



Original/*Deporte y ejercicio*

Relationship of physical activity and sedentarism with tobacco and alcohol consumption, and Mediterranean diet in Spanish teenagers

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Abstract

Background and objectives: This study examined the association of physical activity and sedentarism with tobacco and alcohol consumption, and adherence to the Mediterranean diet in teenagers of both genders.

Methods: A total number of 1897 Spanish teenagers (12-16 year-olds) took part in the present cross-sectional study. The variables were measured by means of questionnaires previously validated for these ages.

Results: Physical activity was positively associated to the degree of adherence to the Mediterranean diet for both genders ($\beta = .144$, $P < .001$ for boys and $\beta = .066$, $P < .05$ for girls), and inversely associated to smoking for boys ($\beta = -.135$, $P = <.001$). Sedentary behaviors for leisure purposes (TV and PC) were negatively associated to adherence to the Mediterranean diet for both boys ($\beta = -.100$ and $\beta = -.104$, both $P < .05$, respectively) and girls ($\beta = -.148$ and $\beta = -.141$, both $P < .001$), and positively associated to alcohol consumption for girls ($\beta = .114$, $P < .01$ and $\beta = .199$, $P < .001$, respectively).

Conclusion: results suggest that physical activity and sedentary behaviors have an important relationship with the adherence to the Mediterranean diet in teenagers. Also, higher levels of physical activity in boys can lead to reduced tobacco use, while watching TV and PC leisure can lead to increased alcohol consumption in girls.

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Key words: *Physical exercise. Sedentary lifestyle. Tobacco use. Alcohol use. Mediterranean food.*

RELACIÓN DE ACTIVIDAD FÍSICA Y SEDENTARISMO CON EL CONSUMO DE TABACO Y ALCOHOL Y DIETA MEDITERRÁNEA EN ADOLESCENTES ESPAÑOLES

Resumen

Introducción y objetivos: Este estudio examinó la asociación de la actividad física y el sedentarismo con el consumo de alcohol y tabaco, y la adherencia a la dieta mediterránea en adolescentes de ambos sexos.

Métodos: Un total de 1897 adolescentes españoles (12-16 años) participaron en el presente estudio transversal. Las variables fueron medidas mediante cuestionarios previamente validados para estas edades.

Resultados: La actividad física estuvo positivamente asociada con el grado de adherencia a la dieta mediterránea en ambos sexos ($\beta = .144$, $P < .001$ para chicos y $\beta = .066$, $P < .05$ en chicas), e inversamente asociada con el tabaquismo en chicos ($\beta = -.135$, $P = <.001$). Los comportamientos sedentarios con propósitos lúdicos (televisión y ordenador) estuvieron negativamente asociados con la adherencia a la dieta mediterránea en chicos ($\beta = -.100$ y $\beta = -.104$, ambos $P < .05$, respectivamente) y chicas ($\beta = -.148$ y $\beta = -.141$, ambos $P < .001$), y positivamente asociados al consumo de alcohol en chicas ($\beta = .114$, $P < .01$ y $\beta = .199$, $P < .001$, respectivamente).

Conclusión: Los resultados sugieren que la actividad física y el sedentarismo tienen una relación importante con la adherencia a la dieta mediterránea en adolescentes. Así mismo, altos niveles de actividad física en chicos puede ayudar a reducir el consumo de tabaco, mientras que ver la televisión y el uso recreativo del ordenador pueden conducir a un incremento del consumo de alcohol entre las chicas.

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Palabras clave: *Ejercicio físico. Estilo de vida sedentario. Consumo de tabaco. Consumo de alcohol. Alimentación mediterránea.*

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Abbreviations

ANCOVA: Covariance analysis.
BMI: Body mass index.
HBSC: Health Behaviour School-aged Children.
PA: Physical activity.

Introduction

Physical activity (PA) is considered essential to support life functions and to maintain a healthy lifestyle. PA in teenagers has proved to play a protective role against future cardiovascular, skeletal and mental diseases.¹ Sedentary teenagers using TV and PC excessively have been proven to undergo greater risk of suffering health problems at physical, psychological and social levels^{1,2}. However, the use of traditional indicators such as disease and death rate to measure health condition provide rather limited information about teenagers, as their incidence among teenagers is rather scarce. Thus, it is important to examine other health-related parameters such as alcohol consumption, smoking^{3,4}, and adherence to the Mediterranean diet^{5,6}.

Alcohol consumption and smoking are determining factors that lead to increased health problems in Western countries. These risky behaviors are related to the main causes of morbidity and mortality, and have the most harmful effects on children and teenagers, due to their greater sensitivity to these substances^{3,4}. The relationship between PA and smoking in teenagers has not yet been fully determined, as a high number of studies have found an inverse association between PA and smoking^{7,8}, while others have shown that this relationship is not always significant⁹⁻¹¹, or that it occurs only among boys yet not among girls^{12,13}.

