

Health-related fitness in school children: compliance with physical activity recommendations and its relationship with body mass index and diet quality

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SUMMARY. This study establishes the relationship between the compliance with the governmental physical activity guidelines (at least a minimum of one hour of moderate to vigorous physical activity, MVPA, five times a week), health-related physical fitness and different health related lifestyle variables in a representative sample of Spanish children. Subjects were a representative group of scholars from five schools randomly selected in Extremadura, a mainly rural region with a very low population density. Statistical analysis comprises a t-test to calculate physical fitness differences between groups, according to the compliance with the mentioned physical activity guidelines. A multinomial logistic regression coefficient is established to determine the differences between the better physical fitness status group (= percentile 75) and the poorer physical fitness status group (= percentile 25) for each fitness test and gender, body mass index, physical activity, Mediterranean diet index and population size. Main findings show that the compliance with physical activity guidelines result in a better handgrip strength in left hand ($p < 0.05$), leg strength ($p < 0.000$), speed-agility run ($p < 0.000$) and 20 m endurance shuttle run ($p < 0.000$). Being a girl, being overweighted and living in an urban setting are associated with a lower physical fitness (= percentile 25), whereas there is no relationship between diet quality and subjects' performance in all physical fitness test evaluated. As a conclusion, this study emphasizes the need to promote an active lifestyle in which physical activity suppose a minimum of one hour of regular MVPA, at least five times a week, to achieve a healthy fitness status.

Key words: Exercise, sport, nutrition, Mediterranean diet, overweight, adolescence.

RESUMEN. Condición física relacionada con la salud en escolares: observancia de las recomendaciones de práctica de actividad física y su relación con el índice de masa corporal y la calidad de la dieta. Este estudio establece la relación entre el cumplimiento de las directrices gubernamentales de actividad física (una hora de actividad física moderada o vigorosa, MVPA, cinco veces a la semana), la condición física saludable, la calidad de la dieta y otras variables en una muestra de escolares de Extremadura (España). Se ha utilizado un t-test para calcular las diferencias de condición física entre los grupos, de acuerdo con el cumplimiento de las mencionadas directrices de actividad física. Se ha establecido un coeficiente de regresión logística multinomial para determinar las diferencias entre el grupo con mejor condición física (= percentil 75) y el grupo con peor condición física (= percentil 25), en función del sexo, índice de masa corporal, actividad física, índice mediterráneo de calidad de la dieta y tamaño de la población. El cumplimiento de las directrices de actividad física se relaciona con mejor fuerza de prensión en la mano izquierda ($p < 0,05$), mayor potencia de las piernas ($p < 0,000$), mejor agilidad ($p < 0,000$) y mayor aptitud cardiorrespiratoria ($p < 0,000$). Ser niña, tener exceso de peso y vivir en un entorno urbano se asocia con peor condición física (= percentil 25), mientras que no existe relación entre calidad de la dieta y la actuación de los sujetos en las pruebas de condición física realizadas. Este estudio enfatiza la necesidad de promover un estilo de vida activo en el que exista al menos una hora de actividad física (MVPA) durante cinco días a la semana, para alcanzar un estado físico saludable.

Palabras clave: Ejercicio, deporte, nutrición, dieta mediterránea, sobrepeso, adolescencia.

INTRODUCTION

Physical fitness is more important in defining health status than compliance with physical activity recommendations and, in absolute terms, physical fitness is a better predictor of morbidity and mortality than physical activity (1,2). In this sense, physical activity guidelines are intended to improve the overall physical fitness of individuals, not only to reduce sedentary-associated morbidity and mortality but also to improve quality of life and physical functioning across lifespan (3).

Adult health appears to be related with childhood physical activity and physical fitness (4,5) and there is a great deal of

evidence of the close relationship between health status and childhood physical fitness. The amount of physical activity at an early age is a factor that would prevent the prevalence of sedentarism related diseases such as obesity, ischaemic heart disease, non-insulin dependent diabetes and some types of cancer in adults (6).

