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Analysis of anaerobic performance and the Body Mass Index measure of adolescents from different areas of Andalusian region (Spain)

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ABSTRACT

Objective: To analyze the behavior of the average height of jumps according to the Body Mass Index, and the sex of subjects, and to find significant differences between the variables measured in the anaerobic test of Counter Movement Jump test over 10 s and 60 s in adolescents according to place of residence.
Method: We selected a huge sample of subjects to different places of residence and we categorized them in three levels; Urban – Interior, Urban – Coast and Rural – Interior. Their corporal composition were measured and analyzed, with this analysis we calculated the Body Mass Index, and categorized them by Body Mass Status (Underweight <18.5; Normal Weight 18.5–24.9; Overweight 25–29.9 and Obesity +30). Then, we measured the Jump 10 s. The next day, the Jump 60 s was measured, finding the anaerobic alactic and anaerobic lactic parameters.
Results: The highest percentages of overweight and obesity (20.23%) were found in a Rural – Interior area, however, these have in turn the lowest percentages of underweight (10.66%). In the Counter Movement Jump test were not found significant difference in the measured obtained between subjects of Urban – Interior and Urban – Coast areas, but we found significant difference in the remaining comparisons.
Conclusions: The significant difference in anaerobic values measured in adolescents, only reside purely in urban and rural areas, rejecting so a possible differentiation from the coast areas.

Análisis del rendimiento anaeróbico y el índice de masa corporal en adolescentes de diferentes zonas de Andalucía (España)

Palabras clave:
Índice de Masa Corporal
Obesidad
Adolescente
Rendimiento
Salto
Residencia

RESUMEN

Objetivo: Analizar la relación entre la altura media de los saltos respecto al Índice de Masa Corporal y el sexo de los sujetos, y encontrar diferencias significativas entre las variables medidas en un test anaérobico de Saltos con Contra Movimiento durante 10 s y 60 s respecto el lugar de residencia.
Método: Seleccionamos una amplia muestra de adolescentes de diferentes lugares de residencia categorizados en tres zonas: Urbano-Interior, Urbano-Costa y Rural-Interior. Se determinó la composición corporal y a partir del Índice de Masa Corporal se clasificaron en sujetos con bajo peso (<18.5), normopeso (18.5-24.9), sobrepeso (25-29.9) y obesidad (>30). A continuación se midieron los Saltos con Contra Movimiento durante 10 s. Al día siguiente, se determinaron los Saltos con Contra Movimiento durante 60 s, obteniéndose así, parámetros alácticos anaeróbicos y parámetros lácticos anaeróbicos respectivamente.
Resultados: Los porcentajes más altos de sobrepeso y obesidad (20.23%) se encontraron en el medio Rural - zona interior, sin embargo, éstos tienen a su vez los porcentajes más bajos de bajo peso (10.66%). En los dos test de Saltos con Contra Movimiento no se encontraron diferencias significativas entre sujetos de zonas Urbano-Interior y zona Urbano-Costa, pero sí se han encontrado diferencias en las otras comparaciones.

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Conclusiones: Existen diferencias significativas en los valores anaeróbicas determinados entre adolescentes residentes en las zonas urbanas y en las zonas rurales, rechazando así una posible diferenciación de las zonas costeras.

A análise do desempenho anaeróbio e índice de massa corporal em adolescentes de diferentes áreas da Andaluzia (Espanha)

