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Longitudinal study of physical activity in Spanish young adolescents: weight status and gender differences

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Abstract

Past research indicates there are marked declines in physical activity (PA) during adolescence. Recent studies are offering new insights. This longitudinal study investigates changes in intensities of PA (moderate-to-vigorous vs. light), by gender and weight-status, in a sample of Spanish adolescents. Students, on average 13.9 years-old (N=833 at baseline), were followed- up a year and two years later (N=474 provided data at the three time points). Self-reported PA was recorded. Analyses revealed that PA prevalence is low, although, overtime, slight increments were observed. Girls showed higher increments in moderate-to-vigorous physical activity (MVPA); boys showed higher increments in light physical activity (LPA). Investigating by weight-status, normal-weight boys showed increments over time in LPA; no changes observed for normal-weight girls. Overweight/obese girls increased their total PA (TPA) and MVPA; overweight/obese boys increased their LPA. Underweight boys and girls decreased their TPA. Interventions targeting specific intensities of PA may be beneficial for different groups based on their gender and weight status.

Keywords: Adolescents; Weight-Status; Longitudinal; Physical Activity Intensity

Physical activity (PA) is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (World Health Organization, 2019). Evidence suggests that modifiable lifestyle factors such as PA play a key role in the development of chronic diseases. Being physically active is associated with a lower risk of developing serious illnesses such as cardiovascular disease, some cancers, diabetes mellitus as well as a crucial aspect in maintaining a healthy weight status and improved psychological wellbeing (Booth, Roberts and Laye, 2014). The Centers for Disease Control and Preventions (CDC), recommends that children and adolescents should do at least 60 minutes per day of physical activity (Centers for Disease Control and Prevention, 2019). Worldwide estimates indicate that almost 80% of youths do not achieve this public health recommendation (Hallal, Andersen, Bull, Guthold and Haskell, 2012).

There is a widespread and strong belief that there is a marked decline in moderate-to-vigorous physical activity (MVPA) during adolescence. This view is supported mostly by cross-sectional, self-reported studies, by and large from US samples, and by studies that did not include samples which crossed over the transition between childhood and adolescence (Dumith, Gigante, Domingues and Kohl III, 2011; Sallis, 2000). In fact, new evidence from longitudinal studies using accelerometers, an objective measure of physical activity, is challenging this widespread view showing non-significant or negligible changes in MVPA (Collings et al., 2013; Cooper et al., 2015; Harding, Page, Falconer and Cooper, 2015; Mitchell et al., 2012). Likewise, data from the International Children's Accelerometry Database (which standardises and pools accelerometer data on MVPA from over 20,000 individuals in different countries) has supported the view that the decline in physical activity (PA) begins around the time of school entry in both sexes, with no evident declines in MVPA during adolescence (Cooper et al., 2015; Reilly, 2016). In sum, there is no conclusive evidence that there are marked declines in PA during adolescence.

Over the last years there has been a number of works carried out aimed at documenting the prevalence of physical activity in the Spanish population. Nearly 70% of a representative sample of 13-16 years-old from the region of Madrid met the 60 minutes per day recommendation, (Martínez-Gómez, Welk, Calle, Marcos and Veiga, 2009). In a representative study of over 1500 adults from Catalonia, found that 77% engaged in health enhancing PA (Pardo et al., 2014). However, analysing data at the national level, the Spanish National Health Survey (Ministerio de Sanidad, 2014) revealed that only 45.28% of over 15 years old performed weekly MVPA. More recently, in a nationally representative sample of the Spanish population it was found that only 38% of all adolescents surveyed achieved the 60 minute PA recommendation (Mielgo-Ayuso et al., 2016).

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Thus, from the available literature it seems that certain areas of Spain are closer to meet the PA recommendation, but in nationally representative samples, the percentage drops substantially. Nonetheless, studies carried out in the Spanish population have similar limitations to those conducted in the USA: most of them are cross- sectional, carried on with adults, and importantly, they mostly focus on prevalence. Likewise, there are few studies looking at changes in intensity of PA throughout the lifespan (Caspersen, Pereira and Curran, 2000). Therefore, our first aim was to explore if there were changes (declines/increments) in PA levels during early adolescence in a Spanish sample.