Regarding the relationship between PA and alcohol consumption, results from previous studies are even more contradictory. Some studies found no significant association between these variables¹⁴, yet the studies that found an association do not agree on whether it is a positive or a negative relationship^{10,15,16}. Besides, when considered jointly, both unhealthy habits (smoking and alcohol consumption) are boosted by sedentary behaviors^{11,17}. However, other authors still question this relationship, and demand further research on this issue^{18,19}.

On the other hand, some preventative factors of premature health problems include those related to the adherence to healthy diets such as the Mediterranean diet, which is characterized by abundant natural antioxidants, low saturated fats, and high fruit, vegetable, legume, fish, dry fruit, and olive oil content²⁰. This diet plays a preventive role in the appearance of cardiovascular, brain, metabolic, oncologic and neurodegenerative diseases^{5,6}. Previous works have shown a positive relationship between PA and the degree of adherence to the Mediterranean diet in children and teenagers²¹⁻²³. However, studies on the relationship between sedenta-

rism and adherence to the Mediterranean diet within this age range are still rather scarce. Furthermore, in the last decade we have witnessed a progressive abandonment of healthy eating habits among teenagers in Mediterranean countries that may be related to the appearance of premature health problems²⁴. To the best of our knowledge, possible gender differences in the relationship of PA and sedentarism with adherence to the Mediterranean diet have not been researched in spite of the fact that active and sedentary behaviors differ according to gender²⁵.

Recent studies in Spain have observed a decline in active behaviors²⁶. However, its influence on dependent factors related to quality of life and, particularly, to the degree of adherence to the Mediterranean diet has not yet been determined. This information is thus essential to develop efficient intervention strategies. According to the foregoing, the aim of this article is to examine the association of PA and sedentarism with tobacco and alcohol consumption, and adherence to the Mediterranean diet in Spanish teenagers of both genders. The main hypotheses tested in this study are that teenagers with high PA levels and those less sedentary (compared to those with high sedentarism) will show a lower risk of consuming tobacco and alcohol and having a low adherence to the Mediterranean diet.

Methods

Study design

The study was cross-sectional and it examined relationships between variables. Data collection took place from September to November 2011.

Participants

A total number of 1897 (956 boys and 941 girls) healthy Spanish teenagers (mean age \pm standard deviation: 13.89 \pm 1.29 years, 12-16 years; mean body mass index (BMI) \pm standard deviation: 22.23 \pm 4.45 kg/m²) took part in this study. Teenagers from 16 schools of the eight provinces of Andalusia (South of Spain) were surveyed. They were randomly selected by two-stage cluster sampling, using the database of the census of the Autonomous Region of Andalusia as a reference. The different strata were selected according to the geographical localization, by age and sex. The participation rate allowed working with a margin of error of less than 2.5% and a 95% confidence level.

Teenagers, parents, teachers and school boards were summoned and informed on the nature and objectives of the present study, and parents and teenagers were asked to provide informed consent. This work meets the highest safety and ethical standards, observes Spanish laws, and meets the ethical standards according to the authors' University. The present study was de-

veloped following the ethical guidelines of the 2008 Declaration of Helsinki.

Independent variables

Physical activity

PA was measured by means of the *Moderate-to-Vigorous Physical Activity Screening Measure* developed by Prochaska et al²⁷. This measurement was based on the following two items: the number of days of (moderate to vigorous) PA completion for at least 1 hour within the past week and within a regular week. The response scale was the same for both items (namely, 0 = *no day*, 1 = *one day*, 2 = *two days*, 3 = *three days*, 4 = *four days*, 5 = *five days*, 6 = *six days*, and 7 = *seven days*). A mean of the responses to both items was used to complete the statistical analysis. PA items' internal consistency was high (Cronbach's alpha = .861).

Sedentarism

Sedentary activities were measured by means of the questionnaire *Health Behavior in School-aged Children (HBSC)*²⁸. Participants responded to six items indicating the number of daily hours devoted to watching TV on weekdays and on weekends, using PC on weekdays and on weekends, and doing homework on weekdays and on weekends. The response scale included nine options (namely, 1 = *no time*, 2 = *half an hour*, 3 = *one hour*, 4 = *two hours*, 5 = *three hours*, 6 = *four hours*, 7 = *five hours*, 8 = *six hours*, and 9 = *seven hours*). Internal consistency in sedentarism-related items was high (Cronbach's alpha = .721; .745 and .719 for the TV, PC and homework items, respectively). All the questions used to measure PA and sedentarism showed good reliability and validity in teenagers^{29,30}.

