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Health-related physical fitness and nutritional behaviours in 14–17-year-old Spanish secondary school males

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Abstract

This paper examines adolescent physical fitness and nutritional behaviours. It is a descriptive study of the analysis of health-related physical fitness nutritional behaviours based on a food consumption frequency questionnaire. A total of 194 male participants were divided into subsamples 1, 2, 3 and 4. Anthropometric and physical fitness and nutritional variables were measured. Kolmogorov–Smirnov goodness-of-fit, visual and analytical univariate analyses and Pearson's correlation coefficient were calculated to determine the inter-variable relationships, confirmed by multiple linear regressions. High fitness test scores were found in subsamples 1 and 2, low in subsample 3 and very low in subsample 4; above average protein and fat consumption, below average carbohydrate intake and total Kcal requirements were met in subsamples 1 and 2 only. The study reveals that the physical fitness score and nutritional behaviours are the highest in 14 and 15-year olds, which declines with increasing age.

Keywords: Physical fitness, adolescent, nutrition.

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1. Main text

Physical fitness in the adolescent population is of vital importance for health (Becerra, Reigal, Hernandez-Mendo & Martin-Tamayo, 2013). Moreover, physical fitness values are significantly related to participants' nutritional behaviours (Hammar & Ostgren, 2013; Maestre-Rodriguez, 2010). Physical fitness is the ability to undertake everyday tasks vigorously and willingly (Caspersen, Powell & Christenson, 1985). In the context of health, it consists in the physical condition needed to properly perform everyday activities (Ruiz et al., 2006). The elements involved include cardiorespiratory and muscular endurance, flexibility, body composition and muscular strength (Nelson et al., 2006).

A number of studies have been conducted on the analysis and assessment of the aforementioned elements among adolescents to determine their health-related physical fitness. One was run on a sample of 648 students (Alonso & GarcIa-SoidAn, 2011), whose physical fitness was measured using the AFISAL-INEFC (Rodriguez et al., 1998) test battery. As handgrip strength (DYN), upper body flexibility and lower body short burst strength were found to be low, this group was recommended to enhance upper and lower limb strength and to maintain upper body flexibility. Another study (Portela-Pozo & Rodriguez, 2012) assessed the development of conditional physical capacities in students. The authors concluded that development was scant, unstable and tended to decline with age in both sexes. Yet another research team (Ortega et al., 2013) concluded that over 30% of 15-year olds in many countries are physically sedentary and that the levels of general physical activity decline with subject age, raising the risk of heart disease and the likelihood of late adolescent obesity.

Overweight and obesity, understood as the abnormal or excessive accumulation of fat, are directly related to physical activity and nutrition. Nutrition, in turn, is food intake relative to the body's dietary needs. Poor nutrition may lower physical and physiological immunity, raise vulnerability to disease, alter physical and mental development and adversely affect people's productivity (World Health Organization, 2010). The pathologies most directly associated with overweight and obesity include pulmonary and cardiovascular diseases, diabetes, cancer, gynaecological disorders, venous and periodontal disease (Bjorntorp, 1998; Danielsson, Grandinetti & Kistner, 2002; Russell & Allen, 2008). Similarly, the relationship between participants' physical fitness and their nutrition is a determinant in the development of attitudes towards overweight and obesity. In 2012, 26% of Spanish youth aged between 8 and 17 were overweight and 13% obese. In other words, 4 in every 10 youngsters were overweight (Sanchez-Cruz, Jimenez-Moleon, Fernandez-Quesada & Sanchez, 2013).

The study abovementioned (Cuenca et al., 2011), in conjunction with further research by the same authors, analysed physical fitness and nutritional habits in primary and secondary school students. The conclusion drawn was that overweight was prevalent in the childhood and adolescent population studied.

Other researchers (Dura & Gallinas, 2013), after sizing 694 participants and determining their body max index (BMI), found that adolescence is the period in the life cycle in which excess body weight rises in proportion to unhealthy nutritional habits and life styles.