In addition, it is often reported that males have higher levels of PA than females (Azevedo et al., 2007; Owen, Nightingale, Rudnicka and Cook, 2009; Rangul et al., 2011). However, there is less research on changes in intensity levels by gender. Furthermore, overweight/obese youth have frequently been reported to be less active than their normal weight counterparts (Cooper et al., 2015; Martínez-Gómez et al., 2009; Raudsepp and Viira, 2008) and to our knowledge there are not studies looking at changes over time in PA levels in adolescents with overweight. Hence, our second aim is to investigate whether there would be changes (increments/decrements) in PA intensity levels by gender and weight status.

Method

Participants and Procedures

Data for the present study was drawn from baseline assessments of the MABIC, and from the MABIC-II projects. The MABIC is a multi-centre, nonrandomized, controlled, effectiveness trial for the reduction of risk factors associated to eating and weight-related problems (EWRP) in adolescents conducted in the Barcelona area, Spain (Sanchez-Carracedo et al., 2016). This trial was followed by the MABIC-II, a longitudinal study on risk factors for EWRP conducted with the control group of the MABIC. Participation in the MABIC project was offered to all schools from the participating localities, and was voluntary. No exclusion criteria were applied a priori, and full classes in the recruited schools participated. Participants with incomplete assessments or problems that might introduce relevant bias in the data (e.g. language problems) were excluded. A cohort of participants in the control group of the MABIC project [Time1 (T1), May 2011, n=833 *M*=13. 9, *SD*= 0.58years old] were followed- up a year [Time 2 (T2), March 2012, n=701 (84.1 of retention), *M*=14.9, *SD*=.51] and two years later [Time 3 (T3), March 2013, n=520 (62.4% of retention), *M*=16, *SD*=.48]. As is typical of longitudinal research, the highest percentage of missing data was found at the older follow-up ages (Twisk and de Vente, 2002). Table1 presents sample characteristics at baseline by gender group.

Of the original study population, the majority of participants were lost primarily due to absenteeism on the assessment day or change from school (T2= 130; T3=189); no consent (T2=0; T3=20), or to unwillingness to participate/medical condition/lack of understanding (T2=2; T3=104). Regardless the number of participants who attended to the assessment in each moment, informed previously, the final analytic sample included only participants who provided complete data at about PA the three time points, which consisted of 474 students, representing a 56.9% of the initial sample. There were no significant differences between those who remained in the study and those who dropped out in baseline total physical activity (TPA) levels (T1-T2: p=.39; T1-T2-T3: p=.18). All details about recruitment, presentation of the study, data collection and other procedure details could be found in Sanchez-Carracedo et al. (2016). The study was conducted according to the Declaration of Helsinki and all procedures were approved by the Animal and Human Experimentation Ethics Committee of the Universitat Autònoma de Barcelona and the Clinical Research Ethics Committee of the Parc Tauli Health Corporation. Parental consent and participant assent were obtained. The confidentiality of participating adolescents was protected with coded data, and the data processing was anonymous.

Participants completed a paper and pencil booklet with a battery of validated questionnaires that included among others, measures on physical activity and sociodemographic variables (age, gender, parental education and employment, parental origin). The booklet was completed individually during regular class time, whilst height and weight were taken by trained researchers following a standardized procedure, in a private room near the area of booklet administration (Sánchez-Carracedo et al., 2013).

Table 1.
Sample characteristics at baseline by gender group

		Boys (N=427)	Girls (N= 406)	*p*
Age M (SD)		13.99 (0.6)	13.87 (0.5)	**0.04**
Origin n (%)				
	Spanish/European	315 (74.5)	275 (67.7)	**0.05**
	Other Ethnicity	108 (25.5)	131 (32.3)	

		Boys (N=427)	Girls (N= 406)	*p*
SES n (%)				0.57
	Low	41 (9.7)	50 (12.3)	
	Medium-low	163 (38.6)	148 (36,5)	
	Medium-low	105 (24.9)	110 (27.2)	
	Medium-high	72 (17.1)	61 (15.1)	
	High	41 (9.7)	35 (8.7)	
Weight Status n (%)				**0.01**
	Underweight	18 (4.2)	5 (1.2)	
	Normal weight	270 (63.5)	281 (69.2)	
	Overweight/Obese	137 (32.2)	120 (29.6)	
TPA M (SD)		8.28 (5.0)	6.85 (4.6)	0.14
MVPA M (SD)		5.71 (3.7)	4.14 (3.3)	**0.01**
LPA M (SD)		2.56 (2.6)	2.72 (2.4)	0.09

Note: SES= Socio-economic status; TPA=total physical activity; MVPA=moderate-vigorous physical activity; LPA= light physical activity
p-values in bold indicate significant gender differences

