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Title page

Adolescents' physical activity trends over the years. A three-cohort study based on the Health Behaviour in School-aged Children (HBSC) Portuguese survey

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Abstract

Objective: Many young people do not practice enough physical activity (PA) to benefit their health. The study aimed to investigate the prevalence of PA and understand the trends between 2002 and 2010, using three-cohort of representative samples of Portuguese adolescents.

Design, setting and participants: Participants were 8483 adolescents (4067 boys, 4416 girls), that participated in the Health Behavior in School-aged Children Portuguese survey in 2002, 2006 and 2010.

Design, setting and participants: A questionnaire was used to collected data of physical activity. Analyses were run separately for boys and girls.

Results: For the boys, at the age of 15-17 they reported practicing 3.5±1.9 times a week in 2002, 3.9±1.9 in 2006 and 3.8±1.9 in 2010, with a significant increase from 2002 to 2006/2010 (p<0.05). PA practice during the last 7 days decreased from 4.2±2.1 to 3.9+.1.9 between 2002 and 2006 (p<0.001) and decreased 4.4±2.1 to 3.8±1.9 between 2006 and 2010 (p<0.001). Among girls, PA practices during the last 7 days declined significantly from 3.5±1.9 to 2.7±1.7 between 2002 and 2006 (p<0.001), and from 3.3±1.9 to 2.9±1.7 between 2006 and 2010 (p<0.001).

Conclusions: The study points to age as a factor related to diminished PA participation. The study also revealed that the prevalence of PA has decreased over the years for the same age groups.

Strengths and limitations of this study

– Data from a representative sample was collected from three different cohorts (2002, 2006 and 2010), using a standard protocol, which allows for comparisons and for

understanding of the differences of PA over the years in two different age groups of boys and girls.

– Measurements of PA were based on self-report. Self-report generally has limited reliability and validity. So, the use of accurate objective measures is preferable, but it is not often feasible in epidemiological studies with large samples.

– Boys and girls do not practice enough physical activity to meet the recommended levels of 60 minutes in moderate to vigorous intensity on all or most days of the week. From a public health perspective there is a need to augment the time spent on physical activity.

– Soccer is the most practiced sports activity among boys and older girls. Thus, when considering an intervention aimed to increase PA, soccer should be considered as an activity that attracts adolescents.

INTRODUCTION

Young people's participation in physical activity (PA) is associated with health benefits, specifically improved bone mineral density, aerobic fitness, muscular strength, endurance, cardiovascular risk factor and mental health.[1] There is also a negative relationship between PA and careless nutrition, overweight and obesity among young people.[2, 3] Additionally, PA incorporated as a personal habit at a young age may persist into adulthood.[4] Thus, current guidelines from the World Health Organization (WHO) recommend that young people should engage in at least 60 minutes of PA in moderate to vigorous (MVPA) intensity on all or most days of the week.[5]

In spite of the health benefits, data suggests that many young people are not engaging in PA of sufficient length and intensity to benefit their health.[6, 7] The Portuguese figures are quite dramatic, revealing that only 36% of children aged 10-11 and 4% of adolescents aged 16-17 were considered sufficiently active.[8] Besides the lower levels of PA, the prevalence of active children and adolescents tended to decrease with age, particularly among girls.

In order to intervene and reverse this situation, it is important to understand the trends of PA over the years as well as the PA practices of adolescents. Nevertheless, most studies are cross sectional[8, 9] and results can only be interpreted in the light of the period in which they were collected. Since little is known about the PA practices of adolescents and how they have evolved over the years, studies that allow researchers to compare patterns and practices of PA are needed. Therefore, the present study, using three-cohort of representative samples of Portuguese adolescents, aimed to investigate the prevalence of PA among Portuguese adolescents and understand how it has changed between 2002 and 2010.

METHODS

Participants

A proportionate nationally representative sample of 8485 adolescents (4067 boys, 4416 girls), randomly selected from grades 6 and 10 participated in the Health Behaviour in School-aged Children (HBSC) Portuguese survey in 2002 (n=3023), 2006 (n=2556), and 2010 (n=2904).[10-12] HBSC Portugal is one of 43 countries and regions across Europe and North America that make up the HBSC Network. HBSC collects data every four years on children's and adolescent's health and well-being, social environments and health behaviors. Data is used at a national and international level to add new vision into young people's health and well-being, understand the social and psychological determinants of health, and incorporate policies to improve young people's lives. The methodological aspects of the HBSC study are well developed and published internationally.[13] The study received approval from the Ethical Committee of Lisbon Medical School and the Portuguese National Data Protection System. All school administrators gave their consent, legal guardians gave written informed consent, and students provided assent.

Measures

To assess PA, adolescents were provided with a common definition of PA,[14] and then were asked "How many days did you practice PA during the last 7 days?" Answers were given on an 8-point scale (1 = none to 8 = daily). Seven days of PA recall is shown to be reliable and valid for use in research on PA in adolescents.[15] Adolescents were also asked if they practiced regular PA during the last 6 months. Answers were yes (≥ 3 times a weeks) or no (<3 times a week). The item has a high reliability, with intraclass correlation coefficients (one-week interval) of 0.95. Adolescents were then asked about the sports activity they usually practiced in organized or non-organized contexts.

Procedures

Questionnaires were administered in schools in January 2002, 2006 and 2010, and were answered anonymously. Participation in the study was voluntary. The administration of the surveys was conducted according to standard guidelines from the HBSC survey protocol[13] and it was carried out by trained school teachers during class time.

Analysis

Adolescents were grouped into two age groups (11-13 and 15-17). Descriptive statistics were calculated for all variables (means, standard deviation and percentages) for the entire sample and according to HBSC survey years (2002, 2006, and 2010), age group, and sex. ANOVA and chi-square were used to assess the differences among HBSC survey years in each age group. Independent t-tests and chi-square were used to compare adolescents from different cohorts. All statistical analyses were performed using IBM SPSS Statistics 20.0. The level of significance was set at 0.05.

