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## Body composition and physical performance of Spanish adolescents: the AVENA pilot study

**Abstract** In order to validate the physical fitness tests and anthropometric parameters of the AVENA multicenter study, a pilot study was carried out in 101 adolescents (48 girls and 53 boys) aged 15–18 years. Body composition was established by the sum of skinfolds (SS) in millimeters (biceps, triceps, subscapular, suprailiac) and body mass index (BMI, weight/height<sup>2</sup>) in kilograms per meters squared. Physical fitness was measured by means of the Course-Navette test (CNT). Median BMI was 22.5 and 20.3 for boys and girls, respectively, while their median SS was 32.5 and 47.47, respectively. The median CNT score was 8 and 4 for boys and girls, respectively. For both groups, there was a negative

correlation between body fat and physical fitness, the correlation being stronger in boys ( $r=-0.65$ ) than in girls ( $r=-0.43$ ;  $p<0.01$ ). SS appears to be more suitable than BMI in expressing body composition in this context. The CNT indicates physical fitness in adolescents satisfactorily. This subject will be explored in more depth during the final phase of the multicenter study.

**Key words** Physical fitness • Anthropometry • Body fat • Health • Adolescents

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### Introduction

AVENA (Alimentación y Valoración del Estado Nutricional en Adolescentes) is a multicenter study supported by the Spanish ministry of health. The AVENA study was designed to evaluate the nutritional status, dietary and leisure time habits, and physical activity and fitness of a representative sample of Spanish adolescents ( $n=1,750$ ) in order to identify risk factors for chronic diseases in adulthood [1]. Previous studies have shown that during adolescence, most youths stop practicing sports, which may have a negative effect on their current and future health [2, 3]. Before starting the final phase of the AVENA study, a pilot study was carried out to determine the tendencies between all groups and between genders and to validate the fitness tests and anthropometric parameters by means of test-retest and indexes of reliability and validity.

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### Subjects and methods

#### Subjects

In total, 101 adolescents (48 girls and 53 boys) aged 15–18 years, from Granada, Zaragoza, Madrid, Murcia, and Santander participated in the AVENA pilot study. They all fulfilled the inclusion cri-

teria of the study [1]. After receiving complete information about the aims and methods of the study, all subjects and their parents or guardians signed fully informed written consent. The protocol was approved by the Review Committee for Research Involving Human Subjects of the Hospital Universitario Marqués de Valdecilla (Santander, Spain).

## Methods

For anthropometric measurements, subjects were barefoot and in their underwear. Weight was measured with a Seca scale (with a precision of  $\pm 100$  g), height with a stadiometer incorporated with the scale, and skinfold thickness (biceps, triceps, subscapular, suprailiac) with a Holtain lipocaliper (0–40 mm) following standard procedures for adolescents [1]. The anthropometric measurements for the multicenter survey were harmonized and on the basis of the data obtained, the anthropometric measures used seem to be adequate for assessment of body composition in Spanish adolescents [4]. Body composition was established by the sum of skinfolds (SS; biceps, triceps, subscapular and suprailiac) in millimeters and body mass index (BMI; weight/height<sup>2</sup>) in kilograms per meters squared. Physical fitness was measured by means of the Course-Navette test (CNT, test Léger-Mercier) [5]. The complete and detailed methodology of the project has been described elsewhere [1].

## Statistical analysis

For the whole population, the *t* test was performed to find differences between means, and the Mann-Whitney test to find differences between genders. For each gender, the principal statistics were studied to establish a simple relationship between the variables. Correlation analysis was performed using Pearson's product-moment formula. For graphic representation, a study of the slope (xy graphics) was used. Statistical significance was set at  $p < 0.05$ .