Measures

Physical activity. Based on a version of the Leisure Time Exercise Questionnaire adapted by Neumark-Sztainer et al., (Neumark-Sztainer, Goeden, Story and Wall, 2004), three questions assessed hours spent in light (little effort), moderate (not exhausting) and vigorous (heart beats rapidly) physical activity behaviors in a usual week. Each type of activity was exemplified with a list of activities to aid comprehension. Responses were on a scale ranging from "0 hours to 7 or more hours", and later recoded for analyses following Neumark-Sztainer et al's (Neumark-Sztainer et al., 2004). For each subject the '*Total Physical Activity" (TPA)* was generated as an aggregate of the three individual measures. In addition, a *MVPA* score was generated as the sum of moderate and vigorous items, and a "*Light Physical activity" (LPA)* score considering simply that response. In addition, we computed a dichotomic variable to calculate the percentage of adolescents meeting the CDC recommendation for adolescents. Those reporting at least 7 hours per week of MVPA were classified as meeting the CDC recommendation. The internal consistency was adequate in the sample of the study (?=.82) and average inter-item correlation was =.6.

Socio-demographic variables. Adolescents provided information regarding age, parental origin, parental education and employment. An index of socio-economic status was derived following Hollingshead index (1975), which combines parental education and employment. Regarding their parental origin, due to small numbers in certain origins, responses were categorized in Spanish/ European background vs other.

Body Mass Index (BMI). Researchers measured participant's body weight in light clothing and no shoes to the nearest 0.1 kg using digital scales (SECA- model 872; 0-200 kg; accuracy range .1 kg; precision ± 0.15%), and height to the nearest 0.1 cm with a wall-mounted stadiometer (Seca-model 214; 20-207cm; accuracy range of 0.1 cm). Weight values were later corrected by subtracting 0.9 kg from the boys and 0.7 kg from the girls, which are average values estimated after weighing several sets of clothes similar to those worn at the time of assessment. BMI z-scores accounting for age and gender were calculated with the WHO growth reference data for 5-19 years old (De Onis, Onyango, Borghi, Siyam and Siekmann, 2007), and later on classified into underweight, normal weight, overweight or obese following the WHO criteria. For analyses, we collapsed the overweight and obese categories.

Statistical analyses

Changes in physical activity levels in adolescence may differ by gender, age, weight, and it has been suggested that youth form lower SES and minorities have fewer opportunities to engage in PA (Gonzalo-Almorox and Urbanos-Garrido, 2016; Owen et al., 2009). Analyses controlled for these factors as they may play a role in explaining different patterns in PA. All analyses were performed with STATA13 (StataCorp.2013, 2013) with alpha set at ≤ .05. Quantitative variables were expressed as means and standard deviations, and categorical variables as frequencies (percentages); we

used chi-square and t-test statistics to determine statistical differences by gender. Multiple comparisons between weight status groups were conducted to check for statically significant differences in levels of PA. We ran linear mixed-models effects (LME) accounting for the clustering of participants within schools. To test for changes over time in physical activity levels, controlling for covariates, we ran a model with TPA score, and then repeated them separating MVPA from LPA as we wanted to investigate potential differences in changes across time in intensities of PA. We further explored differences in changes over time in PA (TPA, MVPA and LPA) across weight status categories. When testing changes over time, the reference category for the variable of interest was always T1. We stratified all analyses a priori, and present gender specific estimates for all analyses given the differences between boys and girls reported in the literature on PA levels.

Results

Mean number of TPA, MVPA, LPA hours per week and percentage of adolescents meeting the CDC recommendation at baseline and at the two follow-ups are depicted on Table 2. At all time-points, boys engaged in significantly greater amounts of MVPA compared to girls (all p <0.001), and a higher proportion of males met the 60 minute MVPA recommendation (T1: $X^2_{(845)} = 16.95$, $p < .001$, T2: $X^2_{(702)} = 25.11$, $p < .001$; T3: $X^2_{(522)} = 16.69$, $p < .001$). Furthermore, TPA at T1 was associated with TPA at T2 (boys: $r = .39$, girls: $r = .58$, both $p < .001$) and at T3 (boys: $r = .35$, girls: $r = .43$, both $p < .001$) in both genders. Across all time points, boys engaged in significantly greater amounts of MVPA and intense PA than girls (all $p < .001$), but there were non-significant differences between genders for the other intensity levels (see Table1). Exploring differences by weight, we observed in boys, statistically significant differences in TPA ($F_{(5, 254)} = 3.85$, $p < .05$) and MVPA ($F_{(5, 254)} = 5.68$, $p < .05$) at T3, with normal weight boys being significantly more active than boys in the overweight/obese category. For girls, we observed a significant difference in TPA at T3 ($F_{(5,257)} = 4.79$, $p < .05$) with normal weight girls being more active than underweight girls.

