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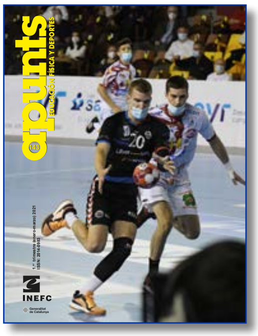

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Level of Physical Condition and Practice of Physical Activity in Adolescent Schoolchildren

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Abstract

The objective of the study was to ascertain the level of physical condition of adolescents and its association with the practice of physical activity, gender and age. A total of 214 Compulsory Secondary Education students aged between 13 and 16 years participated. The instrument used to ascertain the level of weekly physical activity was the Adolescent Physical Activity Measure-MVPA, whereas the different physical tests contained in the ALPHA-Fitness® battery were used for physical condition. The results show that males do more physical activity and have a better physical condition than females. The physical condition of active adolescents is superior to that of sedentary ones. Physical condition evolves according to age. These results underline the need to develop social programmes to promote physical and sports activity in order to improve people's physical condition and health.

Keywords: activity, school, ALPHA battery, body composition, adolescence.

Introduction

Adolescence is a stage in life involving major physical, psychological and psychosocial changes and is a difficult period to negotiate. It involves the acquisition of healthy lifestyles (Mora, 2014), such as a physically active life, in which the subject can acquire a suitable level of physical condition (PC) and healthy eating habits which are major determinants of present and future health (Ruiz et al., 2009).

In recent years, different research works have reported a substantial reduction in PC levels in children and adolescents alike (Rosa-Guillamón et al., 2016). This situation is relevant because the available scientific evidence indicates that PC is a factor that is more related to a person's health than physical activity (PA) in itself. In fact, in absolute terms PC is a greater predictor of morbidity and mortality among individuals (Gómez-Cabello et al., 2018), both males and females, and is also regarded as a decisive factor in longevity and health-related quality of life (Gálvez et al., 2015). The basic objective of the recommendations of engaging in PA is to increase the individual's overall PC, the latter defined as a set of assessable physical attributes possessed by people and which are related to the capacity to do PA (Caspersen et al., 1985) and which is not only associated with a reduction in the population's morbidity and mortality but also with an increase in quality of life (Rosa-Guillamón et al., 2016).

At this moment in time, the development of unhealthy behavioural patterns among young people is on the increase (Gálvez et al., 2015). Technological progress fosters a more sedentary lifestyle, whereas and at the same time the extensive and varied offer of food products exposes young consumers to inappropriate nutritional habits which translates into a mounting increase in overweight young Spaniards (Cuenca-García et al., 2011). Recent studies suggest that a low PC index is one of the factors directly associated with being overweight and with obesity in young children and adolescents (Gálvez et al., 2015; Rush et al., 2014). Therefore, taking the strong relationship between obesity and several physiological and psychosocial disorders into account (García-Sánchez et al., 2013) as well as public health, wellbeing and the quality of life of young people (Han et al., 2010), it is necessary to detect overweight or obese subjects and observe whether the relationship between this and their level of PC may be important in avoiding health problems in the medium or long term (Gálvez et al., 2015).

Scientific evidence has demonstrated that this entire process does not begin in adulthood but rather at much earlier ages. Longitudinal studies have shown that the degree of PC and the presence of risk factors such as diseases with onset in adulthood caused by a sedentary lifestyle are directly related to the individual's degree of PC in adolescence (Lavielle-Sotomayor et al., 2014).

The level of PC can be evaluated objectively by means of laboratory and field tests, both of which are the most commonly-used methods in the school setting because they are easy to perform, require few financial resources, do not involve the use of sophisticated technical equipment and the time required to perform them is minimal. For these reasons, and in view of the myriad discussions and debates generated among physical education teachers and investigators, a group of European investigators developed and published the ALPHA-Fitness test battery (Ruíz et al., 2011).