## Results and discussion

Median BMI was 22.5 kg/m<sup>2</sup> and 20.3 kg/m<sup>2</sup> for boys and girls, respectively; while their median SS was 32.5 mm and 47.47 mm (the latter being statistically significant,  $p < 0.01$ ). For boys, the score of CNT ranged from 3 to 11, with a median of 8. For girls, the score ranged from 1.5 to 7.5, with a median of 4. The difference in the CNT between genders was also statistically significant, ( $p < 0.01$ ). For both groups, there was a significant negative correlation between SS and CNT (Fig. 1), which was stronger in boys ( $r = -0.65$ ) than in girls ( $r = -0.43$ ; both  $p < 0.01$ ), using both parametric and nonparametric tests. However, BMI and CNT did not correlate. From our data, the body fat content seems to be a determinant of physical fitness, and SS seems to express this correlation better than BMI. Since BMI does not indicate differences between adolescents engaged in sport activities and sedentary adolescents, the feasibility of BMI in this population has been questioned [6, 7].

In the same way, BMI does not show differences in body composition in girls and boys after puberty [3, 8]. Our data show that although there was no difference in BMI between genders, girls had a lower BMI than boys, but when analyzing body composition by means of SS, girls had significantly more body fat than boys. These data can be considered as contradictory. Another difference between boys and girls is the CNT score obtained, the median value for boys is double of that obtained for girls. These data may confirm the decline in physical activity during adolescence observed in previous studies [2, 3], which is much more evident in girls than in boys in our study and in others [8].

It has also been conjectured that adolescents have become less active in recent years, and that this trend may

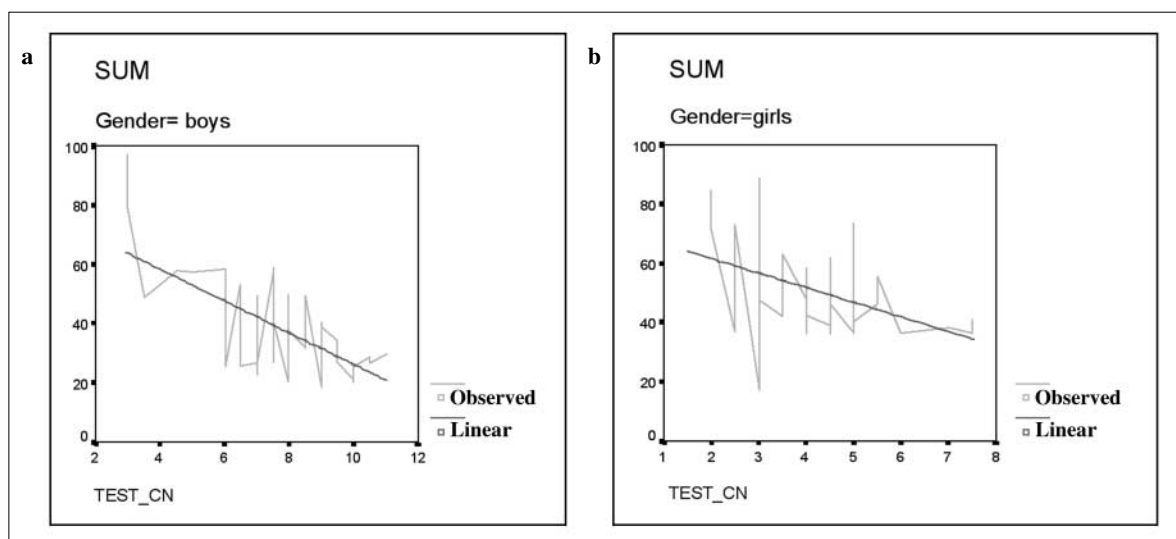


Fig. 1a, b Correlation between SS and Course-Navette test (CNT) for boys and girls

be responsible for the increased prevalence of obesity and related risk factors [2, 3, 8]. Cole et al. [6] recently proposed a new definition for overweight and obesity in children and adolescents. In the same way, it seems necessary to redefine body composition parameters for those adolescents who engage in sport activities [2, 7] and to differentiate between genders. The relationship of body composition-performance and health-related physical fitness deserves more attention in adolescence for better understanding the mortality or morbidity-related approach as adolescents enter adulthood.

In conclusion, the data express a negative association between body fat and physical fitness, which is stronger in boys than in girls. SS appears to be more suitable than BMI in expressing body composition in this context. The CNT indicates physical fitness in adolescents satisfactorily. These preliminary data will be studied in more detail as we continue in the final phase of the multicenter study.

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