Table 2.
Mean (SD) number of MVPA hours per week and proportion of adolescents meeting the CDC PA recommendation at three time points

	Males			Females			TOTAL	
	N	Mean Hours	% meet CDC recommendation	N	Mean	% meet CDC recommendation	Mean Hours	% meet CDC recommendation
T1 MVPA	427	5.71 (3.7)	28.1	406	4.14 (3.2)†	16.3‡	4.95 (3.6)	22.2
T2 MVPA	364	6.39 (3.5)	37.4	337	4.91 (3.3)†	20.2‡	5.68 (3.5)	28.8
T3 MVPA	261	6.73 (3.8)	37.5	259	4.84 (3.3)†	21.2‡	5.79 (3.7)	29.4

T1= Time 1; T2=time 2; T3= time 3.; MVPA= moderate-vigorous physical activity
†Gender difference in mean number of MVPA hours per week is significant at p<0.001
‡Gender difference in the proportion meeting the CDC MVPA recommendation is significant at p<0.001

First objective: Comparison of changes overtime in TPA, MVPA and LPA

Mean number of hours and changes over time in TPA, MVPA and LPA levels and controlling for age, origin, weight status and SES at baseline are illustrated in Table 3. For boys, in terms of TPA, we found statistically non-significant changes over time. Separating MVPA from LPA, we observed statistically non- significant changes in MVPA across time, but a significant increase in LPA from T1 to T2 and T3. There were no statistically significant effects of SES, origin, weight status or age for boys in any of the three models ran (i.e., TPA, MVPA, LPA). For girls, in terms of TPA levels, we observed a significant increase from T1 to T2. Discriminating between MVPA and LPA, we observed only a statistically significant increase from T1 to T2 in MVPA. There were no statistically significant effects of SES, origin, or age for girls in any of the three models ran (i.e., TPA, MVPA, LPA).

Table 3.
Changes in TPA. MVPA and LPA across time by gender group

	MALES							FEMALES						
	M (SD)	**B**	**SE**	**z**	***p***	**95% CI**		**M (SD)**	**B**	**SE**	**z**	***p***	**95% CI**	
	TPA													
T1	8.28 (5.0)	-	-	-	-	-	-	6.85 (3.3)	-	-	-	-	-	-
T2	9.73 (4.9)	1.57	1.04	1.51	0.13	-0.47	3.61	8.64 (3.3)	1.46	0.57	2.57	**0.01**	0.35	2.58
T3	10.12 (5.2)	2.26	1.76	1.28	0.20	-1.19	5.71	8.38 (3.4)	1.03	1.08	0.95	0.34	-1.09	3.15
	MVPA													
T1	5.71 (3.7)	-	-	-	-	-	-	4.14 (4.6)	-	-	-	-	-	-
T2	6.39 (3.5)	0.37	0.71	0.52	0.60	-1.02	1.76	4.91 (4.5)	0.81	0.35	2.34	**0.02**	0.13	1.49
T3	6.73 (3.8)	0.38	1.08	0.35	0.73	-1.73	2.48	4.84 (4.6)	0.76	0.80	0.95	0.34	-0.81	2.33
	LPA													
T1	2.56 (2.6)	-	-	-	-	-	-	2.71 (2.4)	-	-	-	-	-	-
T2	3.36 (2.6)	1.16	0.43	2.67	**0.01**	0.31	2.01	3.72 (2.5)	0.63	0.47	1.35	0.18	-0.29	1.55
T3	3.39 (2.7)	1.79	0.87	2.05	**0.04**	0.08	3.50	3.54 (2.5)	0.22	0.79	0.28	0.78	-1.33	1.76

Note: TPA=total physical activity; MVPA=moderate-vigorous physical activity; LPA=light physical activity. T1= Time 1; T2=time 2; T3= time 3. Model adjusted for socioeconomic status. origin. age and weight status. The reference category is Time 1. p- values in bold indicate significant gender differences. Mean and SD are unadjusted raw scores; SE= Standard error of B; 95%CI= 95% Confidence Interval