Thus, this study was designed against the aforementioned backdrop of overweight and obesity and low levels of physical fitness among adolescents. The objective was to analyse physical fitness and nutritional behaviour in 14–17-year-old males and establish differences in health-related fitness by age as well as correlations between participants' fitness and nutritional variables.

2. Methods

2.1. Participants

The sample for this study consisted of 194 male participants attending an all-boys school in the Spanish city of Seville. The sample was divided into four subsamples by age: subsample 1 (14 years old, n = 37), subsample 2 (15 years old, n = 47), subsample 3 (16 years old, n = 72) and subsample

4 (17 years old, *n* = 38). The participants' physical fitness was tested during school hours and more specifically during physical education class.

2.2. Procedures

The standardised Alpha-Fitness Test battery (Espana-Romero et al., 2010; Moreno et al., 2006) protocol was used to weigh and measure participants, find their waist circumference (WAIST), BMI, DYN, standing long jump score (LONG) and their motor fitness (MF, agility/speed). Their cardiorespiratory fitness (CARDIO, endurance) was tested using the Cooper method (Cooper, 1968; Martinez, 2004).

The variables related to the participants' nutritional parameters studied in this survey were weekly and monthly intake in grams, calculated as the number of portions consumed per week multiplied by the estimated weight of each portion. The basal metabolic rate (BMR) and estimated energy requirements (EER) were determined with the Harris-Benedict (Mifflin et al., 1990) equation. In the EER calculations, the daily activity level was based on the participants' cardiorespiratory test results.

The percentage of proteins, fat and carbohydrates present in the participants' total diet was calculated from the number of portions that the students eat per week and month. This information was collected from a food consumption frequency questionnaire (Rodriguez, Ballart, Pastor, Jorda & Val, 2008) completed by the students on a voluntary basis during their physical education class.

2.3. Data analysis

Each variable studied was first analysed using the Kolmogorov–Smirnov test to determine whether it was normally distributed. Univariate descriptive analysis was subsequently conducted, both visually (as a rule with sector graphs or, for traits with a wide range of numerical values, with box diagrams) and analytically by calculating the mean, standard deviation and percentiles.

That was followed by bivariate analysis using the Pearson's correlation coefficient to establish the relationship between each variable analysed and the factors associated with the participants' profile or environment. It was likewise used to determine the relationship between the variables studied and the daily activity level, for which linear regression analyses were also performed. P-values lower than 0.5 were considered as significant.

3. Results

3.1. Objective 1: analysis of health-related physical fitness

The results were analysed by comparing to the Alpha Fitness (Ruiz et al., 2011) reference values, which classify variable scores on a five-step scale: very low, low, medium, high and very high.

The participants in subsamples 1 and 2 proved to be the most physically fit of the sample (Ruiz et al., 2006). The health-related fitness of the participants in subsample 3 was medium and low among the subsample 4 participants (Table 1).

Table 1. Test results for the subsamples studied (*N* = 194)

					Physical test		
Subsample	**Age**	**BMI**	**WAIST**	**DYN**	**Long jump**	**Speed**	**Endurance**
1	14	M	M	H	VH	VH	L
2	15	M	M	H	M	H	L
3	16	M	M	M	M	M	L
4	17	M	M	M	L	L	VL

BMI: body mass index; DYN: grip strength (hand dynamometer); VL: very low; L: low; M: medium; H: high; VH: very high; IC = 95%; $p \leq 0,05$

The mean and standard deviation values for the variables studied and the findings used to classify the subsamples to international scientific standards are given in Table 2.