The ALPHA-Fitness test battery was constructed in the course of a four-stage process, all of which are explained in the paper by Ruiz et al. (2011). Following an extensive review of the scientific literature and methodological studies pertaining to the validity, reliability, viability and safety of physical condition tests, the ALPHA group published the evidence-based ALPHA-Fitness battery test. This battery includes the following measurement tests: body weight and body height to calculate BMI; waist circumference and skinfold thickness (triceps and subscapular) to assess body composition; handgrip strength test and standing long jump to assess musculoskeletal fitness, and a 20-m shuttle run test to evaluate performance and estimate aerobic capacity.

Although PC may be impacted by the regular practice of moderate-vigorous PA, currently there is insufficient information to establish a connection between PC and the daily amount of PA done by adolescents. Therefore, the objective of this research was to ascertain the level of PC in adolescents according to handgrip strength (HGS), long jump, speed and endurance to ascertain the possible existence of a relationship between PC and the degree of practice of PA while also taking gender and age into account.

Methodology

Method and participants

A four-month transversal descriptive study was designed during which the data were collected from the 214 students distributed in eight groups/class from a Compulsory Secondary Education (CSE) school participating in the study, with a mean age of 14.26 ± 1.33 years and within a range comprised between 13 and 16 years, 58.9% (n = 126) of whom were males. The sample was selected by means of two-stage proportional cluster sampling (taking the year and the group/class into account), assuming an error of <0.3 with a 95% confidence interval. All the adolescents belonging to the classes selected (two groups/class per school year of CSE) were invited to participate. The adolescents were distributed into a sedentary and an active group. The WHO

(2016) recommendations regarding the daily practice of at least 60 minutes of moderate or vigorous PA were taken into account when classifying the groups. This classification (active or sedentary) was established on the basis of the answers given about their practice of PA in the previous week according to the Adolescent Physical Activity Measure-MVPA questionnaire (Prochaska et al., 2001).

Instruments

Various instruments were used to estimate the level of practice of PA by the participants and their physical condition. Weekly PA was ascertained by means of the original version of the MVPA (Prochaska et al., 2001). This questionnaire consisted of two questions about the number of days of PA carried out a week including at least 60 minutes a day of physical exercise ranging in intensity from moderate to vigorous over the previous seven days and in another typical week. The response scale was the same for both items (from zero to seven days of PA a week). The questionnaire was administered and all the students who in the course of the four months fulfilled the PA practice recommendations according to their group (control: sedentary and experimental: active) were selected.

The physical tests contained in the ALPHA-Fitness® battery (Ruiz et al., 2011) were used to measure the adolescents' physical condition:

a) Cardiovascular fitness was studied with the 20-m shuttle run test. The distance to be covered was measured using a 30-metre Elephant brand measuring tape. The time was measured by means a system of photoelectric cells (Timer Plus Control model) which, connected to a laptop computer (Asus 7072), yielded as a result the total time taken to perform the test. Two measurements were taken (separated by five minutes) from which the average of both measurements was calculated as a final value.

b) Musculoskeletal fitness was analysed using the upper-body HGS test and a standing long jump (lower body). A Baseline® digital hand dynamometer was used for the HGS measurements. Long-jump distance was measured using a 30-metre Elephant brand measuring tape. Two measurements were taken (separated by five minutes) from which the average of both measurements was calculated as a final value.

c) Speed of movement was evaluated by the 4x5 metre shuttle test and time was recorded with a CALESI TF-C300 stopwatch.

d) Body composition was studied by means of BMI (kg/m^2 ratio). The measuring instruments used for weight and height were an Elegant model digital scale by ASIMED® (Barcelona) and a SECA® 214 mobile stadiometer (SECA Ltd., Hamburg) (Ruiz-Ariza et al., 2019), respectively.