Second objective

Exploring changes in intensity of physical activity over time by weight status and gender are illustrated in Table 4. We observed that, for normal weight boys and girls no changes over time in TPA were observed in this weight status category in any gender group. Looking at the intensity level, though, we observed a gradual and statistically significant increase in LPA from T1 to T2 and T3 for normal weight boys, but no statistically significant changes were observed in normal-weight girls. Within the underweight category, we observed statistically significant decrements in TPA for boys and girls. Looking into the intensity levels, we observed only in girls, a significant drop in MVPA from T1 to T2 and T3 and a more gentle decrease in LPA from T1 to T3. Within the overweight/obese category, we observed in boys, statistically significant increases in LPA from T1-T2 and T3. For overweight/obese girls we observed significant increases in TPA and MVPA fromT1-T2 and T3.

Table 4.
Changes overtime in TPA, MVPA, LPA by gender and weight status

		Males																					
		TPA							MVPA							LPA							
		M(SD)	**B**	**SE**	**z**	***p***	**95% CI**		M(SD)	**B**	**SE**	**z**	***p***	**95% CI**		M (SD)	**B**	**SE**	**z**	***p***	**95%CI**	
Under weight	T1	8.82(5.3)	-	-	-	-	-	-	6.02(4.2)	-	-	-	-	-	-	2.79(3.1)	-	-	-	-	-	-
	T2	7.61(4.5)	9.00	4.51	2.00	**0.05**	0.16	17.83	4.27(2.4)	3.78	3.07	1.23	0.22	-2.24	9.79	3.33(2.9)	5.22	3.17	1.65	0.10	-1.00	11.44
	T3	8.77(7.0)	9.91	7.88	1.26	0.21	-5.52	25.35	6.07(4.9)	1.84	5.25	0.35	0.73	-8.46	12.13	2.7 (2.6)	8.08	5.73	1.41	0.16	-3.15	19.30
Normal weight	T1	8.34(5.2)	-	-	-	-	-	-	5.87(3.8)	-	-	-	-	-	-	2.46(2.6)	-	-	-	-	-	-
	T2	10.02(5.1)	1.67	1.15	1.45	0.15	-0.58	3.92	6.69(3.6)	0.73	0.84	0.87	0.38	-0.92	2.39	3.33(2.6)	0.94	0.44	2.11	**0.04**	0.07	1.81
	T3	10.77(5.3)	2.73	1.72	1.59	0.11	-0.63	6.10	7.29(3.9)	1.16	1.23	0.95	0.34	-1.24	3.57	3.48(2.7)	1.57	0.81	1.94	**0.05**	-0.02	3.16
Overweight/ Obese	T1	8.10 (4.6)	-	-	-	-	-	-	5.39(3.4)	-	-	-	-	-	-	2.71(2.6)	-	-	-	-	-	-
	T2	9.48 (4.5)	1.57	1.59	0.99	0.32	-1.55	4.70	6.07(3.2)	-0.11	1.48	-0.08	0.94	-3.01	2.79	3.45(2.6)	1.73	0.26	6.62	**0.001**	1.22	2.24
	T3	9.02 (4.3)	1.23	2.94	0.42	0.68	-4.54	6.99	5.67(3.2)	-0.94	2.40	-0.39	0.70	-5.64	3.77	3.36(2.7)	2.24	0.84	2.65	**0.01**	0.58	3.89
		Females																					
		TPA							MVPA							LPA							
		M (SD)	**B**	**SE**	**z**	***p***	**95% CI**		M (SD)	**B**	**SE**	**z**	***p***	**95% CI**		M(SD)		**SE**	**z**	***p***	**95%CI**	
Under weight	T1	5.2(4.7)	-	-	-	-	-	-	3.02(1.9)	-	-	-	-	-	-	2.18(3.3)	-	-	-	-	-	-
	T2	5.0(1.6)	-11.09	1.31	-8.44	**0.001**	-13.66	-8.52	3.20(1.6)	-5.60	2.45	-2.28	**0.02**	-10.41	-0.79	1.80(1.0)	-5.49	3.52	-1.56	0.12	-12.39	1.40
	T3	3.5(2.1)	-20.27	2.16	-9.38	**0.001**	-24.51	-16.04	1.45(0.2)	-12.19	2.83	-4.31	**0.001**	-17.73	-6.65	2.05(2.2)	-8.08	3.47	-2.33	**0.02**	-14.88	-1.28
Normal weight	T1	6.94(4.6)	-	-	-	-	-	-	4.28(3.4)	-	-	-	-	-	-	2.66(2.4)	-	-	-	-	-	-
	T2	8.93(4.4)	0.58	0.99	0.59	0.56	-1.37	2.53	5.10(3.4)	0.07	0.73	0.10	0.92	-1.35	1.49	3.83(2.4)	0.50	0.48	1.05	0.30	-0.44	1.43
	T3	8.87(4.6)	-1.05	1.85	-0.57	0.57	-4.67	2.58	5.17(3.4)	-0.86	1.48	-0.58	0.56	-3.77	2.04	3.70(2.5)	-0.25	0.91	-0.27	0.79	-2.03	1.54
Overweight/ Obese	T1	6.70(4.7)	-	-	-	-	-	-	3.86(3.1)	-	-	-	-	-	-	2.83(2.5)	-	-	-	-	-	-
	T2	8.06(4.6)	3.98	0.75	5.28	**0.001**	2.50	5.46	4.52(3.2)	2.80	0.67	4.16	**0.001**	1.48	4.12	3.52(2.7)	1.14	0.75	1.52	0.13	-0.33	2.61
	T3	7.56 (4.4)	6.52	1.18	5.53	**0.001**	4.21	8.84	4.30(3.2)	4.93	0.98	5.02	**0.001**	3.01	6.86	3.26(2.4	1.56	1.30	1.20	0.23	-0.98	4.10