RESULTS

Sample characteristics and displayed in table 1.

Table 1. Characteristics of participants.

	Total		Cohorts					
			2002		2006		2010	
	n	%	n	%	n	%	n	%
Sex								
Boys	4067	47.9	1466	48.5	1261	49.3	1340	46.1
Girls	4416	52.1	1557	51.5	1298	50.7	1564	53.9
Age								
11-13	4266	50.3	1746	57.8	1275	49.8	1245	42.9
15-17	4220	49.7	1277	42.2	1284	50.2	1659	57.1
School grade								
Sixth grade	4348	51.2	1809	59.8	1275	49.8	1264	43.5
Tenth grade	4138	48.8	1214	40.2	1284	50.2	1640	56.5

Descriptive statistics and the differences among HBSC survey years for each age group and sex are presented in table 2.

For the boys aged 11-13, the number of times they reported practicing PA during the last 7 days was between 4.2±2.1 to 4.4±2.1 times. At the age of 15-17 they reported practicing 3.5±1.9 times a week in 2002, 3.9±1.9 in 2006 and 3.8±1.9 in 2010, with a significant increase from 2002 to 2006/2010 ($p<0.05$). In both age groups the prevalence of PA over the last 6 months decreased slightly between 2006 and 2010, but decreased significantly between 2006 and 2010 ($p<0.05$ and $p<0.01$). Soccer was the most practiced sports activity, but over the years there was a significant decline in the number of participants ($p<0.001$ for both age-groups). On the other hand, gymnastics participation decreased from 2002 to 2006 and then increased from 2006 to 2010, reaching the higher value in 2010 for the ages of 11-13 ($p<0.05$) and 15-17 years ($p<0.05$). The type of PA practiced changed over the years for the younger participants, decreasing the number of team sports participants and increasing participation in individual sports ($p<0.01$). Boys, younger and older, preferred team sports activities more than individual activities. However, over the years, young boys participation in team sports decreased progressively from 2002 to 2010 ($p<0.01$).

Girls reported practicing PA between 3.3±1.9 to 3.5±1.9 at the age of 11-13, and 2.7±1.9 to 2.9±1.7 at the age of 15-17. Soccer, gymnastics, and swimming were the most popular sports activities. Over the years, the number of soccer practitioners significantly decreased among younger girls ($p<0.001$). For the older girls, the number of participants decreased significantly from 2002 to 2006 and then increased significantly from 2006 to 2010 ($p<0.001$). In respect to gymnastics, the number of participants decreased significantly from 2002 to 2006/2010 for both younger ($p<0.01$) and older girls ($p<0.01$). The number of older girls that practiced volleyball was inconsistent, decreasing significantly from 2002 to 2006 and increasing significantly again from 2006 to 2010 ($p<0.05$). Girls aged 11-13, preferred individual sports activities rather than team sports activities over the years ($p<0.05$). On the

other hand, among older girls, participants in individual sports activities decreased significantly from 2006 to 2010 ($p<0.01$).

Table 2. Boys' and girls' physical activity participation in 2002, 2006 and 2010, according age group.

	11-13 years				15-17 years			
Boys	**2002 (n=865)**	**2006 (n=686)**	**2010 (n=625)**	***p***	**2002 (n=601)**	**2006 (n=575)**	**2010 (n=715)**	***p***
PA in the last 7 days (M±SD) [1]	4.2±2.1	4.4±2.1	4.3±2.1	0.243	3.5±1.9	3.9±1.9	3.8±1.9	0.019[a]
PA in the last 6 month (%) [2]				0.012				0.001
Did not practice PA	5.4	5.5	9.0		11.1	12.9	18.0	
Practiced PA	94.6	94.5	91.0		88.9	87.1	82.0	
Sports practiced (%) [2]								
Soccer	72.6	69.8	60.8	<0.001	57.1	50.1	44.3	<0.001
Basketball	22.1	26.4	22.4	0.102	16.6	12.7	13.7	0.130
Volleyball	8.6	12.4	10.6	0.089	9.2	7.8	8.1	0.683
Handball	9.7	11.8	11.2	0.388	8.3	7.1	7.0	0.619
Swimming	18.0	15.3	17.3	0.352	15.8	13.6	15.5	0.500
Athletics	12.7	13.8	13.1	0.806	8.2	7.7	9.2	0.575
Gymnastics	17.5	17.1	22.2	0.027	7.0	3.8	6.7	0.038
Cycling	22.7	24.2	21.4	0.490	18.5	16.7	14.7	0.181
Type of sport activity [2]				0.008				0.524
Individual	8.7	8.3	13.0		13.3	13.6	13.4	
Team	40.9	38.2	33.8		41.3	38.4	33.0	
Individual and collective	38.5	37.8	34.9		24.6	19.7	19.7	
Girls	**2002 (n=881)**	**2006 (n=589)**	**2010 (n=620)**	***p***	**2002 (n=676)**	**2006 (n=709)**	**2010 (n=944)**	***p***
PA in the last 7 days (M±SD) [1]	3.5±1.9	3.3±1.9	3.4±1.9	0.456	2.7±1.9	2.7±1.7	2.9±1.7	0.056
PA in the last 6 month (%)[2]				0.491				0.745
Did not practice PA	15.7	13.4	14.8		31.8	30.7	32.5	
Practiced PA	84.3	86.6	85.2		68.2	69.3	67.5	
Sports practiced (%)[2]								
Soccer	35.3	31.4	25.8	<0.001	15.7	9.7	16.7	<0.001
Basketball	17.8	16.6	18.7	0.640	9.3	7.2	9.6	0.189
Volleyball	14.0	11.0	10.3	0.069	13.6	9.7	14.5	0.012
Handball	6.1	6.3	8.4	0.191	2.7	3.8	5.8	0.006
Swim	25.0	21.2	21.0	0.112	13.5	14.8	13.9	0.757
Athletics	12.4	11.0	13.7	0.370	5.8	5.4	7.5	0.155
Gymnastics	36.1	28.4	29.4	0.002	15.4	10.4	9.5	0.001
Cycling	12.8	10.7	10.0	0.195	6.2	6.1	6.1	0.993
Type of sport activity [2]				0.015				0.002
Individual	28.0	26.8	28.4		21.2	21.6	16.3	
Team	17.0	21.1	14.7		19.2	13.7	18.8	
Individual and collective	30.0	23.2	25.0		11.4	8.5	12.0	

PA, physical activity
[1] Tested by ANOVA.
[2] Tested by Chi Square.
[a] Data from 2002 is statically different from 2006 and 2010. Tested by Tukey's HSD.