In order to get this increase in health-related physical fitness is necessary the promotion of an active lifestyle since the early years of age, although it seems that physical activity guidelines for children should be different than those for adults. For example, objectives 22.6, moderate physical activity guideline (≥ 30 min, ≥ 5 d/wk, ≥ 3 METS), and 22.7 (≥ 20 continuous minutes, ≥ 3 d/wk, ≥ 6 METS) of the Healthy People 2010

guidelines for physical activity (7) are not realistic standards for children: most of youth meet the first recommendation and it appears to be a low standard, and the second standard may prescribe a form of physical activity that is common for adults but uncharacteristic of children and youth (8). Otherwise, the UK Group recommendation of accumulating 60 min per day of moderate to vigorous intensity physical activity (=60 min, =5 d/wk, =3 METS) (9) was supported as the best existing guideline for youth (8) and has been adopted by the Spanish Ministry of Health (10).

Physical fitness is a complex phenomenon, with several dimensions related to health and well-being and influenced by most dimensions of life. Nature can explain some aspects of physical activity and physical fitness like age, sex or heredity, whereas nurture and culture can explain others like socio-economic factors, diet, environment or leisure time habits (11). Furthermore, these factors are often associated one with another and habitual physical activity (and then, health-related fitness) could be mediated by all the variables listed above. For example, strength or aerobic fitness appears to be greater in young men than in young women (12), socio-economic factors, like academic level or income, are related with physical fitness (13), neighbourhood's characteristics could decrease or improve the level of habitual and leisure-time physical activity (14), while the relationship between diet quality and physical activity or physical fitness has not been well defined (15).

In this context, the aim of this study is to establish the relationship between several dimensions of health-related physical fitness, the compliance with Spanish physical activity guidelines for scholar population and different variables related with children's lifestyle in a representative sample of children.

MATERIALS AND METHODS

This study was conducted in Extremadura, an inland region situated in the centre-west of Spain with an area of 41,634 km² and a population of 1,073,050 inhabitants. The population in Extremadura is mainly rural (density: 25.2 inhabitants/km) and the 56% of the people live in towns of less than 10,000 inhabitants. The study sample (9.99±0.79 years old, 137 boys and 156 girls) was obtained from five schools randomly selected by means of a four-stage stratified sampling design, taking into account population size, age, sex and type of school of students. This design was used in order to ensure that the sample was representative of the population of interest, i.e., all students registered in 4th and 5th grades in primary schools in the region of Extremadura during the academic year 2006-2007, and the estimated sample size was 349 individuals (5% error, 95.5% CI) according to the characteristics of the participants shown in Table 1. The study was conducted in that school year (2006-2007), during regular school hours after

obtaining written informed consent from all the participants and their parents or guardians. This work received a positive report from the Commission of Bioethics of the University of Murcia.

TABLE 1
Prevalence of participants' characteristics
(boys: n=137; girls: n=156)

Gender	
Male	48.8%
Female	51.2%
Compliance with physical activity guidelines	
Insufficiently active	82.3%
Sufficiently active	17.7%
Weight Status (Body Mass Index)	
Overweight	31.7%
Normal	68.3%
Mediterranean diet index (KIDMED index)	
Low index	72.7%
High index	27.3%
Population size	
Rural (< 10,000 inhabitants)	39.2%
Urban (> 10,000 inhabitants)	60.8%

The procedures for data collection took place during morning school visits from May to June in 2007. The same investigators, following the same order of testing and allowing 5–10 min rest between trials, conducted all the measurements giving to the children demonstrations of each test prior to their performance. These measurements and tests will be presented in the order in which they were conducted.