Procedure

During the study, monitoring the PA practice recommendations made it possible to classify the adolescents into two groups, one sedentary and the other active. The following general inclusion criteria were applied: authorisation of the school and teaching staff, as well as the written consent of the parents or guardians of the minors involved and voluntary student participation. The exclusion criteria, besides non-fulfilment of the inclusion criteria, were: having any type of disease or injury in the four-month study period and failure to observe the PA practice recommendations established for each group (active and sedentary). The students were issued with a log to record their daily PA in order to facilitate the monitoring of this activity. Specific inclusion criteria in the control group were that each subject should do nothing or do less than 60 minutes a day of moderate to vigorous PA; on the other hand, the experimental group had to do at least 60 minutes of moderate to vigorous PA. The participants were given brief instructions and assured that the confidentiality of the data collected in the study would be safeguarded. Anonymity of the answers provided by the participants was also guaranteed since all data were processed in an encoded database. The participants did not receive any academic or financial compensation for their contribution. The research was conducted in accordance with the ethical guidelines of the current Declaration of Helsinki (Brazil, 2013) and the utmost safety and professional ethics standards for this type of work were observed at all times. The informed consent of the parents or legal guardians of the minors involved in the research was secured. The entire process fulfilled all the parameters established by the Research Ethics Committee, pursuant to the Spanish Organic Law 3/2018 of December 5 on data protection and the guarantee of digital rights, as well as by Law 14/2007 on biomedical research.

Data analysis

A descriptive and frequency analysis (Student's t-test for the continuous variables and Chi-squared test for the categorical variables) was performed to extract the information about the sample characteristics as precisely as possible. An ANOVA was used to obtain correlations and comparisons (reporting the mean, standard deviation and effect size) between the different PC tests and the independent variables used. A linear regression analysis was also performed to verify whether the level of PC (analysed with the different tests) was related to the practice of PA, using the ALPHA Fitness battery tests as dependent variables and the level of PA practice as the independent variable, all adjusted according to the gender and age covariates. The level of significance was regarded as $p<.05$. All the analyses were performed using the Statistical Package for Social Sciences (SPSS, version 20.0 for Windows; SPSS, Inc., Chicago, IL, USA).

Results

The 214 adolescents who comprised the total sample, of which 58.9% ($n=126$) were male, were aged from 13 to 16 years (14.26 ± 1.33 years) and 20.1% ($n=43$) were first-year CSE, 21.5% ($n=46$) second-year, 24.8% ($n=53$) third-year and 33.6% ($n=72$) fourth-year. The average BMI was 19.43 (±3.31), with 87.9% ($n=188$) presenting normal weight, 10.3% ($n=22$) overweight and 1.9% ($n=4$) obesity. The remaining variables and their distribution according to the level of PA practice are detailed in Table 1.

The data extracted from the general descriptive analysis showed that right HGS presented higher average values than left HGS (19.82 ± 7.27 kilos vs. 16.06 ± 5.96 kilos), the long jump average was 163.41 ± 43.36 centimetres, mean speed in the 4x5-m shuttle test was 10.75 ± 1.05 seconds and mean endurance in the Course-Navette test was 5.50 ± 2.66 minutes.

More specifically. the one-way ANOVA yielded significant differences in all the variables analysed according to PA practice levels (sedentary and active). Generally speaking, the active adolescents obtained better values in most of the physical tests compared to their sedentary counterparts. By way of example, these differences were evident related to the level of practice of PA and left HGS (F(2.212) = 582,203; $p<.000$) or when endurance was analysed according to PA practice (F(2.212) = 39,354; $p<.000$). The other variables and data are presented in Table 2.

To complement this, linear regression analysis was performed to verify whether the level of PC, evaluated by means of the different physical tests (dependent variables), presented any type of connection with the level of practice of PA (independent variable), for which purpose they were all adjusted on the basis of the gender and age covariates.

For example, HGS and the practice of PA presented a significantly positive relationship, indicating that the more active adolescents had greater strength (non-standardised ß = 2,306, $p=.011$). Considering that the speed test's ten-

Table 1
Sociodemographic and descriptive analysis according to the level of PA practice.