Table 3 presents PA information from 2 different cohorts, 4 years apart. Among boys, PA practices during the last 7 days decreased from 4.2±2.1 to 3.9+.1.9 between 2002 and 2006 (p<0.001) and decreased 4.4±2.1 to 3.8±1.9 between 2006 and 2010 (p<0.001). The prevalence of PA practiced over the last 6 month also declined significantly in both cohorts (p<0.001). Looking at the different sports activities, the number of practitioners decreased over the years in almost all activities. It is noteworthy that only volleyball from 2002 to 2006 and swimming from 2006 to 2010 remained relatively stable. In both cohorts, as age increased the number of participants of team sports activities declined, and, in contrast, participants of individual activities significantly increased (p<0.001).

Among girls, PA practices during the last 7 days declined significantly from 3.5±1.9 to 2.7±1.7 between 2002 and 2006 (p<0.001), and from 3.3±1.9 to 2.9±1.7 between 2006 and 2010 (p<0.001). Similar to what was observed among boys, the prevalence of PA over the last 6 months decreased in both cohorts (p<0.001). The practice of PA decreased significantly in all sports activities from 2002 to 2006. Data from 2006 and 2010 shows that the practice of PA also declined, with the exception of handball which remained stable and volleyball which, in contrast to other sports, had a marginally significant increase (p=0.052). Girls team and individual sports participation decreased between 2002 and 2006 (p<0.001) and between 2006 and 2010 (p<0.01).

Table 3. Boys' and girls' physical activity participation over the years.

Boys	**2002 11-13 years (n=865)**	**2006 15-17 years (n=575)**	***p***	**2006 11-13 years (n=686)**	**2010 15-17 years (n=715)**	***p***
PA in the last 7 days (M±SD [1]	4.2±2.1	3.9±1.9	0.001	4.4±2.1	3.8±1.9	<0.001
PA in the last 6 month (%) [2]			<0.001			<0.001
Did not practice PA	5.4	12.6		5.5	18.0	
Practiced PA	94.6	87.4		94.5	82.0	
Sports practiced (%) [2]						
Soccer	72.6	51.1	<0.001	69.8	45.1	<0.001
Basketball	22.1	13.9	<0.001	26.4	14.0	<0.001
Volleyball	8.6	8.6	0.082	12.4	9.1	0.010
Handball	9.7	6.9	0.104	11.8	7.2	0.002

Swimming	18.0	13.6	0.029	15.3	15.2	0.941
Athletics	12.7	7.8	0.002	13.8	9.3	0.007
Gymnastics	17.5	4.7	<0.001	17.1	7.1	<0.001
Cycling	22.7	17.0	0.006	24.2	14.8	<0.001
Type of sport activity [2]			<0.001			<0.001
Individual	8.7	13.6		8.3	13.4	
Team	40.9	38.4		38.2	33.0	
Individual and collective	38.5	19.7		37.8	19.7	

Girls	**2002 11-13 years (n=881)**	**2006 15-17 years (n=709)**	***p***	**2006 11-13 years (n=589)**	**2010 15-17 years (n=944)**	***p***
PA in the last 7 days (M±SD) [1]	3.5±1.9	2.7±1.7	<0.001	3.3±1.9	2.9±1.7	<0.001
PA in the last 6 month (%) [2]			<0.001			<0.001
Did not practice PA	15.7	30.1		13.4	32.1	
Practiced PA	84.3	69.9		86.6	67.9	
Sports practiced (%) [2]						
Soccer	35.3	11.1	<0.001	31.4	16.6	<0.001
Basketball	17.8	7.5	<0.001	16.6	9.7	<0.001
Volleyball	14.0	10.0	0.011	11.0	14.5	0.052
Handball	6.1	3.7	0.039	6.3	5.9	0.741
Swimming	25.0	14.8	<0.001	21.2	13.7	<0.001
Athletics	12.4	5.2	<0.001	11.0	7.4	0.021
Gymnastics	36.1	11.1	<0.001	28.4	10.0	<0.001
Cycling	12.8	6.1	<0.001	10.7	6.1	0.002
Type of sport activity [2]			<0.001			0.004
Individual	28.0	21.6		26.8	16.3	
Team	17.0	13.7		21.1	18.8	
Individual and collective	30.0	8.5		23.2	12.0	

[1] Tested by t Test.
[2] Tested by Chi Square.

DISCUSSION

This is the first study among Portuguese adolescents to explore the PA practices of different cohorts, collecting data through the same standard protocol. The goal of the study was, using three-cohort of representative samples of Portuguese adolescents, to investigate the prevalence of PA among Portuguese adolescents, and understand how it changed between 2002 and 2010. Overall, the study points to age as a factor related to diminished PA participation. The study also revealed that the prevalence of PA has decreased over the years for the same age groups.