TPA= total physical activity; MVPA= moderate-vigorous physical activity; LPA= light physical activity; T1= Time 1; T2=time 2; T3= time 3. The reference category is Time1. M= Mean number of hours; standard deviations (SD) in brackets. Mean and SD are unadjusted raw scores; SE= Standard error of B; 95%CI= 95% Confidence Interval. Significant p-values in bold. Models adjusted for age. origin, socio-economic status.

Discussion

Worldwide levels of MVPA among adolescents are typically much lower than recommended: as few as 20% of 13-15 years old globally appear to meet the MVPA recommendation (Hallal et al., 2012). At baseline, in our sample, we found similar percentages with only 22 % meeting the MVPA recommendation. This figure is similar to the latest Health Behaviour in School-aged Children (HBSC) study showing for Spain, that only 24% of children and adolescents (11-18 years) reach the recommended physical activity levels for health (according to the WHO recommendations) (World Health Organization, 2018). In line with worldwide estimates, we also found in our sample that the percentage of boys regularly engaging in physical activity is significantly higher that the percentage of girls. Interestingly, following our sample, we found that two years later, the percentage meeting the recommendation increased substantially to 29.4%. Although a significant increase, the prevalence of PA uptake in our sample and especially for girls is quite low and it highlights the need of interventions aimed at promoting PA for healthy benefits.

There is a common belief that there is a marked decline in MVPA during adolescence. One of the main goals of this study was to investigate whether we observed drops in PA levels in a sample of non-Anglo Saxon adolescents. In line with recent studies challenging the view of a marked decline in PA during adolescence, we found overall, no statistically significant drops from 13 to 15 years old. Even more, we found increments in LPA for boys, and in MVPA and TPA for girls from 13-15 years old. These results are in line with those reported for a sample of Finnish students for whom leisure physical activity slightly increased on average between 9 and 17 years-old, and was stable from 13 to 17 years-old (Pahkala et al., 2013). Likewise, a recent longitudinal study with measurements at 7, 9,12 and 15 years of age, found that for boys and girls, there were no initial high levels of total of physical activity followed by sharp drops during adolescence. In fact, drops were steadily from age 7, but between 12 and 15 years of age (which would be comparable to our sample), MVPA levels remained stable in both gender groups (Farooq et al., 2017). In sum, our study does not support the view that there is a marked decline during adolescence in physical activity in fact in our sample we observed increments.