Table 2. Physical fitness variables: mean and standard deviation values for the different subsamples (*N* = 194)

Variable	Subsample 1 (*n* = 37)			Subsample 2 (*n* = 47)			Subsample 3 (*n* = 72)			Subsample 4 (*n* = 38)		
	M	SD	*A*	*M*	SD	*A*	*M*	SD	*A*	*M*	SD	*A*
WAIST	74	7	71	77	9	75	76	8	76	79	10	77
BMI	19.8	2.6	20	21.9	3.6	21	21.4	3.4	21	22.1	2.7	21
DYN M	31.9	5.1	26	37.1	7	32	38.7	8.02	37	42.6	7.1	46
Long	183	0.27	160	182	0.23	177	187	0.20	190	191	0.24	200
4 × 10	11	0.79	12	11.2	0.6	11.6	11.1	0.57	11.2	11.1	0.61	10.8
CARDIO	2116	321	2200	2183	376	2399	2254	449	2300	2124	557	2499

WAIST: waist circumference (cm); BMI: body mass index (kg/m^2); BMR: basal metabolic rate (Kcal/day); EER: estimated energy requirements (kcal/day); DYN M: handgrip mean (kg); LONG: long jump (cm); 4X10: shuttle run test (s); CARDIO: cardiovascular endurance (m). IC 95% P ≤ 0,05; M: mean; SD: Standard deviation

3.2. Objective 2. Analysis of nutritional behaviours

The variables studied were protein (P), carbohydrate (CH) and fat (F) intake per week, expressed in grams, and the respective Kcal. The P value recommended for adolescents ranges from 44 to 59 grams per day. Further to the data gathered with the food consumption frequency questionnaire, all the participants in all subsamples consumed more protein than recommended (Table 3).

The CH findings showed that only the subsample 2 participants consumed the amount recommended for their age group; the value found for all the others was below the estimated requirements. Given that fat should account for 25% of the total daily Kcal intake in adolescents, these youngsters should consume from 50 to 70g of fat daily at most. Consumption was observed to be higher than those values in all four subsamples (Gidding et al., 2005) (Table 3).

Total Kcal intake requirements for participants between 14 and 17-year olds were estimated from 1800 to 2600. Consumption among subsample 1 and 2 participants was consequently within the recommended range for their age, whereas the participants of subsamples 3 and 4 consumed less than they should have (Trumbo, Schlicker, Yates & Poos, 2005). The means and standard deviations for the nutritional variables analysed in this study were found with a view in comparison to scientific standards (Table 3).

Table 3. Nutritional variables: mean and standard deviation

V	Proteins		Carbo-hydrates		Fat		Kcal		BMR		EER	
	M	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD
S. 1	123	69	209	125	85	48	1996	1188	1478	111	3239	418
S. 2	113	45	184	56	81	32	1837	589	1550	130	3539	592
S. 3	104	47	177	85	74	39	1720	712	1563	156	3407	574
S. 4	119	71	181	100	81	59	1763	943	1587	150	2996	431

V: variable; BMR: basal metabolic rate (Kcal/day); EER: estimated energy requirements (Kcal/day)
IC = 95 %; $p \leq 0.05$; *M*: mean; SD: Standard deviation

Possible inter-subsample nutritional variable relationships were also calculated, and significance (0.913) was found in fat intake per week between subsamples 2 and 3.

An analysis of the variables associated with health-related physical fitness for each subsample (Table 4) showed that for the 14-year-old participants (subsample 1), BMR was highly correlated to

BMI and EER, with linear regression values of close to 1 (*R* = 0.990). In the 16-year-olds (subsample 3), as in the two younger subsamples (subsample 1 and subsample 2), BMI was closely correlated to variables BMR and EER (*R* = 0.988, *R* = 0.976). A correlation was also found between BMI and BMR in 17-year-old participants (subsample 4) in whom the latter variable rose with the former.

Table 4. Health-related physical fitness variables: inter-variable correlations (*n* = 194)

	Physical variables			
	Variables	**Correlation**	***R***	***p***
Subsample 1	BMR-BMI	0.700**	0.990	0.000
	BMR-EER	0.567**	0.989	0.000
Subsample 2	BMI-BMR	0.856**	0.988	0.000
	BMI-EER	0.537**	0.976	0.000
Subsample 3	BMI-BMR	0.888**	0.990	0.000
Subsample 4	BMI-BMR	0.822**	0.994	0.000

BMI: body mass index (kg/m^2); BMR: basal metabolic rate (Kcal/day);
EER: estimated energy requirements (Kcal/day); $p \leq 0.05$ Pearson's
correlation coefficient, multiple linear regression