Dependent variables

Tobacco and alcohol consumption

Smoking, alcohol consumption, and drunkenness episodes were measured by means of the HBSC questionnaire²⁸. All the questions used to measure tobacco and alcohol consumption showed good reliability and validity in teenagers^{29,30}.

Only one item titled "How often do you smoke nowadays?" was used to measure smoking. The response scale included 4 options (namely, 1 = *I do not smoke*, 2 = *less than once a week*, 3 = *at least more than once a week yet not every day*, and 4 = *every day*).

To assess alcohol consumption participants indicated how often they had each of these drinks: beer, wine and spirits. The response scale comprised 5 options

(namely, 0 = *never*, .10 = *hardly ever*, .25 = *every month*, 1 = *every week*, and 7 = *every day*). The average value of the three responses represented alcohol consumption⁸. The scale's internal consistency in the studied sample was high (Cronbach's alpha = .788).

Only one item was used to assess how often teenagers have drunkenness episodes: "Have you ever had enough alcohol to get drunk?" The response scale comprised 5 options (namely, 0 = *never*, 1 = *once*, 2 = *2-3 times*, 3 = *4-10 times*, and 4 = *over 10 times*).

Adherence to the Mediterranean diet

Adherence to the Mediterranean diet was assessed by means of the *Adherence to the Mediterranean Diet Test KIDMED* successfully used in Spanish teenagers^{22,23,31}. This instrument is comprised of 16 dichotomous (yes/no) questions, for example "Consumes fish regularly (at least 2-3 times per week)?" Affirmative responses in the 12 questions on positive aspects in relation with the Mediterranean diet summed 1 point, while affirmative responses to the 4 questions on negative aspects related to the adherence to the Mediterranean diet took away 1 point. Negative responses contributed no score.

Adolescents completed all the questionnaires anonymously (average completion time was 15 min). All measurements were completed in the presence of trained researchers.

Control variables

Weight and height

Anthropometric measurements of weight [TANITA BC-420-S class III scale (TANITA Corporation Inc., Arlington Heights, Illinois, US)] and height [SECA 214 (SECA Ltd., Hamburg, Germany) portable stadiometer] were completed on barefoot teenagers dressed in light clothes. BMI (weight in kilograms divided by the square of the height in meters) was calculated.

Statistical analysis

The data are presented as means and standard deviation, unless indicated otherwise. Comparisons of gender of anthropometric measures, PA, sedentarism, tobacco and alcohol consumption, and adherence to the Mediterranean diet were completed by means of Student's T-test for independent samples.

Linear regression analysis was used to study the association of PA and sedentarism (independent variables) with tobacco and alcohol consumption, and adherence to the Mediterranean diet (dependent variables). These analyses were made separately (each independent variable with each dependent variable),

were completed on boys and girls separately, and were adjusted (control variables) by age and BMI.

Finally, covariance analysis (ANCOVA) was completed when the dependent variables showed gender differences (namely, smoking and adherence to the Mediterranean diet) (see Table I), in which PA and sedentarism levels were the fixed factors, while age and BMI were the covariates.

Results

Results showed that boys had significantly higher BMI, PA, and adherence to the Mediterranean diet than girls, while the latter showed higher devotion to homework and a higher level of smoking (see Table I).

Regression analysis

Table II shows the association of PA and sedentarism with tobacco and alcohol consumption, and adherence to the Mediterranean diet. PA was positively associated to the degree of adherence to the Mediterranean diet for both genders ($\beta = .144$, $r = .142$, $P < .001$ for boys and $\beta = .066$, $r = .071$, $P < .05$ for girls), and negatively associated to smoking for boys ($\beta = -.135$, $r = -.144$, $P < .001$). The number of weekly hours of TV watching and PC use were negatively associated to adherence to the Mediterranean diet for boys ($\beta = -.100$, $r = -.098$ and $\beta = -.104$, $r = -.111$, both $P < .05$, respectively) and girls ($\beta = -.148$, $r = -.152$

and $\beta = -.141$, $r = -.145$, both $P < .001$), and positively associated to alcohol consumption ($\beta = .114$, $r = .120$, $P < .01$ and $\beta = .199$, $r = .221$, $P < .001$, respectively) and drunkenness episodes ($\beta = .088$, $r = .095$, $P < .01$ and $\beta = .117$, $r = .140$, $P < .001$, respectively) for girls only. Time devoted to PC use was also positively associated to smoking for girls ($\beta = .096$, $r = .111$, $P < .01$), while the time devoted to homework was positively associated to the degree of adherence to the Mediterranean diet ($\beta = .158$, $r = .170$ for boys and $\beta = .132$, $r = .131$ for girls, both $P < .001$), and negatively associated to smoking, alcohol consumption, and drunkenness episodes for both genders (for boys: $\beta = -.101$, $r = -.105$, $P < .01$; $\beta = -.097$, $r = -.108$, $P < .01$, and $\beta = -.124$, $r = -.143$, $P < .001$, and for girls: $\beta = -.160$, $r = -.146$, $P < .001$; $\beta = -.092$, $r = -.071$, $P < .01$, and $\beta = -.131$, $r = -.111$, $P < .001$, respectively).