The body mass index (BMI) was calculated from weight and height: the body mass was assessed to the nearest 0.1 kg (Seca Beam Balance 710) and the standing height was measured to the nearest 0.5 cm using a Seca Stadiometer (Seca, Hamburg, Germany) with the subject's shoes off and head in the Frankfort horizontal plane. Thereafter, participants were classified into two groups with only one cut off point to establish gross differences, "normal weight" and "overweight", as having normal weight or overweight according to the age- and sex-specific BMI cut-offs from international guidelines (16).

The physical fitness was assessed using five field tests previously validated for their use in children (17): sit and reach (cm), handgrip strength (N), horizontal jump (cm), agility 10 x 5 m run (s) and 20 m shuttle run (step). For all but the last test, two trials were allowed and the best score was recorded for further analyses.

Sit and reach

The sit and reach test was used to assess flexibility of the spine and posterior leg muscles. Each subject was asked to sit

on the gymnasium floor, with their knees straight and resting their bare feet vertically against a box 30 cm in height. To perform the test, the subject was asked to lean forward with straight arms and knees and reach over the top surface of the box as far as possible. The distance between toes and finger was measured, having positive values if the subject was able to reach further than his/her toes, negative values if the subject was unable to reach his/her toes and a zero value if the subjects could just touch their toes.

Handgrip

The subjects were asked to squeeze a calibrated hand dynamometer as forcefully as possible with their hands. The handle length was adjusted to account for variations in hand size. Results, expressed in kilograms (kg), were transformed to newtons (N) by multiplying by 9.8.

Horizontal jump test

Following a short familiarisation period, the volunteers had to perform the required counter-movement horizontal jump getting it measured with a non-extensible tape.

Agility 10 x 5 m run

Two lines 5 m apart each other were drawn on the gymnasium floor. On the command of “go”, the pupil had to run forward as fast as possible, pivot on the far line, and return to the starting line. This had to be repeated five times in total and the time required to complete the test was recorded to the nearest 0.1 s.

20 m shuttle run

The subjects performed the test individually and were instructed to run between two lines 20 m apart in synchrony with a sound signal emitted from an audio system. The frequency of signals increased by 0.5 km/h every minute from a starting speed of 8.5 km/h. The test was finished when the subjects were unable to maintain the prescribed pace for three consecutive signals. The equivalent shuttle running duration (steps) was used as an endurance performance indicator (18).

A previously validated seven-days diary was employed to estimate weekly physical activity (19). The participants were asked to report the type and amount of performed activity daily by temporal segments and to report the number of hours spent in sleeping; any other time in the day was assumed to be spent in low intensity activities. The daily physical activity was determined by calculating the average number of minutes of activity (sum of moderate, hard, and very hard) that was performed each week according to the values of energetic cost compendium of physical activities in children (20). After that, the subjects were split in two groups, “Sufficiently actives” or “Insufficiently actives”, according to their compliance with the Spanish physical activity guidelines for children(10), ≥ 60

min, ≥ 5 d/wk of moderate to vigorous physical activity (MVPA, ≥ 3 METS).

The diet quality was established by the KIDMED index, an index obtained from an international questionnaire developed for children previously validated and widely employed with the Spanish scholar population (21). After the calculation of the KIDMED index values, two groups were established according to the compliance of the mediterranean diet guidelines: low KIDMED index (poor mediterranean diet) or high KIDMED index (good mediterranean diet).

The Kolmogorov-Smirnov test of normality was used to ensure that the calculated variables were normally distributed. A t-test was calculated between groups (“Sufficiently active” and “Insufficiently active”) to establish the differences in health related physical fitness variables in relation to the compliance with described physical activity guidelines. Multinomial logistic regression coefficient was established to calculate odd ratios (OR’s) and 95% confidence intervals (CI’s) in order to determine differences between good physical fitness status group (\geq percentile 75) and poor physical fitness status group (\leq percentile 25) for each fitness test and gender, body mass index, physical activity, Mediterranean diet index and population size. The statistical treatment of the data was made using the program package SPSS 15.0.