A comparative analysis between healthy physical fitness variables and the nutritional values for each subsample revealed that in the subsample 1 participants, the correlation held for protein consumption only, with an acceptable linear regression coefficient (*rxy* = 0.363*, *R* = 0.823). A higher protein intake was related to higher EER. The subsample 3 participants exhibited an inverse correlation between their BMI and carbohydrate consumption with high correlation and linear regression coefficients (*rxy* = -0.952*, *R* = 0.832)

4. Discussion

These findings are consistent with results reported in similar studies (Mayorga-Vega, Merino-Marban & Rodriguez-Fernandez, 2013), which concluded that a higher BMI was related to lower long jump scores, i.e., participants with a higher BMI jumped a shorter distance. That compares to the lower long jump scores recorded in this study for the subsample 2 participants with a higher BMI (*p* = 0.000 and *r* = 0.693). The results obtained here are also comparable to those of prior research in which reference values were defined (Jimenez-Pavon et al., 2010; Lopez de Lara et al., 2010). In terms of BMI, subsample 1 was close to the 25th percentile, while subsamples 2, 3 and 4 were observed to lie in the 50th percentile.

Mean grip strength was closely related to EER and BMR (*p* = 0.000). In other words, high mean grip scores were directly related to higher health-related variable values. That may denote a close association with adolescents' health, for as other authors (Luque, Garcia-Martos, Villaverde & Garatachea, 2010) have noted, a rise in strenuous work is related to an increase in VO_2 max (maximal oxygen intake or maximal aerobic capacity). That, in turn, translates into a rise in EER, a correlation likewise found to be significant in this study (*p* = 0.000). Similarly, speed was consistently and directly related to cardiovascular endurance and long jump test scores.

In another vein, the most prominent finding in this study has to do with the participants' nutritional behaviours, with protein and fat intake in excess of the amounts deemed suitable for their age. Based on the reference values found in the scientific literature, carbohydrate intake was appropriate among subsample 2 participants only, and below par in the other three subsamples (Garcia Gabarra, 2006). Calorie intake, in turn, was suitable among subsample 1 and 2 participants, but below the recommended values among subsample 3 and 4 participants.

The insufficient calorie intake and inappropriate protein and fat distribution in subsamples 3 and 4, with participants consuming more than the amounts established as ideal for their age group, is consistent with previous reports (Palenzuela, Perez, Perula, Fernandez & Maldonado, 2014), which grouped food intake by adolescents into healthy and unhealthy patterns.

The present observations are also similar to recent findings by other authors (Delgado, Caamano, Crespo, Osorio & Cofre, 2015) who assessed the nutritional status of 113 students along with their fitness and cardiovascular risk factors. In both this and the other study, the students with higher BMI values obtained lower physical fitness scores.

Several authors (Camacho, 2009; Moreno et al., 2006) studied the nutritional behaviours and nutritional assessment of a representative sample of adolescents, as well as their health, behaviour patterns and metabolic-nutritional status. Their results concurred with the present findings, in which the participants had a high fat and low carbohydrate intake. Except in subsamples 1 and 2, these young people’s diet was hypocaloric, an observation that was associated with lower healthy fitness scores.

Similarly, aerobic capacity was inversely related to lipid profile in adolescents, whether of normal weight, overweight or obese. That is also consistent with the findings of an earlier study (Mesa et al., 2006) in which a comparison of physical fitness to adolescents’ lipid profile and body weight revealed that the higher the lipid profile, the poorer were the aerobic scores.

5. Implications for research and practice

Scant research has been conducted on the association between overall health-related physical fitness and the nutritional status of the adolescent population. This study showed that the variables related to good physical health changed with increasing age in the adolescents studied. Changes in food intake patterns were also observed. Despite the significant results obtained in the exclusively male population study here, further to recent research (de Moraes et al., 2013; Ishii, Shibata, Adachi, Nonoue & Oka, 2015) on the gender-based differences in physical fitness and nutritional behaviours, one of the future lines of research envisaged is to replicate the study among female students.

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