Variance analysis by gender

Figure 1 shows the ANCOVA when the dependent variables showed significant differences between boys and girls (namely, tobacco consumption and adherence to the Mediterranean diet) (see Table I). Boys with low PA levels showed significantly greater levels of smoking ($1.24 \pm .70$ vs. $1.11 \pm .47$ out of 4, $F(1, 950) = 11.465$, $P = .001$, $\eta^2 = .012$), and lower adherence to the Mediterranean diet than their active counterparts (6.09 ± 2.35 vs. 6.62 ± 2.35 points out of 12, $F(1, 944) = 12.760$, $P < .001$, $\eta^2 = .013$). Girls with high sedentarism levels reported lower adherence to

Table I
Mean (M) and standard deviation (SD) for anthropometric measures, physical activity and sedentarism (TV, PC and homework) levels, tobacco and alcohol consumption, and adherence to the Mediterranean diet

	Boys (956)			Girls (941)			P
	n	M	SD	n	M	SD	
Age (years)	956	13.93	1.30	941	13.84	1.28	.097
Weight (kg)	956	61.92	15.48	941	55.29	12.17	<.001
Height (m)	956	1.65	.09	941	1.58	.06	<.001
Body mass index (kg/m ²)	956	22.54	4.64	941	21.91	4.23	.002
PA (days a week)*	956	4.37	1.91	941	3.50	1.95	<.001
TV (hours/day)	956	2.24	1.37	941	2.27	1.31	.627
PC (hours/day)	956	2.04	1.54	941	2.14	1.56	.147
Homework (hours/day)	956	1.66	1.14	941	2.09	1.11	<.001
Smoking (1-4)	953	1.18	.62	939	1.26	.73	.008
Alcohol consumption (days/week)	927	.06	.17	914	.05	.12	.310
Drunkenness (0-4)	927	.51	1.04	914	.47	1.00	.332
Adherence to Mediterranean diet (0-12)	947	6.35	2.36	935	6.07	2.31	.008

*PA (days a week) = Average number of days that accumulated at least one hour of moderate-vigorous activity over the past seven days and in a typical week (a mean of the responses to both items).

Table II
*Association of physical activity and sedentarism (TV, PC and homework) (independent variables) with tobacco and alcohol consumption, and adherence to the Mediterranean diet (dependent variables) in teenagers**

	Boys (956)					Girls (941)				
	<i>n</i>	β^\dagger	<i>SE</i> ‡	<i>r</i>	<i>P</i>	<i>n</i>	β^\dagger	<i>SE</i> ‡	<i>r</i>	<i>P</i>
Physical Activity										
Smoking	953	-.135	.010	-.144	<.001	939	-.049	.012	-.077	.138
Alcohol consumption	927	.015	.003	.003	.639	914	.018	.002	-.023	.540
Drunkenness	927	-.036	.016	-.057	.241	914	.016	.017	-.024	.633
Mediterranean diet	947	.144	.040	.142	<.001	935	.066	.040	.071	.049
TV										
Smoking	953	<.001	.014	.008	.991	939	.062	.017	.067	.063
Alcohol consumption	927	-.013	.004	-.002	.697	914	.114	.003	.120	.001
Drunkenness	927	.011	.023	.025	.714	914	.088	.025	.095	.007
Mediterranean diet	947	-.100	.056	-.098	.002	935	-.148	.059	-.152	<.001
PC										
Smoking	953	-.056	.013	-.043	.088	939	.096	.015	.111	.004
Alcohol consumption	927	-.003	.003	.019	.928	914	.199	.003	.221	<.001
Drunkenness	927	.030	.020	.055	.347	914	.117	.021	.140	<.001
Mediterranean diet	947	-.104	.051	-.111	.002	935	-.141	.049	-.145	<.001
Homework										
Smoking	953	-.101	.017	-.105	.002	939	-.160	.021	-.146	<.001
Alcohol consumption	927	-.097	.004	-.108	.003	914	-.092	.004	-.071	.006
Drunkenness	927	-.124	.027	-.143	<.001	914	-.131	.030	-.111	<.001
Mediterranean diet	947	.158	.067	.170	<.001	935	.132	.070	.131	<.001

*All analyses were completed separately (each independent variable with each dependent variable), and were adjusted (control variables) by age and body mass index.

† β = Standardized regression coefficients.