R E S U M O

Objetivo: Analisar a relação entre a altura média dos saltos em relação ao índice de massa corporal e sexo dos sujeitos, e encontrar diferenças significativas entre as variáveis medidas em um teste anaeróbico Saltos contra o movimento por 10 s e 60 s sobre o lugar residência.
Método: Foram selecionados uma grande amostra de adolescentes de diferentes locais de residência categorizados em três áreas: interior urbano, costa urbana e Interior rural. Se determinou a composição corporal e a partir do Índice de Massa de corpo foram classificadas em baixo peso (<18,5), peso normal (18.5-24.9), sobrepeso (25-29.9) e obesidade (> 30). Em continuação se mediu os saltos contra movimento durante 10 s. No dia seguinte, se determinou os saltos contra movimento durante 60 s, obtendo assim, parâmetros alático anaeróbios e láctico anaeróbias respectivamente.
Resultados: A percentagem mais elevada de sobrepeso e obesidade (20.23%) foram encontrados em áreas médio rurais - zona interior, no entanto, por sua vez têm percentagens mais baixas de baixo peso ao nascer (10.66%). Em ambos os testes de salto contra Movimento não houveram diferenças significativas entre os sujeitos de áreas interior urbanas e costa urbana, mas encontraram diferenças em outras comparações.
Conclusões: Existem diferenças significativas em certos valores anaeróbias entre adolescentes que vivem em áreas urbanas e em áreas rurais, rejeitando assim uma possível diferenciação de áreas costeiras.

Palavras-chave:
Índice de Massa Corporal
Obesidade
Adolescentes
Desempenho
Saltar
Residence

Introduction

The Counter Movement Jump (CMJ) test described by Bosco[1,2] is used to evaluate the characteristics of metabolic process in muscle endurance, over a period that can vary from 5 to 60 s. For its execution, CMJ has to be performed continuously during the time set. Recent studies[3] have proven the reliability and validity of the CMJ repeated jumps test to assess anaerobic performance.

The scientific evidences say that physical condition is partly genetically determined, but may also be influenced greatly by environmental factors such as place of residence.[4] Many studies have examined the association between place of residences (Urban and Rural) and physical condition in children and adolescents around the world, as is the case of studies with subjects from the USA,[5] Mexico,[6] Taiwan,[7] Spain[2] and Turkey.[8] Although in none of these studies the place of residence Coast or Interior has been taken into account, nor the exclusive performance of a single type of test.

There are authors who have already undertaken studies on the CMJ test at the age of adolescence[9] finding significant differences between sexes from the age of 14 onwards, not finding scientific evidence of this same study compared to the place of residence.

Also, there is scientific evidence that anaerobic parameters such as maximum anaerobic power or anaerobic resistance are negatively correlated with Body Mass Index (BMI), and the Percentage of Fat in adolescents who regularly practice sport.[10]

Moreover, the level of fitness is directly associated with the outcomes related to health during childhood and adolescence.[11,12] And appropriate physical activity is a major determinant of fitness in children and adolescents.[13,14] So, we can say that adolescence is a critical period for the onset of obesity[15] and the morbidity associated with obesity in adulthood.[16]

We have determined to execute the CMJ repeated jumps test over 10 s, which we have referred to in this article as (J10s); with this measurement we intend to find alactic anaerobic parameters.[17] And the CMJ repeated jumps test over 60 s, which we have referred to as (J60s), to find thus lactic anaerobic parameters.[17] This last test highlights the developmental capacities of lactic anaerobic power, mechanical power and resistance power to fatigue.[2]

Method

318 Andalusian adolescents participated in the study, 182 teenage boys (15.16 ± 1.36 years, 170.7 ± 7.7 cm, 65.81 ± 14.68 kg) and 136 teenage girls (15.07 ± 1.33 years, 161.1 ± 5.4 cm, 55.96 ± 9.74 kg), aged from 13 to 18 years, from seven Secondary Education Institutes spread over the provinces of Granada, Malaga, Cordoba and Almeria. The descriptive results of the sample and the variables measured for both sexes can be seen in (Table 1).

As a criterion of exclusion in the study, the presence of cardiovascular chronic diseases or musculoskeletal injury risk was established. Centers were selected in such a way that they would have a wide sample of subjects whose place of residence was very different (2 centers in Urban – Interior environments, 3 in Rural – Interior and 2 in Urban – Coast). The study was approved by the Committee of Ethics of Human Research of the University of Granada, according to the code of ethics of the World Medical Association (Declaration of Helsinki). A letter of consent was given to all participants and/or tutors, in the same way, prior to the completion of the measurements a letter of information was given to the centre's school council.