RESULTS

As we mentioned before in Table 1, we could determine that 52 children were sufficiently active (17.75%) and 241 were insufficiently active (82.25%). As shown in Table 2, the group that met the physical activity guidelines performed better in most of the assessed physical fitness variables except for the sit and reach test and right handgrip strength test.

Table 3 lists the results of the multinomial logistic regression analysis (odds ratio and confidence interval) considering the differences in physical fitness status (percentile 25 versus percentile 75) as a function of the selected lifestyle-related variables and finding higher physical fitness values between boys than girls, except for sit and reach test.

Being overweight appears to be a risk factor for poorer physical fitness. It is more frequent to find a normal BMI among the better physical fitness group (percentile 75) in three of the six fitness tests, having the opposite relationship in grip strength, and no differences in the sit and reach test between overweight and normal weight children.

The results of our multinomial logistic regression model between the “fit” group and the “unfit” group support the finding made in the previous statistical analysis (t-test): it seems to be more probable to find sufficiently active subjects in the fitter group in four of the six tests (except sit and reach and right handgrip, as listed above).

Finally, diet quality does not appear to be related to the

physical fitness variables and living in urban settings is related to a minor presence in the percentile 75 group for all the fitness variables except for sit and reach and agility 10 x 5 m run.

TABLE 2
Comparison of level attained in the different physical fitness test as a function of compliance with physical activity guidelines (t-test)

	ufficiently active (n=52) ±SD	Insufficiently active (n=241) M±SD	t	p
BMI (kg·m ⁻²)	16.39 ± 2.91	18.78 ± 3.59	-4.479	0.000
Sit and reach (cm)	1.41 ± 6.50	1.26 ± 6.41	0.154	0.878
Handgrip – right (N)	182.76 ± 40.61	173.44 ± 42.67	1.437	0.152
Handgrip – left (N)	175.79 ± 41.49	162.06 ± 40.12	2.234	0.026
Horizontal jump (cm)	133.02 ± 52.69	101.82 ± 50.79	3.949	0.000
Agility 10 x 5 m run (s)	22.18 ± 3.77	24.84 ± 5.00	-3.540	0.000
20 m shuttle run (step)	6.80 ± 1.12	3.35 ± 1.49	15.624	0.00

TABLE 3
Multinomial logistic regression model examining good physical fitness status (= percentile 75) as a function of selected lifestyle-related variables

	Sit and reach R (95% CI)	Handgrip – right OR (95% CI)	Handgrip – left OR (95% CI)	Horizontal jump OR (95% CI)	Agility 10 x 5 m OR (95% CI)	20 m shuttle run OR (95% CI)
Gender						
Female	1.00	1.00	1.00	1.00	1.00	1.00
Male	0.27 (0.14-0.53) _‡	0.94 (0.307-2.86)	0.69 (0.37-1.31)	4.26 (0.22-0.83)*	0.32 (0.16-0.64) _‡	5.48 (2.70-11.10) _‡
Body mass index						
Overweight	1.00	1.00	1.00	1.00	1.00	1.00
Normal	1.33 (0.67-2.65)	0.07 (0.02-0.29) _‡	0.26 (0.08-0.84)*	4.54 (2.12-9.68) _‡	2.65 (1.25-5.63)*	12.14 (4.90-30.05) _‡
Physical activity						
Insufficiently active	1.00	1.00	1.00	1.00	1.00	1.00
Sufficiently active	1.05 (0.45-2.44)	0.58 (0.14-2.44)	2.38 (1.02-5.55)*	7.42 (2.84-19.36) _‡	7.08 (2.85-17.61) _‡	2.78 (2.05-3.75) _‡
Mediterranean diet index						
Low index	1.00	1.00	1.00	1.00	1.00	1.00
High index	0.79 (0.40-1.56)	0.65 (0.22-1.92)	1.46 (0.74-2.89)	0.50 (0.24-1.01)	0.81 (0.39-1.68)	1.82 (0.88-3.74)
Population size						
Rural	1.00	1.00	1.00	1.00	1.00	1.00
Urban	0.83 (0.43-1.59)	0.07 (0.10-0.29) _‡	0.11 (0.05-0.23) _‡	0.006 (0.001-0.02) _‡	1.05 (0.55-2.04)	0.213 (0.10-0.43) _‡