There are several potential explanations for our findings. First, it has been argued that declines in PA may take place already between ages 7 and 9 years (Basterfield et al., 2011). Data on Spanish young people has indicated that the age at which physical activity begins to plateau or decrease may be around 11 years of age (Lasheras, Aznar, Merino and Eg, 2001). In this study, we take on board 13 years old adolescents, that have relatively low PA levels, and therefore there may be a floor effect (Reilly, 2016). Besides, there are also social and environmental explanations for these differences. For example, active travel to school or to non-school places can be substantial contributors to overall physical activity (Southward, Page, Wheeler, and Cooper, 2012). According to a report from the European Commission, the Spanish population tends to exercise on the way to-and-from work/school/shops (European Comission, 2010). This is in contrast to other samples from Anglo-Saxon cultures, where travelling is most often done with cars. In our sample we may not be observing drops, thanks to minutes of PA accumulated in this unstructured way. Another explanation is the weather conditions may contribute to more active lifestyle, for instance, it has been shown that PA levels tend to decrease during winter and when adverse weather conditions occur (e.g., snowfall) (Bélanger, Gray-Donald, O'Loughlin, Paradis, and Hanley, 2009). In Catalonia there is a gentle weather throughout the year that could work as motivator and not as barrier for outdoor activities. In any case, these are hypothetical explanations which should be confirmed with new studies.

Another goal of the study was to explore changes in physical activity intensities by gender and weight status. Results from our study confirm previous and consistent findings in the literature reporting differences in PA levels by gender. Overall we found that boys are more active than girls, and in line with previous studies, we found that boys engaged in significant greater amounts of MVPA (Martínez-Gómez et al., 2009; Nader, Bradley, Houts, Mcritchie, and Brien, 2008) interestingly, when we explored changes in intensity of PA from 13 to 15 years of age, in our sample, we observed that girls, on average, increased their levels of MVPA whereas boys increased their levels of LPA. We could hypothesize that this may be an effect of ceiling effects, whereas we observe changes were there is room to be observed. Literature is scarce and it highlights the need for future research on this topic given the importance of the intensity and not only the amount of PA.

Overweight/obese youth have frequently been reported to be less active than normal weight adolescents (Raudsepp and Viira, 2008). In our sample there was no conclusive evidence that overweight/obese adolescents were less active than their normalweight counterparts. Nevertheless, we wondered if throughout adolescence there would be changes in the frequency and intensity of PA. We observed in overweight/obese boys, increments in LPA whereas in overweight/obese girls, we observed increments in MVPA and TPA. We did not ask participants for their reasons for engaging in PA, therefore we can only hypothesize that a degree of body dissatisfaction, which is quite common in adolescence, may be a reason to increase their physical activity to lose weight/ shape-up their body (McCabe, Ricciardelli, and Banfield, 2001; McCabe and Ricciardelli, 2003). Nonetheless, it is important to highlight that for this age group, body dissatisfaction it is not an efficient motivator to lose weight nor to increase physical activity (Añez et al., 2016). Another explanation for our finding may reflect adherence to medical recommendations among other reasons. To our knowledge studies researching these issues are scarce and more research certainly is needed.

This study has strengths and limitations. One of the main limitations is related to the self-reported measure used to assess PA levels. Social desirability and self-report bias, whereby participants possibly over/underreported their amount of physical activity are potential limitations. The use of more objective measures as accelerometers for assessing PA would have been preferred, but it was not feasible in our sample. As it has been explained, data of the present study was drawn from the assessments of the control group of the MABIC project, a school-based study on the prevention of eating and weight- related problems, which was followed by a longitudinal study on risk factors to these problems. The assessment consisted in a wide group of questions included in a survey and a group of questionnaires, and it was not feasible to introduce objective measures of PA. This type of extensive inventories have been also used in other longitudinal studies on risk factors in this field, as the project EAT (Neumark-Sztainer, Wall, Chen, Larson, Christoph, Sherwood, 2018), which used the same measure of PA as in our study. To limit social desirability, researchers emphasized participants that there was no right or wrong answers. In addition, it is important to point out that the questions used in the present study to assess PA duration and intensity, have been shown to be reliable in the adult population (Jacobs, Ainsworth, Hartman, and Leon, 1993). Another possible bias of self-reported PA assessment used, is that assessment of PA levels at baseline could have influenced the motivation for engaging in later PA activities. Therefore, these results should be taken with caution, and data should be replicated using more objective measures. As with many longitudinal studies, we lost participants during follow-ups, particularly in the second year. We compared PA levels at baseline between those who provided data at all three times, against those who did not, and we found no statistically significant differences. However, due to reduction in sample size, the final results should be taken with caution. Although, a longitudinal study which crossed over childhood and adolescence would have been preferable, it is worth highlighting that this it is one of the few studies from a non-Anglo-Saxon culture and that includes more than the standard two-time points common in the literature to date. There are further strengths to the study. Cluster by school was taken into account; weight status was determined from objective measure; we surveyed a large Spanish sample, it is one of the first studies investigating changes in intensity of PA through early adolescence, and in addition, that it has looked at these issues by weight status.