The measurements were made on two consecutive days in each center. During these days, a room at a temperature of 20 ± 2 °C was ensured so that the measurements were as consistent as possible, also measurements took place at midday (13–15 h), to rule out a possible effect of heart rate on performance.[11] Once their body

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Table 1
Descriptive results of the sample and measured variables.

	Range		Minimum		Maximum		Mean		SD	
Sex	M	F	M	F	M	F	M	F	M	F
BMI kg.m^{-2}	19.70	15.80	16.50	14.90	36.20	30.70	22.48	21.51	4.25	3.36
% Fat	37.20	41.90	3.20	1.70	40.40	43.60	15.01	25.86	7.71	7.07
Avg. Flight t J10s (ms)	323.00	225.00	220.00	252.00	543.00	477.00	408.51	351.31	59.32	45.88
Avg. Contact t J10s (ms)	390.00	265.00	162.00	141.00	552.00	406.00	257.16	246.92	65.83	44.31
No. Jumps J10s	13.00	11.00	9.00	12.00	22.00	23.00	15.62	17.18	2.17	1.75
Avg. Height J10s (cm)	30.20	20.10	5.90	7.80	36.10	27.90	20.88	15.39	5.92	4.00
ALACPI	3.28	2.26	1.15	1.33	4.43	3.59	3.05	2.51	0.60	0.51
Avg. Flight t J60s (ms)	282.00	249.00	196.00	177.00	478.00	426.00	341.51	289.84	56.78	43.08
Avg. Contact t J60s (ms)	275.00	159.00	171.00	171.00	446.00	330.00	235.44	237.71	43.59	32.31
No. Jumps J60s	79.00	40.00	69.00	93.00	148.00	133.00	105.20	114.27	12.20	8.45
Avg. Height J60s (cm)	23.30	18.40	4.70	3.80	28.00	22.20	14.69	10.52	4.72	3.16
LACPI	2.89	2.55	1.09	.82	3.98	3.37	2.46	1.94	0.61	0.47

BMI: Body Mass Index; J10s: CMJ repeated jumps test 10 s; J60s: CMJ repeated jumps test 60 s; t: time; Avg: average; M: male; F: female. LACPI: Lactic Power Index; ALACPI: Alactic Power Index.

composition was analyzed the procedure was to measure the CMJ repeated jumps test described by Bosco.[1,2]

Following various studies[4,18] we have considered cities of more than 10 000 inhabitants as urban, and less than 10 000 inhabitants, rural.

The anthropometric assessment was determined by measuring height and body composition. For height, subjects were measured barefoot, standing up, with the heels, buttocks and back in contact with the Anthropometer of Homologated Base GPM (SiberHegner, Ltd, Switzerland) with accuracy of 0.1 cm. The assessment of body composition was carried out via bioelectrical impedance through the impedanciometre TANITA (TBF 300 GS, Arlington Heights, IL, USA).

The first day, as soon as the previously selected subjects arrived, their body composition was measured and analyzed with the instruments previously mentioned, and with this analysis their BMI was calculated, and they were categorized by determining their body weight status (Underweight < 18.5; Normal Weight 18.5–24.9; Overweight 25–29.9 and Obesity >30), using BMI cutoffs according to international standards.[19]

For measure the CMJ repeated jumps test, we used the contact platform Tapeswitch Control Mat CKP 30 cm × 48 cm, 24 vac, NEMA 4, BLACK (Anderson-Bolds. Beachwood, OH. USA), with ribbed edge, PC interface module, with a response time less than 25 ms, and a sensitivity to detect subjects whose mass was greater than 25 kg was used to measure the tests of continuous movement jumps. The contact platform software uses the formulas proposed by Bosco[1] to calculate the average flight time, the average contact time, and the average height of J10s and J60s. Moreover, Alactic Power Index (ALACPI) and Lactic Power Index (LACPI), depending on J10s and J60s respectively also are calculated. Finally, the number of jumps whenever there is a contact time is quantified.