Younger and older adolescents reported practicing PA less than 7 times a week. Although it was not assessed the duration and intensity of PA, results indicated that adolescents do not get enough practiced to meet the recommended levels of 60 minutes of

moderate to vigorous PA each day.[5] This is in line with other recent studies among Portuguese people that described the prevalence of PA.[8, 9] Because our data is from different HBSC waves, it was possible to observe the evolution of PA in each age group over the 2002-2010 time frames. With the exception of boys aged 15-17, there were no significant changes over the years in regard to PA practiced during the last 7 days. Moreover, there was a decrease in the prevalence of PA over the last 6 months, especially among boys. These results can be interpreted in several different ways. First, strategies to increase the number of times that adolescents practice PA have not been successful. Second, adolescents and adults may not be aware of the recommended levels of PA for young people. Consequently they might assume that they are active enough and therefore may conclude that there is no need to be more physically active.[16] Third, schools, even though called to give greater attention to provision of PA for students,[17] seem to have failed at promoting PA. Results indicate that there has been no progress made toward attaining this goal.

Adolescent behavior, such as PA and inactivity over the years, is an issue rarely studied in Portugal. This type of study is important and should be of interest on a national and international level because it helps policy makers, educators and health professionals to understand young people's health in their social context and tracks changes as they develop over the years. Therefore, with data from successive surveys, trends can be identified making it possible to evaluate more accurately the impact of programs and strategies implemented in order to promote PA and reduce sedentary behavior among adolescents. While the HBSC conducts national[10-12] and international systematic surveys,[6, 13] in the United States of America, the Center for Disease Control and Prevention also conducts a periodic survey of adolescent health risk and health protective behaviors.[18] This shows the importance of studying and tracking adolescent behavior and allows cross-national comparisons.

The trend of PA declining with age was significant among boys and girls in the two different cohorts of adolescents (2002 to 2006 and 2006 to 2010). These results are similar to those found in others studies with adolescents from Portugal[19] and other countries.[6, 7] In Europe, the inverse relationship between PA and age is common in most countries.[6] Riddoch et al.[20], in what is considered the first study to objectively measure physical activity with a representative sample of European children, verified that 9 year old children were considerably more active than 15 year old adolescents, presenting similar results in all countries. Virtually all 9 year old children practiced the recommended amount of PA, or more than recommended, while only a small percentage of 15 year olds did so. This indicated that as age increased PA decreased.

The decline of PA with age has triggered much discussion in the scientific community. Sallis[21] analyzed various studies related to the decline of PA, and concluded that the ages between 13 and 18 are at risk. Having also observed the decline in animals, the author was lead to suppose that the decline had a biological origin. The consistency of the results of the Riddoch et al.[20] among adolescents from different countries is in some way congruent with Sallis'[21] assumptions, allowing one to conclude that children's and adolescents' PA is probably determined biologically. However, although the effect of age is significant on PA, it sometimes only explained 1% of the variability[22] which means that the decline in PA with age could be related to other factors such as the great academic pressure adolescents are under,[23] longer time in sedentary activities such as screen time [24], and having part-time jobs to earn some money.[25] Therefore, qualitative studies to understand clearly the reasons for the decrease in PA among adolescents are needed.

Soccer was the most practiced sports activity among boys and older girls over the years and at different ages. This is understandable since it is the most popular sports activity in Portugal and it is the activity with the most participants.[26, 27] Nevertheless, the number

of participants decreased over the years within both age-groups. As the number of participants in others sports activities did not increase significantly, this suggests that the decrease of soccer participants might be related to the prevalence of adolescents who did not practice PA over the last 6 month. This shows the importance of soccer as a sports activity among Portuguese adolescents. Thus, when considering an intervention aimed to increase PA, soccer should be considered as an activity that attracts adolescents.

The type of activity practiced by boys has the tendency to change over the years. While the number of team sports participants decreased between 11-13 and 15-17 years, participation in individual sports increased. On the other hand, for the girls, participation in both individual and team sports decreased with age. The reason for the choice of individual or team sports may be related to social factors, and some could argue that team sports would be better for the development of social skills. However, studies have shown that there is no difference in social self-esteem between participants in individual or team sports.[28, 29] For the older boys the increased participation in individual sports may be related to their level of autonomy.

The present study had some limitations. Measurements of PA were based on self-report. Self-report generally has limited reliability and validity.[30] So, the use of accurate objective measures is preferable, but it is not often feasible in epidemiological studies with large samples. Moreover, the intensity and duration of PA sessions were not measured. These evaluations would be useful in determining the prevalence of adolescents who attained recommended levels of PA.

There are also several strengths in the present study. First, data from a representative sample was collected. Second, data from three different cohorts was collected (2002, 2006 and 2010), using a standard protocol, which allows for comparisons and for understanding of the differences of PA over the years in two different age groups of boys and girls.

CONCLUSION

The prevalence of physical inactivity increased significantly among boys between ages 11-13 and 15-17, but not in girls. The number of times adolescents practiced PA during the last 7 days remained relatively stable, which means that the campaigns and attempts to increase PA among adolescents have not been very successful. With age, there was a significant decrease in most sports activities among boys and girls. This indicated that as adolescents are getting older they may have different interests leading some to stop practicing PA. These findings imply that it is important to more effectively promote PA among adolescents, using different strategies based on age and sex.

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Contributorship Statement

AM and MGM contributed in conception and design. MGM contributed in acquisition of the data. AM and MGM contributed in analysis and interpretation of the data. AM contributed to the drafting of the manuscript. AM and MGM contributed to the revisions of the manuscript and the interpretation of the findings.

Competing interests

The authors declare that they have no competing interests.

Data Sharing Statement

No additional data available.