‡ SE = Standard error.

the Mediterranean diet (5.86 ± 2.26 vs. 6.29 ± 2.24 points out of 12, $F(1, 932) = 6.979$, $P = .008$, $\eta^2 = .009$) than their more active counterparts. No significant tobacco consumption differences were observed between active and inactive girls or between subjects with high and low sedentarism levels. Likewise, no differences for adherence to the Mediterranean diet were found between active and inactive girls, as well as between sedentary boys and those with low sedentarism levels.

Discussion

The goal of the present study is to analyze the association of PA and sedentarism with alcohol and tobacco consumption, and adherence to the Mediterranean diet in teenagers. Results indicate that PA is positively associated to adherence to the Mediterranean diet in Spanish teenagers, and negatively associated to smo-

king for boys. Moreover, boys and girls who allocate more time to TV and PC follow a less Mediterranean diet, and in the case of girls, consume more alcohol than their peers who devote less time to these sedentary behaviors. However, these associations do not appear when sedentarism is devoted to homework. Likewise, physically active boys and less sedentary (TV and PC) girls showed higher adherence to the Mediterranean diet than their inactive and very sedentary counterparts.

The present study showed that PA is inversely associated to smoking. However, this association was only significant in boys. These results are similar to those reported by Moreno-Murcia et al.¹² on 472 Spanish adolescents, Rodríguez et al.¹³ on a sample of 845 Spanish teenager, and Paupério et al.¹⁰ on 5624 Portuguese adolescents, who have corroborated the previous association in boys but not in girls. This may be explained by the kind of PA practiced by girls, since high intensity, volume or frequency levels would be essential fac-

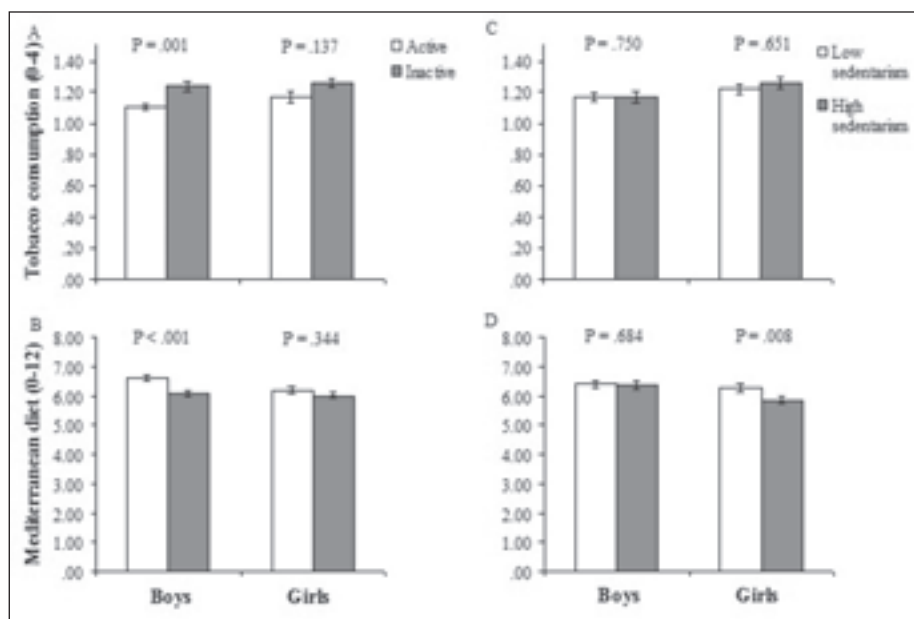


Fig. 1.—Covariance analysis with physical activity and sedentarism as fixed factors, and smoking and adherence to the Mediterranean life as dependent variables. Age and body mass index were used as covariates.*

* Physical activity was classified as either active (60 min/day of moderate-to-vigorous PA ≥ 5 days/week) or inactive (60 min/day of moderate-to-vigorous PA < 5 days/week). Sedentarism was classified as either low (TV, PC and homework ≤ 2 hours/day) or high (TV, PC and homework > 2 hours/day)

tors to obtain a positive relationship with other healthy behaviors¹². Likewise, the current models of sport promotion and the different reasons to practice PA of boys and girls may lead to gender differences in the association between PA and tobacco consumption¹³.

On the other hand, this study found no significant relationship between PA and alcohol consumption. Recent studies by Delisle et al.¹⁴ on US teenagers, and Ruiz-Risueño et al.³² on Mexican teenagers, report no significant relationship between these variables either. Yet, studies by Ruiz-Risueño et al.³² on Spanish teenagers and Kristjansson et al.¹⁵ on Icelandic teenagers report that PA leads to reduced risk of alcohol consumption. Still other authors found a significant yet inverse relationship^{10,16}. As argued by Ruiz-Risueño et al.³² these inconsistencies regarding the relation of PA and alcohol consumption among studies may be due to the influence of the kind of PA completed.