The first day of measurement, the CMJ repeated jumps test over 10 s (J10s) took place. The next day, the subjects realized the CMJ repeated jumps test over 60 s (J60s). By doing this, we avoid the accumulation of possible fatigue.

Statistical analysis

Data were analyzed with the statistical program SPSS (v. 20.0 of SPSS Inc., Chicago, IL, USA), setting the level of significance at $\alpha = 0.05$. A graphical representation of variables has been performed. The resulting histograms do not show data significantly outside the normal range. Given the continuous nature of the data and the high sample size with which we work, we can admit the Gaussian character of the variables in the study. Average, minimum and maximum values and their standard deviations were calculated for all variables. The distribution in percentages of categorical variables was calculated.

Subsequently, an analysis of variance (ANOVA) was carried out to study the relationship between the different variables measured with the test of continuous movement jumps and the subject's place of residence, further validating the model by checking the normality, homoscedasticity and independence of residual data. Since significant differences between the levels of some factors were detected, we proceeded to an analysis of multiple comparisons, using Bonferroni's test, between the three levels of the factor of Place of Residence (Urban – Interior; Urban – Coast and Rural – Interior), thus solving the problem of multiple comparisons.

Finally, a study of the average values of the average height and number of jumps from the test of repeated jumps J10s and J60s was performed, with its corresponding standard error of mean.

Results

Depending on where the subjects live, the results of this study (Fig. 1) show that the highest rates of overweight and obesity (20.23%) are in rural – Interior subjects, however, they have the lower percentage in underweight body weight status (10.66%).

However, is the Urban – Interior which has the lower percentage of overweight and obesity. In addition, these subjects have the highest percentage within the underweight status (22.86%). Finally, it can be noted, that this means that they also show the highest percentage of normal weight (67.14%).

In the results of the analysis of variance of a factor, there are no significant differences for the variables measured; average contact time J10s ($p = 0.77$), number of jumps J10s ($p = 0.09$), average contact time J60s ($p = 0.48$), and number of jumps J60s ($p = 0.12$), finding significant differences for the other variables measured.

After applying Bonferroni's test for multiple comparisons, we found that significant differences are found among the subjects of Urban – Interior and Rural – Interior environments, and between Urban – Coast and Rural – Interior environments; not finding significant differences in the measurements obtained in the test of continuous movement jumps between the subjects of Urban – Interior and Urban – Coast environments (Table 2).

The following graph (Fig. 2) shows the behavior in terms of the average height that subjects reach in J10s and J60s, in both sexes. In males, the normal weight status is that which has the best average height in both tests. However, in women, the behavior is different, as the underweight status is the one that has better performance, subsequently producing a declining relationship, which is attenuated, even equated from overweight status to obesity status.

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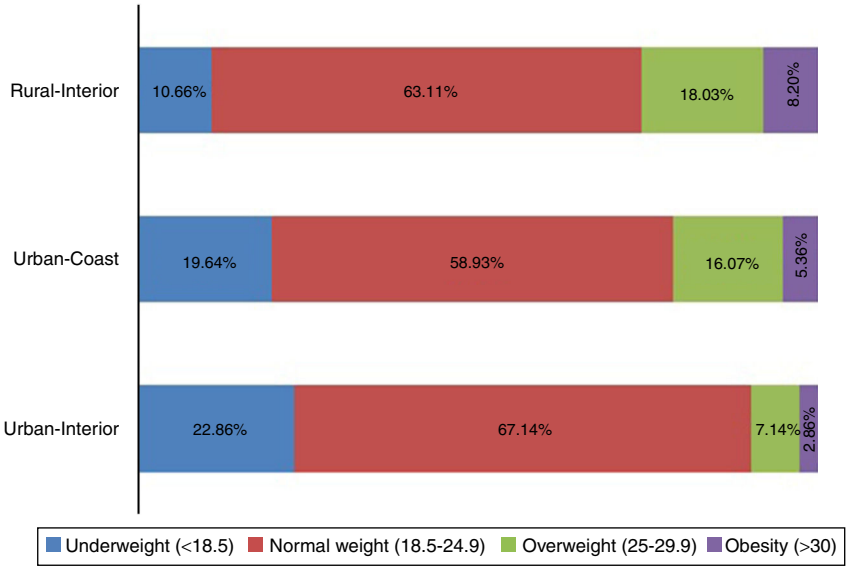