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Research checklists

	Item No	Recommendation
Title and abstract	1	Indicate the study's design with a commonly used term in the title or the abstract. Provide in the abstract an informative and balanced summary of what was done and what was found.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported.
Objectives	3	State specific objectives.
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	Give the sources and methods of selection of participants.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers.
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement).
Bias	9	Describe any efforts to address potential sources of bias
Quantitative variables	10	Explain how quantitative variables were handled in the analyses.
Statistical methods	11	Describe all statistical methods
Results		
Participants	12	Report numbers of individuals at each stage of study.
Descriptive data	13	Give characteristics of study participants.
Outcome data	14	Report numbers of outcome events or summary measures over time
Main results	15	Give estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
Other analyses	16	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	17	Summarise key results with reference to study objectives.
Limitations	18	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.
Interpretation	19	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.
Generalisability	20	Discuss the generalisability of the study results.
Other information		
Funding	21	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

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Adolescents' physical activity trends over the years. A three-cohort study based on the Health Behaviour in School-aged Children (HBSC) Portuguese survey

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Title page

Adolescents' physical activity trends over the years. A three-cohort study based on the Health Behaviour in School-aged Children (HBSC) Portuguese survey

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Abstract

Objective: Many young people do not practice enough physical activity (PA) to benefit their health. The study aimed to investigate the prevalence of PA and understand the trends between 2002 and 2010, using three-cohort of representative samples of Portuguese adolescents.

Design, setting and participants: Participants were 8483 adolescents (4067 boys, 4416 girls), that participated in the Health Behavior in School-aged Children Portuguese survey in 2002, 2006 and 2010.

Design, setting and participants: A questionnaire was used to collected data of physical activity. Analyses were run separately for boys and girls.

Results: For the boys, at the age of 15-17 they reported practicing 3.5±1.9 times a week in 2002, 3.9±1.9 in 2006 and 3.8±1.9 in 2010, with a significant increase from 2002 to 2006/2010 (p<0.05). PA practice during the last 7 days decreased from 4.2±2.1 to 3.9+.1.9 between 2002 and 2006 (p<0.001) and decreased 4.4±2.1 to 3.8±1.9 between 2006 and 2010 (p<0.001). Among girls, PA practices during the last 7 days declined significantly from 3.5±1.9 to 2.7±1.7 between 2002 and 2006 (p<0.001), and from 3.3±1.9 to 2.9±1.7 between 2006 and 2010 (p<0.001).

Conclusions: The study points to age as a factor related to diminished PA participation. The study also revealed that the prevalence of PA has decreased over the years for the same age groups.

Strengths and limitations of this study

– Data from a representative sample was collected from three different cohorts (2002, 2006 and 2010), using a standard protocol, which allows for comparisons and for understanding of the differences of PA over the years in two different age groups of boys and girls.

– Measurements of PA were based on self-report. Self-report generally has limited reliability and validity. So, the use of accurate objective measures is preferable, but it is not often feasible in epidemiological studies with large samples.

– Boys and girls do not practice enough physical activity to meet the recommended levels of 60 minutes in moderate to vigorous intensity on all or most days of the week. From a public health perspective there is a need to augment the time spent on physical activity.

– Soccer is the most practiced sports activity among boys and older girls. Thus, when considering an intervention aimed to increase PA, soccer should be considered as an activity that attracts adolescents.

INTRODUCTION

Young people's participation in physical activity (PA) is associated with health benefits, specifically improved bone mineral density, aerobic fitness, muscular strength, endurance, cardiovascular risk factor and mental health.[1] There is also a negative relationship between PA and careless nutrition, overweight and obesity among young people.[2, 3] Additionally, PA incorporated as a personal habit at a young age may persist into adulthood.[4] Thus, current guidelines from the World Health Organization (WHO) recommend that young people should engage in at least 60 minutes of PA in moderate to vigorous (MVPA) intensity on all or most days of the week.[5]

In spite of the health benefits, data suggests that many young people are not engaging in PA of sufficient length and intensity to benefit their health.[6, 7] The Portuguese figures are quite dramatic, revealing that only 36% of children aged 10-11 and 4% of adolescents aged 16-17 were considered sufficiently active.[8] Besides the lower levels of PA, the prevalence of active children and adolescents tended to decrease with age, particularly among girls.

In order to intervene and reverse this situation, it is important to understand the trends of PA over the years as well as the PA practices of adolescents. Nonetheless, because most adolescents do not commute actively to school, do not spend much time on PA and spend excessive time in sedentary behaviours[9], it is important to highlight sport participation. Studies have shown that sport participation contributes to adolescent attained PA guidelines,[10] and there is evidence that adolescents who participated in sports are more persistent exercisers than non-participants[11]. Most studies related to PA and sports participation are cross sectional[8, 9, 12] and results can only be interpreted in the light of the period in which they were collected. Since little is known about the PA and sport participation of adolescents and how they have evolved over the years, studies that allow researchers to

compare patterns and practices of PA and sport participation are needed. Therefore, the present study, using three-cohort of representative samples of Portuguese adolescents, aimed to investigate the prevalence of PA and sport participation among Portuguese adolescents and understand how it has changed between 2002 and 2010.

METHODS

Participants

A proportionate nationally representative sample of 8483 adolescents (4067 boys, 4416 girls), randomly selected from grades 6 and 10 participated in the Health Behaviour in School-aged Children (HBSC) Portuguese survey in 2002 (n=3023), 2006 (n=2556), and 2010 (n=2904).[13-15] HBSC Portugal is one of 43 countries and regions across Europe and North America that make up the HBSC Network. HBSC collects data every four years on children's and adolescent's health and well-being, social environments and health behaviors. Data is used at a national and international level to add new vision into young people's health and well-being, understand the social and psychological determinants of health, and incorporate policies to improve young people's lives. The methodological aspects of the HBSC study are well developed and published internationally.[16] The study received approval from the Ethical Committee of Porto Medical School and the Portuguese National Data Protection System. All school administrators gave their consent, legal guardians gave written informed consent, and students provided assent.