Variables analysed			Physical activity group				p
			Sedentary group		Active group		
Gender	[n (%)]	Male	47	(43.9)	79	(73.8)	.000
	[n (%)]	Female	60	(56.1)	28	(26.2)	
Age	[x̄ (sd)]	Value	14.64	(±1.28)	13.88	(±1.28)	.000
	[n (%)]	13 years	25	(23.4)	46	(43)	
	[n (%)]	14 years	7	(6.5)	27	(25.2)	
	[n (%)]	15 years	51	(47.7)	21	(19.6)	
	[n (%)]	16 years	24	(22.4)	13	(12.1)	
Year	[n (%)]	1st CSE	15	(14)	28	(26.2)	.001
	[n (%)]	2nd CSE	16	(15)	30	(28)	
	[n (%)]	3rd CSE	28	(26.2)	25	(47.2)	
	[n (%)]	4th CSE	48	(44.9)	24	(22.4)	
Weight	[x^2 (sd)]	Kilos	55.02	(±11.48)	57.50	(±11.30)	.113
Height	[x^2 (sd)]	Metres	1.66	(±.09)	1.73	(±.09)	.000
BMI*	[x^2 (sd)]	Value	19.82	(±3.86)	19.05	(±3.31)	.090
Ponderal status	[n (%)]	Normal weight	90	(84.1)	98	(91.6)	.079
	[n (%)]	Overweight	13	(12.1)	9	(8.4)	
	[n (%)]	Obesity	4	(3.7)	0	(0)	

Note. n: sample no.; %: percentage; x̄ (sd): mean (standard deviation); CSE: Compulsory Secondary Education. *BMI: adjusted according to gender and weight, according to the scale by Cole et al. (2000). Ponderal index: it is extracted from the BMI value obtained.

Table 2
Analysis of variance according to hand grip strength, long jump, speed and endurance. Classification by levels of PA practice (active and sedentary).

		Descriptive				One-Way ANOVA					
		N	Mean	SD	SE		Sum of squa-res	df	Root mean square	F	*p*
Right HGS (kg)	S	107	18.25	6.810	.658	Inter-G	527.551	1	527.551	10.400	.001
	A	107	21.39	7.421	.717	Intra-G	10.753.701	212	50.725		
	Total	214	19.82	7.278	.497	Total	11.281.252	213			
Left HGS (kg)	S	107	17.25	6.332	.612	Inter-G	12.246.797	1	12.246.797	582.203	.000
	A	107	14.86	5.792	.079	Intra-G	4.312.227	212	21.035		
	Total	214	16.05	5.966	.623	Total	16.559.024	213			
Long jump (cm)	S	107	149.20	44.408	4.293	Inter-G	43.241.888	1	43.241.888	25.653	.000
	A	107	177.63	37.407	3.616	Intra-G	357.361.925	212	1.685.669		
	Total	214	163.41	43.368	2.965	Total	400.603.813	213			
Speed (sec.)	S	107	11.18	.930	.090	Inter-G	39.551	1	39.551	42.601	.000
	A	107	10.32	.996	.096	Intra-G	196.822	212	.928		
	Total	214	10.75	1.053	.072	Total	236.374	213			
Endurance (min)	S	107	4.43	2.124	.205	Inter-G	242.916	1	242.916	39.354	.000
	A	107	6.56	2.799	.271	Intra-G	1.308.579	212	6.173		
	Total	214	5.50	2.699	.184	Total	1.551.495	213			

Note. A: active (experimental group); S: sedentary (control group); SD: standard deviation; SE: standard error; df: degrees of freedom; Inter-G: intergroup; Intra-G: intragroup. Right HGS: right-hand grip strength; Left HGS: left-hand grip strength; Long jump: continuous value; Speed: continuous value; Endurance: continuous value.

dency is contrary to the other tests analysed, the negative and significant relationship between speed and level of PA (non-standardised ß=-.552, p=.000) and gender (non-standardised ß =-.766, p=.000) was thus accounted for, whereby speed tended to be greater (fewer seconds were taken to do the test) in active as opposed to sedentary adolescents and in males as opposed to females. The other related variables, as well as the different values found, can be seen in Table 3.

Finally, an analysis of variance (ANOVA) of the different tests analysed was performed according to gender, age and level of PA, yielding significant differences between HGS and gender (p=.000), age (p=.000) and PA (p=.000); between speed and gender (p=.000), age (p=.023) and PA (p=.000); between endurance and gender (p=.000), age (p=.036) and PA (p=.000); and between explosive strength and gender (p=.000) and PA (p=.000) (Figure 1).