Fig. 1. Body weight status distribution according to place of participants residence.

Table 2
Bonferroni's test for multiple comparisons.

	p-ANOVA value	Urban. Int. – Urban. Coast	Urban. Int. – Rural. Int.	Urban. Coast – Rural Int.
Avg. Flight t J10s	0.000	1	0.000	0.02
Avg. Contact t J10s	0.771	–	–	–
No. Jumps J10s	0.085	–	–	–
Avg. Height J10s	0.000	1	0.000	0.003
ALACPI	0.000	1	0.001	0.002
Avg. Flight t J60s	0.007	1	0.009	0.086
Avg. Contact t J60s	0.479	–	–	–
No. Jumps J60s	0.115	–	–	–
Avg. Height J60s	0.015	1	0.020	0.123
LACPI	0.013	1	0.014	0.181

Avg: average; t: time; J10s: CMJ repeated jumps test 10 s; ALACPI: Alactic Power Index; J60s: CMJ repeated jumps test 60 s; LACPI: Lactic Power Index.

Discussion

The results of this study suggest that between the values of the variables measured in the repeated jumps test and place of residence, there are significant differences between the subjects of Urban – Interior and Rural – Interior environments, and between the ones of Urban – Coast and Rural – Interior environments. On the other hand, no significant differences were found in the measurements obtained between the subjects of Urban – Interior and Urban – Coast environments. A study with 1501 Spanish adolescent subjects[4] showed significant differences in term of physical condition values among subjects residing in urban and rural

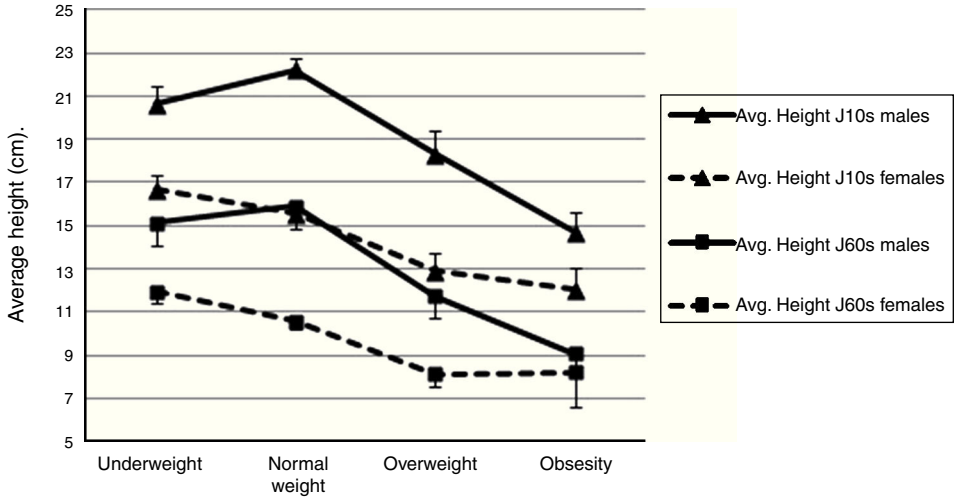

Fig. 2. Average height of J10s and J60s according to body weight status and sex.