Measures

For data collection was used a questionnaire that was designed by the international HBSC members and is described in detail elsewhere.[16, 17] To assess PA, adolescents were provided with a common definition of PA,[18] and then were asked "How many days did you practice PA during the last 7 days?" Answers were given on an 8-point scale (1 = none to 8 =

daily). Seven days of PA recall is shown to be reliable and valid for use in research on PA in adolescents.[19] Adolescents were also asked if they practiced regular PA during the last 6 months. Answers were yes (≥ 3 times a weeks) or no (<3 times a week). The item has a high reliability, with intraclass correlation coefficients (one-week interval) of 0.95. Adolescents were then asked about the sports activity they usually practiced in organized or non-organized contexts.

Procedures

Questionnaires were administered in schools in January 2002, 2006 and 2010, and were answered anonymously. Participation in the study was voluntary. The administration of the surveys was conducted according to standard guidelines from the HBSC survey protocol[16] and it was carried out by trained school teachers during class time.

Analysis

Adolescents were grouped into two age groups (11-13 and 15-17). Descriptive statistics were calculated for all variables (means, standard deviation and percentages) for the entire sample and according to HBSC survey years (2002, 2006, and 2010), age group, and sex. ANOVA and chi-square were used to assess the differences among HBSC survey years in each age group. Independent t-tests and chi-square were used to compare adolescents from different cohorts. All statistical analyses were performed using IBM SPSS Statistics 20.0. The level of significance was set at 0.05.

RESULTS

Sample characteristics and displayed in table 1.

Table 1. Characteristics of participants.

	Total	Cohorts		
		2002	2006	2010

	n	%	n	%	n	%	n	%
Sex								
Boys	4067	47.9	1466	48.5	1261	49.3	1340	46.1
Girls	4416	52.1	1557	51.5	1298	50.7	1561	53.9
Age								
11-13	4266	50.3	1746	57.8	1275	49.8	1245	42.9
15-17	4217	49.7	1277	42.2	1284	50.2	1656	57.1
School grade								
Sixth grade	4348	51.3	1809	59.8	1275	49.8	1264	43.5
Tenth grade	4135	48.7	1214	40.2	1284	50.2	1637	56.5

Descriptive statistics and the differences among HBSC survey years for each age group and sex are presented in table 2.

For the boys aged 11-13, the number of times they reported practicing PA during the last 7 days was between 4.2±2.1 to 4.4±2.1 times. At the age of 15-17 they reported practicing 3.5±1.9 times a week in 2002, 3.9±1.9 in 2006 and 3.8±1.9 in 2010, with a significant increase from 2002 to 2006/2010 ($p<0.05$). In both age groups the prevalence of PA over the last 6 months decreased slightly between 2006 and 2010, but decreased significantly between 2006 and 2010 ($p<0.05$ and $p<0.01$). Soccer was the most practiced sports activity, but over the years there was a significant decline in the number of participants ($p<0.001$ for both age-groups). On the other hand, gymnastics participation decreased from 2002 to 2006 and then increased from 2006 to 2010, reaching the higher value in 2010 for the ages of 11-13 ($p<0.05$) and 15-17 years ($p<0.05$). The type of PA practiced changed over the years for the younger participants, decreasing the number of team sports participants and increasing participation in individual sports ($p<0.01$). Boys, younger and older, preferred team sports activities more than individual activities. However, over the years, young boys participation in team sports decreased progressively from 2002 to 2010 ($p<0.01$).

Girls reported practicing PA between 3.3±1.9 to 3.5±1.9 at the age of 11-13, and 2.7±1.9 to 2.9±1.7 at the age of 15-17. Soccer, gymnastics, and swimming were the most popular sports activities. Over the years, the number of soccer practitioners significantly decreased among younger girls ($p<0.001$). For the older girls, the number of participants

decreased significantly from 2002 to 2006 and then increased significantly from 2006 to 2010 (p<0.001). In respect to gymnastics, the number of participants decreased significantly from 2002 to 2006/2010 for both younger (p<0.01) and older girls (p<0.01). The number of older girls that practiced volleyball was inconsistent, decreasing significantly from 2002 to 2006 and increasing significantly again from 2006 to 2010 (p<0.05). Girls aged 11-13, preferred individual sports activities rather than team sports activities over the years (p<0.05). On the other hand, among older girls, participants in individual sports activities decreased significantly from 2006 to 2010 (p<0.01).

Table 2. Boys' and girls' physical activity participation in 2002, 2006 and 2010, according age group.

	11-13 years				15-17 years			
Boys	**2002 (n=865)**	**2006 (n=686)**	**2010 (n=625)**	***p***	**2002 (n=601)**	**2006 (n=575)**	**2010 (n=715)**	***p***
PA in the last 7 days (M±SD) [1]	4.2±2.1	4.4±2.1	4.3±2.1	0.243	3.5±1.9	3.9±1.9	3.8±1.9	0.019[a]
PA in the last 6 month (%) [2]				0.012				0.001
Did not practice PA	5.4	5.5	9.0		11.1	12.9	18.0	
Practiced PA	94.6	94.5	91.0		88.9	87.1	82.0	
Sports practiced (%) [2]								
Soccer	72.6	69.8	60.8	<0.001	57.1	50.1	44.3	<0.001
Basketball	22.1	26.4	22.4	0.102	16.6	12.7	13.7	0.130
Volleyball	8.6	12.4	10.6	0.089	9.2	7.8	8.1	0.683
Handball	9.7	11.8	11.2	0.388	8.3	7.1	7.0	0.619
Swimming	18.0	15.3	17.3	0.352	15.8	13.6	15.5	0.500
Athletics	12.7	13.8	13.1	0.806	8.2	7.7	9.2	0.575
Gymnastics	17.5	17.1	22.2	0.027	7.0	3.8	6.7	0.038
Cycling	22.7	24.2	21.4	0.490	18.5	16.7	14.7	0.181
Type of sport activity [2]				0.008				0.524
Individual	8.7	8.3	13.0		13.3	13.6	13.4	
Team	40.9	38.2	33.8		41.3	38.4	33.0	
Individual and collective	38.5	37.8	34.9		24.6	19.7	19.7	
Girls	**2002 (n=881)**	**2006 (n=589)**	**2010 (n=620)**	***p***	**2002 (n=676)**	**2006 (n=709)**	**2010 (n=944)**	***p***
PA in the last 7 days (M±SD) [1]	3.5±1.9	3.3±1.9	3.4±1.9	0.456	2.7±1.9	2.7±1.7	2.9±1.7	0.056
PA in the last 6 month (%)[2]				0.491				0.745
Did not practice PA	15.7	13.4	14.8		31.8	30.7	32.5	
Practiced PA	84.3	86.6	85.2		68.2	69.3	67.5	
Sports practiced (%)[2]								
Soccer	35.3	31.4	25.8	<0.001	15.7	9.7	16.7	<0.001
Basketball	17.8	16.6	18.7	0.640	9.3	7.2	9.6	0.189
Volleyball	14.0	11.0	10.3	0.069	13.6	9.7	14.5	0.012
Handball	6.1	6.3	8.4	0.191	2.7	3.8	5.8	0.006
Swim	25.0	21.2	21.0	0.112	13.5	14.8	13.9	0.757