Discussion

This study presents the practical application of a battery of tests designed to evaluate, in the school setting, the level of health-related PC and weekly PA practice. The assessment instruments proposed in the study were selected on the basis of validity criteria and on the direct influence on the fact that qualities such as aerobic capacity, muscular strength and correct weight status can impact future health (Ruiz-Ariza et al., 2009).

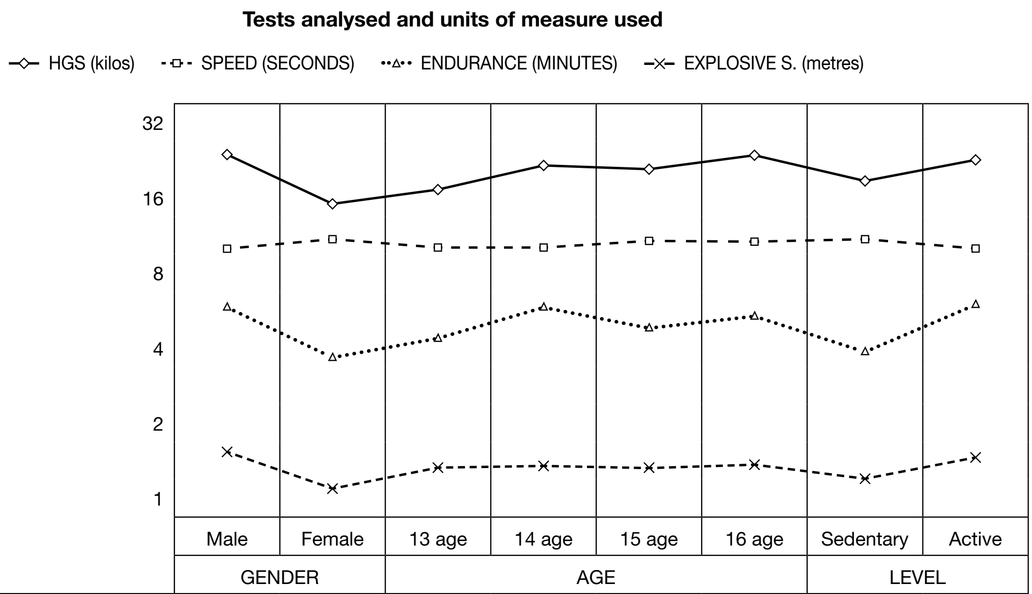
Based on the WHO (2016) BMI classification, this study shows that 84.1% and 91.6% correspond to subjects with normal weight, both in the sedentary and active group, a trend similar to the one found in other papers (Gálvez et al., 2015; Muros et al., 2016). In relation to level of PA practice, a high BMI is significantly associated ($p\leq$.001) with lower levels of PC in the different tests analysed (long jump, 10x5 agility and cardiorespiratory endurance); on the other hand, being overweight is a factor related to an increase in HGS in both hands ($p\leq$.001). This differs from the results obtained by Casajús et al. (2007), since in this study it is the active subjects who present a greater HGS, which coincides with the papers by Mora (2014) and Latorre et al. (2016).

The relationship between PC and the practice of PA yields significant differences in the tests evaluated which are favourable to the active adolescents, as also occurred in the study by López et al. (2016). This study confirms that the active subjects present a better PC (estimated by means of HGS) versus the sedentary subjects, except in the

Table 3
Regression analysis between PC and the level of practice of PA, adjusted with the gender and age covariates.

		Coefficients				ANOVA			
		B	Standard error	t	*p value*	R	df	F	Sig.
HGS (dominant hand)	(Constant)	-3.826	4.034	-.948	.344	.591	3,210	37.636	.000
	PA	2.306	.899	2.565	.011				
	Gender	6.680	.879	7.602	.000				
	Age	1.324	.280	4.726	.000				
Long Jump	(Constant)	117.504	24.329	4.830	.000	.578	3,210	35.089	.000
	PA	16.266	5.420	3.001	.003				
	Gender	43.253	5.299	8.162	.000				
	Age	.878	1.690	.520	.604				
Speed	(Constant)	10.214	-613	16.662	.000	.532	3,210	27.655	.000
	PA	-.552	.137	-4.039	.000				
	Gender	-.766	.134	-5.737	.000				
	Age	.090	.043	2.111	.000				
Endurance	(Constant)	-1.201	1.575	-0762	.447	.528	3,210	27.126	.000
	PA	1.984	.351	5.654	.000				
	Gender	1.502	.343	4.378	.000				
	Age	.344	.109	3.144	.002				

Note. PA: sedentary (0) and active (1); Gender: female (0) and male (1); Age: 13, 14, 15 and 16 years; HGS: hand grip strength; Dominant hand: it is classified depending on the functional predominance of the right or left hand, according to the adolescent's laterality.



