, and therefore may not be representative of the normal diet. Future studies should include at leas two. Due to the relative small sample size of this study, a logical step for future research would be the inclusion of more participants to corroborate our results. Future research should focus on the evaluation of female cyclists due to gender differences regarding diet.[16]

On the other hand, the strengths of our study include the standardized and harmonized methodology for the evaluation of diet-related variables[17] in a well trained adolescent cyclists.

In conclusion, the nutritional intake of the adolescent cyclists in our study does not seem adequate taking into account their special requirements. Establishing dietary requirements for athletes would help to preserve the future health of the active adolescents.

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References

1. Bass SL, Eser P, Daly R. The effect of exercise and nutrition on the mechanostat. *J Musculoskelet Neuronal Interact* 2005; 5 (3): 239-54.
2. Cruz JA. Dietary habits and nutritional status in adolescents over Europe--Southern Europe. *Eur J Clin Nutr* 2000; 54 (Suppl. 1): S29-35.
3. Rodríguez G, Moreno LA. Is dietary intake able to explain differences in body fatness in children and adolescents? *Nutr Metab Cardiovasc Dis* 2006; 16 (4): 294-301.
4. Stellingwerff T, Maughan RJ, Burke LM. Nutrition for power sports: middle-distance running, track cycling, rowing, canoeing/kayaking, and swimming. *J Sports Sci* 29 (Suppl. 1): S79-89.
5. Sánchez-Benito JL, Sánchez Soriano E. The excesive intake of macronutrients: does it influence the sports performances of young cyclists? *Nutr Hosp* 2007; 22 (4): 461-70.
6. Olmedillas H, González-Aguero A, Moreno LA, Casajus JA, Vicente-Rodríguez G. Bone related health status in adolescent cyclists. *PLoS One* 6(9): e24841.
7. Vereecken CA, Covents M, Sichert-Hellert W, Alvira JM, Le Donne C, De Henauw S, De Vriendt T, Phillipp MK, Beghin L, Manios Y, Hallstrom L, Poortvliet E, Matthys C, Plada M, Nagy E, Moreno LA. Development and evaluation of a self-administered computerized 24-h dietary recall method for adolescents in Europe. *Int J Obes (Lond)* 2008; 32 (Suppl. 5): S26-34.
8. Rodríguez G, Moreno LA, Sarria A, Fleta J, Bueno M. Resting energy expenditure in children and adolescents: agreement between calorimetry and prediction equations. *Clin Nutr* 2002; 21 (3): 255-60.
9. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, O'Brien WL, Bassett DR Jr, Schmitz KH, Emplaincourt PO, Jacobs DR Jr, Leon AS. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc* 2000; 32 (9 Suppl.): S498-504.
10. Pinheiro Volp AC, Esteves de Oliveira FC, Duarte Moreira Alves R, Esteves EA, Bressan J. Energy expenditure: components and evaluation methods. *Nutr Hosp* 2011; 26 (3): 430-40.

11. Serra-Majem L, Aranceta J. Nutritional objectives for the Spanish population. Consensus from the Spanish Society of Community Nutrition. *Public Health Nutr* 2001; 4 (6A): 1409-13.
12. Institute of Medicine. Dietary Reference Intakes. 1998.
13. Ballesteros-Vasquez MN, Valenzuela-Calvillo LS, Artalejo-Ochoa E, Robles-Sardin AE. [Trans fatty acids: consumption effect on human health and regulation challenges]. *Nutr Hosp* 2012; 27 (1): 54-64.
14. Maughan RJ, Shirreffs SM. Nutrition for sports performance: issues and opportunities. *Proc Nutr Soc* 71 (1): 112-9.
15. Singh M. Role of micronutrients for physical growth and mental development. *Indian J Pediatr* 2004; 71 (1): 59-62.
16. Hallstrom L, Vereecken CA, Ruiz JR, Patterson E, Gilbert CC, Catasta G, Diaz LE, Gomez-Martinez S, Gonzalez Gross M, Gottrand F, Hegyi A, Lehoux C, Mouratidou T, Widham K, Astrom A, Moreno LA, Sjostrom M. Breakfast habits and factors influencing food choices at breakfast in relation to socio-demographic and family factors among European adolescents. The HELENA Study. *Appetite* 56 (3): 649-57.
17. Moreno LA, De Henauw S, Gonzalez-Gross M, Kersting M, Molnar D, Gottrand F, Barrios L, Sjostrom M, Manios Y, Gilbert CC, Leclercq C, Widhalm K, Kafatos A, Marcos A. Design and implementation of the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study. *Int J Obes (Lond)* 2008; 32 (Suppl. 5): S4-11.