Athletics	12.4	11.0	13.7	0.370	5.8	5.4	7.5	0.155
Gymnastics	36.1	28.4	29.4	0.002	15.4	10.4	9.5	0.001
Cycling	12.8	10.7	10.0	0.195	6.2	6.1	6.1	0.993
Type of sport activity [2]				0.015				0.002
Individual	28.0	26.8	28.4		21.2	21.6	16.3	
Team	17.0	21.1	14.7		19.2	13.7	18.8	
Individual and collective	30.0	23.2	25.0		11.4	8.5	12.0	

PA, physical activity
[1] Tested by ANOVA.
[2] Tested by Chi Square.
[a] Data from 2002 is statically different from 2006 and 2010. Tested by Tukey's HSD.

Table 3 presents PA information from 2 different cohorts, 4 years apart. Among boys, PA practices during the last 7 days decreased from 4.2±2.1 to 3.9±.1.9 between 2002 and 2006 (p<0.001) and decreased 4.4±2.1 to 3.8±1.9 between 2006 and 2010 (p<0.001). The prevalence of PA practiced over the last 6 month also declined significantly in both cohorts (p<0.001). Looking at the different sports activities, the number of practitioners decreased over the years in almost all activities. It is noteworthy that only volleyball from 2002 to 2006 and swimming from 2006 to 2010 remained relatively stable. In both cohorts, as age increased the number of participants of team sports activities declined, and, in contrast, participants of individual activities significantly increased (p<0.001).

Among girls, PA practices during the last 7 days declined significantly from 3.5±1.9 to 2.7±1.7 between 2002 and 2006 (p<0.001), and from 3.3±1.9 to 2.9±1.7 between 2006 and 2010 (p<0.001). Similar to what was observed among boys, the prevalence of PA over the last 6 months decreased in both cohorts (p<0.001). The practice of PA decreased significantly in all sports activities from 2002 to 2006. Data from 2006 and 2010 shows that the practice of PA also declined, with the exception of handball which remained stable and volleyball which, in contrast to other sports, had a marginally significant increase (p=0.052). Girls team and individual sports participation decreased between 2002 and 2006 (p<0.001) and between 2006 and 2010 (p<0.01).

Table 3. Boys' and girls' physical activity participation over the years.

Boys	2002 11-13 years (n=865)	2006 15-17 years (n=575)	*p*	2006 11-13 years (n=686)	2010 15-17 years (n=715)	*p*
PA in the last 7 days (M±SD [1]	4.2±2.1	3.9±1.9	0.001	4.4±2.1	3.8±1.9	<0.001
PA in the last 6 month (%) [2]			<0.001			<0.001
Did not practice PA	5.4	12.6		5.5	18.0	
Practiced PA	94.6	87.4		94.5	82.0	
Sports practiced (%) [2]						
Soccer	72.6	51.1	<0.001	69.8	45.1	<0.001
Basketball	22.1	13.9	<0.001	26.4	14.0	<0.001
Volleyball	8.6	8.6	0.082	12.4	9.1	0.010
Handball	9.7	6.9	0.104	11.8	7.2	0.002
Swimming	18.0	13.6	0.029	15.3	15.2	0.941
Athletics	12.7	7.8	0.002	13.8	9.3	0.007
Gymnastics	17.5	4.7	<0.001	17.1	7.1	<0.001
Cycling	22.7	17.0	0.006	24.2	14.8	<0.001
Type of sport activity [2]			<0.001			<0.001
Individual	8.7	13.6		8.3	13.4	
Team	40.9	38.4		38.2	33.0	
Individual and collective	38.5	19.7		37.8	19.7	

Girls	2002 11-13 years (n=881)	2006 15-17 years (n=709)	*p*	2006 11-13 years (n=589)	2010 15-17 years (n=944)	*p*
PA in the last 7 days (M±SD) [1]	3.5±1.9	2.7±1.7	<0.001	3.3±1.9	2.9±1.7	<0.001
PA in the last 6 month (%) [2]			<0.001			<0.001
Did not practice PA	15.7	30.1		13.4	32.1	
Practiced PA	84.3	69.9		86.6	67.9	
Sports practiced (%) [2]						
Soccer	35.3	11.1	<0.001	31.4	16.6	<0.001
Basketball	17.8	7.5	<0.001	16.6	9.7	<0.001
Volleyball	14.0	10.0	0.011	11.0	14.5	0.052
Handball	6.1	3.7	0.039	6.3	5.9	0.741
Swimming	25.0	14.8	<0.001	21.2	13.7	<0.001
Athletics	12.4	5.2	<0.001	11.0	7.4	0.021
Gymnastics	36.1	11.1	<0.001	28.4	10.0	<0.001
Cycling	12.8	6.1	<0.001	10.7	6.1	0.002
Type of sport activity [2]			<0.001			0.004
Individual	28.0	21.6		26.8	16.3	
Team	17.0	13.7		21.1	18.8	
Individual and collective	30.0	8.5		23.2	12.0	

[1] Tested by t Test.
[2] Tested by Chi Square.