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environments. However, there was not found in literature any reference that compares the place of Coast residence with any of the other places. This relationship can be explained by the results of our study, which show that there are significant differences among subjects who reside in rural and urban environments; not finding any significant difference in subjects whose place of residence is Coast and Interior. So the difference in terms of physical values measured in school adolescents, would seem to reside purely between urban and rural environments, thus ruling out a possible differentiation with the place of Coast residence. This statement will have to be taken cautiously, because our results only evaluated adolescent's anaerobic parameters. In many studies[6,7,20,21] of school population aged 6–13 years, they have noted that exist significant differences in fitness parameters between subjects of rural and urban areas.

If we analyze the distribution of body weight status by place of residence of the participants the results suggest that the highest percentage of overweight and obesity (20.23%) is found in rural subjects – Interior, however, they have, in turn, the lowest percentage in the status of underweight body weight (10.66%). However, it is in the Urban – Interior environment, which has lower percentage of overweight and obesity. In turn, these subjects are the highest percentage in the underweight status (22.86). Finally, we note what the subjects of this environment is also the highest percentage of normal weight (67.14%). Studies as[20,22,23] have found that the prevalence of overweight and obesity is higher in rural areas than in urban areas. This may be because there is evidence that Spanish children living in rural areas are less physically active than those living in urban areas.[24] To end the BMI analysis, our results suggest that there is a higher prevalence of overweight and obesity (21.43%) in males than in females (13.97%). These results are consistent with the results of a study whose sample was 2320 Spanish adolescents whose results were higher prevalence of overweight + obesity in males (25.69%) than in females (19.13%).[25]

The physical condition assessment of school adolescents depending on the place of residence is a field of study which is currently in demand. In the majority of cases, EUROFIT battery is often used for its evaluation. With this battery, the anaerobic performance and differentiating within it between the alactic and lactic variables of the subject in question, is not measured at any moment, so Bosco's CMJ repeated jumps test, could be a good gauge of the anaerobic performance in adolescents, serving as a possible complement alongside the use of the aforementioned battery.

This study showed that there were no significant differences in anaerobic parameters between the places of Coast residence with any other. But if we differentiate urban and rural areas exclusively, we can found significant differences. Therefore, we could assume the possible use of this test as a complement in any test battery to any physical condition assessment.

Ethical responsibilities

Protection of people and animals. The authors state that for this investigation have not been performed experiments on humans or animals.

Confidentiality of data. The authors declare that they have followed the protocols of the workplace on the publication of patient data.

Right to privacy and informed consent. The authors declare that this article does not appear patient data.

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Conflicts of interest

The authors have no conflicts of interest to declare.