Our results proved that PA is positively associated to adherence to the Mediterranean diet. These results are similar to those found by Schröder et al.²³ on 2513 Spanish 10-24-year-old young people, those found by Grao-Cruces et al.²² on 1973 Spanish teenagers, and those found by Farajian et al.²¹ on 4786 Greek 10-12-year-old children. Covariance analysis also showed that physically active youth present greater adherence to the Mediterranean diet. However, in this occasion results were statistically insignificant among females, possibly due to that the relationship between PA and eating habits is not completely linear. An excessive PA in a context of pressure to lose weight could become a potential risk factor for the appearance of body image distortion, and abnormal eating habits in women^{33,34}.

Leisure sedentary time (TV and PC use) in Spanish teenagers presented no association to smoking,

except for PC use in girls. These results are similar to those found by Larson et al.¹⁹ on a sample of 4746 US 11-18-year-old teenagers, yet differ from those reported by Nunez-Smith et al.¹⁷ after their reviewing work, and Peltzer¹¹ on 24593 African 13-15-year-old schoolchildren. Although the foregoing shows a lack of consensus regarding the impact of sedentary habits on smoking in teenagers, the relationship between TV and PC time and the risk of alcohol abuse appears to be clearer. Our results, as well as those from the most recent studies, show that TV and PC time leads to increased risk of alcohol abuse^{11,17}. However, in our sample this association was significant only for girls. This gender difference may be due to differences in marketing receptivity between boys and girls. As indicated by McClure et al.³⁵, it is unknown how marketing influences gender differently. We observed that homework time showed an inverse association with alcohol and tobacco consumption. This may be explained by the potential of a school's curriculum and afterschool programs to reduce substance abuse among students, even when not specifically targeted³⁶. Therefore, it seems beneficial to differentiate sedentary activities like homework from TV and PC time. Like Giannakopoulos et al.¹⁸, we believe that further research is necessary to deepen the understanding of the causes behind the relationship of sedentarism with smoking and alcohol consumption.

The present study proved that sedentary behaviors (TV and PC) have a negative influence on the adherence to the Mediterranean diet in Spanish young people, while sedentary time devoted to homework is positively related to adherence to a healthy diet. Many previous studies conclude that watching TV and PC use put teenagers at a high nutritional risk³⁷. Some authors differ between TV and PC sedenta-

rism, arguing that PC involves lower nutritional risk, as hands are usually engaged and therefore not free for the consumption of generally high calorie food³⁸. We believe that this fact, together with the greater intellectual involvement required by homework, may contribute to the avoidance of the simultaneous consumption of unhealthy food which characterizes sedentary behaviors during time devoted to homework³⁸. Gender differences prove to be another relevant aspect. Spanish girls with high sedentarism levels showed lower adherence to the Mediterranean diet than their less sedentary counterparts. However, there was no evidence of gender differences in the association between sedentarism and food quality. Some previous studies had observed that high sedentarism levels are related to obesity only among females³⁹. Therefore, it seems necessary to cater to gender differences in teenagers, since boys obtain greater benefits from their habits, as they are physically more active and less sedentary, while girls benefit more from avoiding sedentarism than from being active.

As in all studies, we have to recognize some limitations. We must point out that the cross-sectional nature of the present study allows us to speculate yet not to deduce the causes behind the aforementioned associations. Moreover, PA and sedentarism, tobacco and alcohol consumption, and adherence to the Mediterranean diet were self-reported. Some of the questions in the questionnaires may have been misinterpreted either deliberately or unintentionally by participants. However, intentionally mistaken information was potentially minimized by the fact that questionnaires were filled out anonymously, and all of them showed good reliability and validity for the studied age range. We also need to recognize that not only exercising frequency, volume and intensity are relevant with regard to tobacco and alcohol use and adherence to the Mediterranean diet; sport modality, social opportunities and pressures surrounding PA, or motivations to exercising, could be important for PA to exert a protective role against risk behaviors.

In conclusion, the present study reveals that PA is an important contributing factor to lower levels of smoking in boys and to greater adherence to the Mediterranean diet in teenagers of both genders. Watching TV and PC use for leisure purposes reduces adherence to the Mediterranean diet, while in girls it also increases the risk of alcohol consumption. However, these associations do not take place in sedentary time devoted to homework. The prevention of tobacco and alcohol consumption and improved adherence to the Mediterranean diet are particularly related to greater PA in boys and less sedentary behaviors in girls. The present study also suggests that we need to differentiate leisure sedentary activities (TV and PC) from homework-related sedentarism, as they show opposite impact on tobacco and alcohol consumption, and adherence to the Mediterranean diet.