In conclusion, the present study investigated in a less researched sample of non-Anglo- Saxon adolescents two main areas. On one hand, it aimed to investigate the well-established idea that there are marked declines in physical activity during this period of life. Interestingly and in line with more recent studies, it was found that during early adolescence there are no big drops, but that in reality it remains rather constant and even it can increase slightly. Nonetheless, the findings of this study along with others, highlight that only a very small percentage of young adolescents meet the CDC PA recommendation and that interventions to increase participation are needed. The second area of research of this study focused in a less researched question: if there are changes in the amount of PA during early adolescence, are these different across different intensities? It was very interesting to find that when we analyzed total physical activity no changes were observed in boys but when we discriminated between two levels of intensity, MVPA vs LPA, there were significant increments in LPA. Likewise for girls, we observed increments in TPA, but when discriminating it was MVPA the type of physical activity driving the increment. This information is valuable for future interventions: understanding which kind of intensities need to be targeted more heavily and/or which ones may be easier to invite adolescents to practice. Finally, the study provided a rather novel approach to the study of the relationship between physical activity and weight status, by also analyzing if there were changes across time in young adolescence, and whether there would be differences in the type of PA. Certainly, more studies in this area are warranted to further shed light on these differences.

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Estudio longitudinal de la actividad física en adolescentes españoles: diferencias por estatus de peso y género

Resumen

Investigaciones anteriores indican que hay marcadas disminuciones en la actividad física (AF) durante la adolescencia. Estudios más recientes ofrecen nuevos conocimientos. Este estudio longitudinal investiga los cambios en las intensidades de la AF (moderada a vigorosa versus ligera), por género y estatus de peso, en una muestra de adolescentes españoles. Los estudiantes, que en la línea base tenían un promedio de 13.9 años de edad (N = 833 al inicio), fueron seguidos uno y dos años más tarde (N = 474 proporcionaron datos en las tres mediciones de tiempo). La AF fue auto-informada. Los análisis revelaron que la prevalencia de AF es baja, aunque, a lo largo del tiempo, se observaron incrementos leves. Las niñas mostraron incrementos más altos en la actividad física moderada a vigorosa (AFMV); los niños mostraron mayores incrementos en la actividad física leve (AFL). Investigando por estatus de peso, los niños de peso normal mostraron incrementos a lo largo del tiempo en AFL; No se observaron cambios en las niñas de peso normal. Las niñas con sobrepeso/obesidad aumentaron su AF total (AFT) y AFMV; Los niños con sobrepeso / obesidad aumentaron su AFL. Los niños y niñas con bajo peso disminuyeron su AFL. Las

intervenciones dirigidas a intensidades específicas de AF pueden ser beneficiosas para diferentes grupos según su género y estatus de peso.

Palabras clave: adolescentes; estado de peso; longitudinal; intensidad de actividad física

Estudo longitudinal da atividade física em adolescentes espanhóis: diferenças por status de peso e de gênero

Resumo

Pesquisas anteriores indicam que há declínios acentuados na atividade física (AF) durante a adolescência. Estudos recentes estão oferecendo novos conhecimentos. Este estudo longitudinal investiga mudanças nas intensidades de AF (moderada a vigorosa vs. leve), por sexo e status de peso, em uma amostra de adolescentes espanhóis. Os alunos, em média, 13,9 anos de idade (N = 833 no início do estudo), foram acompanhados por um ano e dois anos mais tarde (N = 474 dados fornecidos nos três pontos de tempo). A AF autorreferida foi registrada. Análises revelaram que a prevalência de AF é baixa, embora, horas extras, pequenos incrementos tenham sido observados. Meninas apresentaram maiores incrementos na atividade física moderada a vigorosa (AFMV); os meninos apresentaram maiores incrementos na atividade física leve (AFL). Investigando por peso-status, meninos com peso normal mostraram incrementos ao longo do tempo em AFL; nenhuma alteração observada para meninas com peso normal. Meninas com sobrepeso / obesidade aumentaram seu AF total (AFT) e AFMV; meninos com sobrepeso / obesos aumentaram seu AFL. Meninos e meninas com baixo peso diminuíram o AFT. Intervenções direcionadas a intensidades específicas de AF podem ser benéficas para diferentes grupos com base em seu gênero e status de peso.

Palavras-chave: adolescentes; peso-status; longitudinal; intensidade da atividade física

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