References

1. Bosco C, Luhtanen P, Komi PV. A simple method for measurement of mechanical power in jumping. Eur J Appl Physiol Occup Physiol. 1983;50(2):273–82.
2. Bosco C. La Forza Muscolare Aspetti Fisiologici Ed Applicazioni Pratiche. Roma: Società St; 1997.
3. Dal Pupo J, Gheller RG, Dias Ja Rodacki AL, Moro AR, Santos SG. Reliability and validity of the 30-s continuous jump test for anaerobic fitness evaluation. J Sci Med Sport. 2014;17(6):650–5.
4. Chillón P, Ortega FB, Ferrando JA, Casajus JA. Physical fitness in rural and urban children and adolescents from Spain. J Sci Med Sport. 2011;14(5):417–23.
5. McMurray RG, Harrell JS, Bangdiwala SI, Deng S. Cardiovascular disease risk factors and obesity of rural and urban elementary school children. J Rural Health. 1999;15(4):365–74.
6. Peña Reyes ME, Tan SK, Malina RM. Urban–rural contrasts in the physical fitness of school children in Oaxaca, Mexico. Am J Hum Biol. 2003;15(6):800–13.
7. Wang JH, Wu MC, Chang HH. Urban–rural disparity in physical fitness of elementary schoolchildren in Taiwan. Pediatr Int. 2013;55(3):346–54.
8. Ozdirenç M, Ozcan A, Akin F, Gelecek N. Physical fitness in rural children compared with urban children in Turkey. Pediatr Int. 2005;47(1):26–31.
9. Temfemo A, Hugues J, Chardon K, Mandengue SH, Ahmaidi S. Relationship between vertical jumping performance and anthropometric characteristics during growth in boys and girls. Eur J Pediatr. 2009;168(4):457–64.
10. Nikolaidis PT. Body mass index and body fat percentage are associated with decreased physical fitness in adolescent and adult female volleyball players. J Res Med Sci. 2013;18(1):22–6.
11. Ortega FB, Ruiz JR, Castillo MJ, Sjöström M. Physical fitness in childhood and adolescence: a powerful marker of health. Int J Obes (Lond). 2008;32(1):1–11.
12. Ruiz JR, Castro-Piñero J, Artero EG, Ortega FB, Sjöström M, Suni J, et al. Predictive validity of health-related fitness in youth: a systematic review. Br J Sports Med. 2009;43(12):909–23.
13. Gutin B, Yin Z, Humphries MC, Barbeau P. Relations of moderate and vigorous physical activity to fitness and fatness in adolescents. Am J Clin Nutr. 2005;81(4):746–50.
14. Ruiz JR, Rizzo NS, Hurtig-Wennlöf A, Ortega FB, Wärnberg J, Sjöström M. Relations of total physical activity and intensity to fitness and fatness in children: the European Youth Heart Study. Am J Clin Nutr. 2006;84(2):299–303.
15. Dietz WH. Periods of risk in childhood for the development of adult obesity – what do we need to learn? J Nutr. 1997;127(9):1884S–6S.
16. Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR, Berenson GS. Interrelationships among childhood BMI, childhood height, and adult obesity: the Bogalusa Heart Study. Int J Obes Relat Metab Disord. 2004;28(1):10–6.
17. Marina M, Rodríguez FA. Usefulness and metabolic implications of a 60-second repeated jumps test as a predictor of acrobatic jumping performance in gymnasts. Biol Sport. 2013;30(1):9–15.
18. Grao-Cruces A, Nuviala A, Fernández-Martínez A, Porcel-Gálvez AM, Moral-García JE, Martínez-López EJ. Adherence to the Mediterranean diet in rural and urban adolescents of southern Spain, life satisfaction, anthropometry, and physical and sedentary activities. Nutr Hosp. 2013;28(4):1129–35.
19. Cole TJ, Lobstein T. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. Pediatr Obes. 2012;7(4):284–94.
20. Lara AJ, Zagalaz M. Análisis y evaluación de la condición física en estudiantes de educación primaria de un medio rural y urbano. Apunts: Educ Fís Deporte. 2014;116(2):44–51.
21. Karkera A, Swaminathan N, Pais SM, Vishal K, Rai BS. Physical fitness and activity levels among urban school children and their rural counterparts. Indian J Pediatr. 2014;81(4):356–61.
22. Coronado Vázquez V, Odero Sobrado D, Canalejo González D, Cidoncha Pérez J. Prevalence of overweight and obesity in schoolchildren in rural areas. Gac Sanit. 2012;26(5):460–2.
23. Vázquez FL, Díaz O, Pomar C. Prevalence of overweight and obesity among preadolescent schoolchildren in Galicia, Spain. Child Care Health Dev. 2010;36(3):392–5.
24. Martínez-Ros MT, Tormo MJ, Pérez-Flores D, Navarro C. Actividad física deportiva en una muestra representativa de la población de la Región de Murcia. Gac Sanit. 2003;17(1):11–9.
25. Moreno LA, Mesana MI, Fleta J, Ruiz JR, González-Gross M, Sarría A, et al. Overweight, obesity and body fat composition in Spanish adolescents: The AVENA Study. Ann Nutr Metab. 2005;49(2):71–6.

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