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References

1. Andersen LB. Physical activity in adolescents. *J Pediatr* 2009; 85 (4): 281-3.
2. Tremblay MS, LeBlanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act* 2011; 8: 98.
3. Foltran F, Gregori D, Franchin L, Verduci E, Giovannini M. Effect of alcohol consumption in prenatal life, childhood, and adolescence on child development. *Nutr Rev* 2011; 69 (11): 642-59.
4. Rosewich M, Schulze J, Eickmeier O, Adler S, Rose MA, Schubert R et al. Early impact of smoking on lung function, health, and well-being in adolescents. *Pediatr Pulmonol* 2012; 47 (7): 692-9.
5. Demarin V, Lisak M, Morović S. Mediterranean diet in healthy lifestyle and prevention of stroke. *Acta Clin Croat* 2011; 50 (1): 67-77.
6. Nadtochiy SM, Redman EK. Mediterranean diet and cardioprotection: the role of nitrite, polyunsaturated fatty acids, and polyphenols. *Nutrition* 2011; 27 (7-8): 733-44.
7. Chen L, Haase AM, Fox KR. Physical activity among adolescents in Taiwan. *Asia Pac J Clin Nutr* 2007; 16 (2): 354-61.
8. Iannotti RJ, Janssen I, Haug E, Kololo H, Annaheim B, Borracono A. Interrelationships of adolescent physical activity, screen-based sedentary behavior, and social and psychological health. *Int J Public Health* 2009; 54 (Suppl. 2): S191-8.
9. Grao-Cruces A, Fernández-Martínez A, Nuviala A. Association of fitness with life satisfaction, health risk behaviors, and adherence to the Mediterranean diet in Spanish adolescents. *J Strength Cond Res* 2014; 28 (8): 2164-72.
10. Paupério T, Corte-Real N, Dias C, Fonseca A. Sport, substance use and satisfaction with life: What relationship? *Eur J Sport Sci* 2012; 12 (1): 73-80.
11. Peltzer K. Leisure time physical activity and sedentary behavior and substance use among in-school adolescents in eight African countries. *Int J Behav Med* 2010; 17 (4): 271-8.
12. Moreno-Murcia JA, Hellín P, González-Cutre D, Martínez-Galindo C. Influence of perceived sport competence and body attractiveness on physical activity and other healthy lifestyle habits in adolescents. *Span J Psychol* 2011; 14 (1): 282-92.
13. Rodríguez García PL, López Villalba FJ, López Miñarro PA, García Cantó E. Relationship between tobacco consumption and physical exercise in adolescents. Differences between genders. [Práctica de ejercicio físico y su relación con el consumo de tabaco en adolescentes. Diferencias entre géneros]. *Adicciones* 2013; 25 (1): 29-36.
14. Delisle TT, Werch CE, Wong AH, Bian H, Weiler R. Relationship between frequency and intensity of physical activity and health behaviors of adolescents. *J Sch Health* 2010; 80 (3): 134-40.
15. Kristjansson AL, Sigfusdottir ID, Allegrante JP, Helgason AR. Social correlates of cigarette smoking among Icelandic adolescents: a population-based cross-sectional study. *BMC Public Health* 2008; 8: 86.
16. Nuviala Nuviala A, Grao Cruces A, Fernández Martínez A, Alda Schönemann O, Burges Abad JA, Jaime Pons A. Health self-perception, lifestyle and organized physical activity. [Autopercepción de la salud, estilo de vida y actividad física