	Male	Female	13 age	14 age	15 age	16 age	Sedentary	Active
HGS (kilos)	23.0	15.3	17.1	20.9	20.3	23.1	18.3	21.4
SPEED (seconds)	10.4	11.3	10.5	10.5	11.0	10.9	11.2	10.3
ENDURANCE (minutes)	6.4	4.2	4.9	6.5	5.4	5.9	4.4	6.6
EXPLOSIVE S. (metres)	1.8	1.3	1.6	1.7	1.6	1.7	1.5	1.8

Figure 1
Analysis of HGS, speed, endurance and explosive strength according to gender, age and level of physical activity practice.

left-hand HGS test where the sedentary subjects present greater levels of strength, which coincides with the paper by Mayorga et al. (2013). These results concur with those of Torres-Luque et al. (2014).

The analysis of PC related to gender confirms that the level of PA is greater in males compared to females, a tendency that is maintained in all the ALPHA-Fitness battery tests (HGS, long jump, speed-agility and endurance). Considering that doing the speed test faster denotes better physical condition, this accounts for the significantly negative relationship between speed and gender since males did the test in fewer seconds than females, unlike the results of the study by Prieto-Benavides et al. (2015). Also contrasting with this study, García-Sánchez et al. (2013) found that women scored better in the aerobic endurance test (*Course Navette or Multi-Stage Fitness Test*).

These differences in results in terms of gender coincide with previous studies in which males presented better levels of PC in relation to their PA (Torres-Luque et al., 2014; López et al., 2016), as occurs in studies in which PC is related to body composition, diet and physical self-concept (Mora, 2014; Gálvez et al., 2015) or analysing each one of the physical capacities individually (Pacheco-Herrera et al., 2016), in which, as in this study, males present higher values than females in PC. However, when PC is related to variables such as quality of life (Rosa-Guillamón et al., 2016) and/or emotional wellbeing (Rosa et al., 2018), females obtain better scores.

The linear regression analysis suggests that more active adolescents present better values in all the PC analysed, although Cruz and Pino (2004) found that sedentary subjects obtained better values in the HGS test. The tendency means that males have better values than females. Some authors account for these differences favourable to males through the increase in muscle power in relation to body weight, more testosterone than in females and the lower degree of neuromuscular coordination and redistribution of adipose tissue in females (Pacheco-Herrera et al., 2016).

With regard to age, all the PC assessment tests point to a significantly positive relationship favourable to older subjects, who obtain better results in all tests except speed, coinciding with the studies conducted by authors such as Gálvez et al. (2015) and Pacheco-Herrera et al. (2016).

Conclusions

The results of this research show that schoolchildren aged 12 to 16 years with a normal weight have higher levels of PC. These differences are maintained in the by-gender analysis, particularly in all the tests involving the musculoskeletal dimension. According to the scientific evidence obtained, it may be asserted that aerobic capacity and muscle power, as main health indices, could play a protective role against several diseases and also promote better quality of life.

This study has certain limitations. Firstly, PC was evaluated by means of tests taken from a field battery which does not provide the same accuracy as in-laboratory measurements. However, this battery is internationally validated and has been used previously with reliable results in different studies. Secondly, the need for both a broader and more homogeneous sample in terms of gender as well as learning the type of activity performed during the practice of PA and the adolescents' place of residence might also provide a great deal more information. This study could be developed further in the future in the form of a longer-term longitudinal study design.

Nevertheless, it may be concluded that modern-day society needs to promote PA and sports programmes to improve young people's PC and consequently their body weight condition. Increasing the hours of PE in schools and implementing educational programmes targeting healthy life habits could be efficient measures for improving general health.

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