Note: Comparison group is “≤ percentile 25”; * $p < 0.05$, ‡ $p < 0.001$, † $p < 0.000$

DISCUSSION

As it has been described by other authors, it seems that meeting the physical activity guidelines mentioned in this study results in a better physical fitness (22). Nevertheless, most of Spanish youth show a sedentary lifestyle (23) far from the recommendations given by the Spanish Ministry of Health and limiting their physical activity to the physical education classes received at school. It is important to highlight the fact that physical education in Spain only comprises two sessions of one hour per week. Whereas for children and youth it is possible to achieve some health recommendations in terms of

physical fitness in only two hours per week by a regular and intense exercise program (24), most of Spanish scholar children do not elicit benefits from physical education classes, because it is not possible to develop an intense training program during those classes with all the items included in the actual curricula. It would be desirable to increase the importance of scholar physical education, as well as non-scholar physical activity, because it can greatly contribute to promote a healthy lifestyle during lifespan (25,26).

Even though some studies describe differences between boys and girls before reaching puberty (27), it is not totally clear that there should be differences between boys and girls

performing physical fitness tests until then (28). In our study, the disparity observed in the results of the physical fitness tests according to sex could be explained by the greater proportion of boys that fulfilled the physical activity guidelines in comparison to girls (22.6% versus 13.4%). This difference in regular exercise practice between gender groups has been already described in Spain by Roman *et al.* (23).

A higher BMI is associated with a poorer performance in most of the selected fitness variables, and it seems that the overweight children, when compared with normal-weight counterparts, had lower performances on those tests requiring propulsion or lifting the body mass: horizontal jump ($p<0.000$), 10 x 5 m agility run ($p<0.05$) and endurance shuttle run ($p<0.000$). However, overweight seems to be a factor associated with increased hand grip strength of both hands ($p<0.05$), as it has also been described by Casajús *et al.* for overweight Spanish children (29).

The apparent relationship between an active lifestyle and a good diet quality described by other authors (30) can not be confirmed by our study, maybe because of the different method employed in each study to assess the diet quality. Nonetheless, it has been observed a positive relationship between aerobic fitness and major food groups showing that active boys and girls eat more vegetables and other carbohydrates-enriched meals and less meat or fish servings per week (31). However, habitual exercise might lead to a better aerobic fitness and to a greater energy expenditure, and theoretically, to greater energy requirements. However, a bigger amount of energy intake or certain food groups doesn't mean quality, and usually, from a healthy point of view, athletes show an incorrect dietary pattern (32, 33), not meeting Mediterranean diet guidelines, from a qualitative point of view as used in this study.

Living in rural setting means belonging to the 75 percentile group in five of the seven fitness tests, except for sitting and reaching and 10 x 5 m agility run, although from the point of view of the promotion of an active lifestyle, living in rural areas is often associated with a lower prevalence of physical activity, higher BMI and poorer physical fitness (34). The results obtained by other authors in European or Latin American population are consistent with our results (35-37), and the difference with the North American youth population may be explained by the importance of the built environment in an active use of recreation or sport sites and active transportation to these places (14). The social built environment, and the roles of proximity and active transportation in Spain are very different to those in U.S.A., and these facts and their impact on the amount of children's leisure time might make a difference in the findings of this study. In this regard, more research is needed.

In conclusion, our results show that physical fitness is better in those children that meet the recommendations of practice of physical activity, at least one hour of MVPA, five times a

week. Sex, BMI and neighbourhood's characteristics (rural or urban) are variables that are associated with physical fitness, while there is no relationship between diet quality and physical performance in school children.

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Recibido: 12-01-2910

Aceptado: 12-11-2010