- organizada]. *Rev Int Med Cienc Act Fís Deporte* 2009; 9 (36): 414-30.
17. Nunez-Smith M, Wolf E, Huang HM, Emanuel EJ, Gross CP. Media and child and adolescent health: a systematic review [Internet]. San Francisco: Common Sense Media; 2008 [cited 2014 Oct 16]. Available from: <http://ipsdweb.ipsd.org/uploads/IPPC/CSM%20Media%20Health%20Report.pdf>
 18. Giannakopoulos G, Panagiotakos D, Mihas C, Tountas Y. Adolescent smoking and health-related behaviors: interrelations in a Greek school-based sample. *Child Care Health Dev* 2009; 35 (2): 164-70.
 19. Larson NI, Story M, Perry CL, Neumark-Sztainer D, Hannan PJ. Are diet and physical activity patterns related to cigarette smoking in adolescents? Finding from project EAT. *Prev Chronic Dis* 2007; 4 (3): A51.
 20. Ayeche A, Durá T. Dieta mediterránea y adolescentes. *Nutr Hosp* 2009; 24 (6): 759-60.
 21. Farajian P, Risvas G, Karasouli K, Pounis GD, Kastorini CM, Panagiotakos DB et al. Very high childhood obesity prevalence and low adherence rates to the Mediterranean diet in Greek children: the GRECO study. *Atherosclerosis* 2011; 217 (2): 525-30.
 22. Grao-Cruces A, Nuviala A, Fernández-Martínez A, Porcel-Gálvez AM, Moral-García JE, Martínez-López E. Adherence to Mediterranean diet in rural urban adolescents of southern Spain, life satisfaction, anthropometry, and physical and sedentary activities. [Adherencia a la dieta mediterránea en adolescentes rurales y urbanos del sur de España, satisfacción con la vida, antropometría y actividades físicas y sedentarias]. *Nutr Hosp* 2013; 28 (4): 1129-35.
 23. Schröder H, Mendez MA, Ribas-Barba L, Covas MI, Serra-Majem L. Mediterranean diet and waist circumference in a representative national sample of young Spaniards. *Int J Pediatr Obes* 2010; 5 (6): 516-9.
 24. Tur JA, Romaguera D, Pons A. Food consumption patterns in a mediterranean region: does the mediterranean diet still exist? *Ann Nutr Metab* 2004; 48 (3): 193-201.
 25. Atkin AJ, Gorely T, Biddle SJ, Marshall SJ, Cameron N. Critical hours: physical activity and sedentary behavior of adolescents after school. *Pediatr Exerc Sci* 2008; 20 (4): 446-56.
 26. Roman B, Serra-Majem L, Ribas-Barba L, Pérez-Rodrigo C, Aranceta, J. How many children and adolescents in Spain comply with the recommendations on physical activity? *J Sports Med Phys Fitness* 2008; 48 (3): 380-7.
 27. Prochaska JJ, Sallis JF, Long B. A physical activity screening measure for use with adolescents in primary care. *Arch Pediatr Adolesc Med* 2001; 155 (5): 554-59.
 28. Ministry of Health, Social Policy and Equality of Spanish Government. Adolescent development and health in Spain. Summary of the Health Behavior in School aged Children study (HBSC-2006). [Desarrollo adolescente y salud en España. Resumen del estudio Health Behavior in School aged Children (HBSC-2006)]. Madrid: Paseo del Prado publication center; 2011.
 29. Booth ML, Okely AD, Chey T, Bauman A. The reliability and validity of the physical activity questions in the WHO health behaviour in schoolchildren (HBSC) survey: a population study. *Br J Sports Med* 2001; 35 (4): 263-67.
 30. Roberts C, Freeman J, Samdal O, Schnohr CW, de Looze ME, Nic Gabhainn S et al. The Health Behaviour in School-aged Children (HBSC) study: methodological developments and current tensions. *Int J Public Health* 2009; 54 Suppl. 2: S140-50.
 31. Grao-Cruces A, Nuviala A, Fernández-Martínez A, Pérez-Turpin JA. Association of physical self-concept with physical activity, life satisfaction and Mediterranean diet in adolescents. *Kinesiology* 2014; 46 (1): 3-11.
 32. Ruiz-Risueño J, Ruiz-Juan F, Zamarripa JI. Alcohol and tobacco consumption in Spanish and Mexican adolescents and its relation to physical and sports-related activity and to the family. [Alcohol y tabaco en adolescentes españoles y mexicanos y su relación con la actividad físico-deportiva y la familia]. *Rev Panam Salud Pública* 2012; 31 (3): 211-20.
 33. Jáuregui Lobera I, Estébanez Humanes S, Santiago Fernández, MJ. Physical activity, eating behavior, and pathology. [Ejercicio físico, conducta alimentaria y patología]. *Arch Latinoam Nutr* 2008; 58 (3): 280-5.
 34. Rosen LW, McKeag D, Hough DO, Curley V. Pathogenic weight control behaviour in female athletes. *Phys Sportsmed* 1986; 14 (1): 79-86.
 35. McClure AC, Stoolmiller M, Tanski SE, Engels RCME, Sargent, JD. Alcohol marketing receptivity, marketing-specific cognitions and underage binge drinking. *Alcohol Clin Exp Res* 2013; 37 (Suppl. 1): E404-13.
 36. Amuedo-Dorantes C, Mach T, Clapp JD. The impact of schools on juvenile substance initiation and use. *Prev Sci* 2004; 5 (2): 91-9.
 37. Kontogianni MD, Vidra N, Farmaki AE, Koinaki S, Belogianni K, Sofrona S et al. Adherence rates to the Mediterranean diet are low in a representative sample of Greek children and adolescents. *J Nutr* 2008; 138 (10): 1951-6.
 38. Rey-López JP, Vicente-Rodríguez G, Biosca M, Moreno LA. Sedentary behaviour and obesity development in children and adolescents. *Nutr Metab Cardiovasc Dis* 2008; 18 (3): 242-51.
 39. Kautiainen S, Koivusilta L, Lintonen T, Virtanen SM, Rimpelä A. Use of information and communication technology and prevalence of overweight and obesity among adolescents. *Int J Obes* 2005; 29 (8): 925-33.