DISCUSSION

This is the first study among Portuguese adolescents to explore the PA and sport participation of different cohorts, collecting data through the same standard protocol. The goal of the study was, using three-cohort of representative samples of Portuguese adolescents, to investigate the prevalence of PA and sport participation among Portuguese adolescents, and understand how it changed between 2002 and 2010. Overall, the study points to age as a

factor related to diminished PA participation. The study also revealed that the prevalence of PA and sport participation have decreased over the years for the same age groups.

Younger and older adolescents reported practicing PA less than 7 times a week. Although it was not assessed the duration and intensity of PA, results indicated that adolescents do not get enough practiced to meet the recommended levels of 60 minutes of moderate to vigorous PA each day.[5] This is in line with other recent studies among Portuguese people that described the prevalence of PA.[8, 12] Because our data is from different HBSC waves, it was possible to observe the evolution of PA in each age group over the 2002-2010 time frames. With the exception of boys aged 15-17, there were no significant changes over the years in regard to PA practiced during the last 7 days. Moreover, there was a decrease in the prevalence of PA over the last 6 months, especially among boys. These results can be interpreted in several different ways. First, strategies to increase the number of times that adolescents practice PA have not been successful. Second, adolescents and adults may not be aware of the recommended levels of PA for young people. Consequently they might assume that they are active enough and therefore may conclude that there is no need to be more physically active.[20] Third, schools, even though called to give greater attention to provision of PA for students,[21] seem to have failed at promoting PA. Results indicate that there has been no progress made toward attaining this goal.

Adolescent behaviour, such as PA and inactivity over the years, is an issue rarely studied in Portugal. This type of study is important and should be of interest on a national and international level because it helps policy makers, educators and health professionals to understand young people's health in their social context and tracks changes as they develop over the years. Therefore, with data from successive surveys, trends can be identified making it possible to evaluate more accurately the impact of programs and strategies implemented in order to promote PA and reduce sedentary behaviour among adolescents. While the HBSC

conducts national[13-15] and international systematic surveys,[6, 16] in the United States of America, the Center for Disease Control and Prevention also conducts a periodic survey of adolescent health risk and health protective behaviours.[22] This shows the importance of studying and tracking adolescent behaviour and allows cross-national comparisons.

The trend of PA declining with age was significant among boys and girls in the two different cohorts of adolescents (2002 to 2006 and 2006 to 2010). These results are similar to those found in others studies with adolescents from Portugal[23] and other countries.[6, 7] In Europe, the inverse relationship between PA and age is common in most countries.[6] Riddoch et al.[24], in what is considered the first study to objectively measure physical activity with a representative sample of European children, verified that 9 year old children were considerably more active than 15 year old adolescents, presenting similar results in all countries. Virtually all 9 year old children practiced the recommended amount of PA, or more than recommended, while only a small percentage of 15 year olds did so. This indicated that as age increased PA decreased.

The decline of PA with age has triggered much discussion in the scientific community. Sallis[25] analysed various studies related to the decline of PA, and concluded that the ages between 13 and 18 are at risk. Having also observed the decline in animals, the author was lead to suppose that the decline had a biological origin. The consistency of the results of the Riddoch et al.[24] among adolescents from different countries is in some way congruent with Sallis'[25] assumptions, allowing one to conclude that children's and adolescents' PA is probably determined biologically. However, although the effect of age is significant on PA, it sometimes only explained 1% of the variability[26] which means that the decline in PA with age could be related to other factors such as the great academic pressure adolescents are under,[27] longer time in sedentary activities such as screen time [28], and having part-time

jobs to earn some money.[29] Therefore, qualitative studies to understand clearly the reasons for the decrease in PA among adolescents are needed.

Soccer was the most practiced sports activity among boys and older girls over the years and at different ages. This is understandable since it is the most popular sports activity in Portugal and it is the activity with the most participants.[30, 31] Nevertheless, the number of participants decreased over the years within both age-groups. As the number of participants in others sports activities did not increase significantly, this suggests that the decrease of soccer participants might be related to the prevalence of adolescents who did not practice PA over the last 6 month. This shows the importance of soccer as a sports activity among Portuguese adolescents. Thus, when considering an intervention aimed to increase PA, soccer should be considered as an activity that attracts adolescents.

The type of activity practiced by boys has the tendency to change over the years. While the number of team sports participants decreased between 11-13 and 15-17 years, participation in individual sports increased. On the other hand, for the girls, participation in both individual and team sports decreased with age. The reason for the choice of individual or team sports may be related to social factors, and some could argue that team sports would be better for the development of social skills. However, studies have shown that there is no difference in social self-esteem between participants in individual or team sports.[32, 33] For the older boys the increased participation in individual sports may be related to their level of autonomy.

The present study had some limitations. Measurements of PA were based on self-report. Self-report generally has limited reliability and validity.[34] So, the use of accurate objective measures is preferable, but it is not often feasible in epidemiological studies with large samples. Moreover, the intensity and duration of PA were not measured. These

evaluations would be useful in determining the prevalence of adolescents who attained recommended levels of PA.

There are also several strengths in the present study. First, data from a representative sample was collected. Second, data from three different cohorts was collected (2002, 2006 and 2010), using a standard protocol, which allows for comparisons and for understanding of the differences of PA over the years in two different age groups of boys and girls.

CONCLUSION

The prevalence of physical inactivity increased significantly among boys between ages 11-13 and 15-17, but not in girls. The number of times adolescents practiced PA during the last 7 days remained relatively stable, which means that the campaigns and attempts to increase PA among adolescents have not been very successful. With age, there was a significant decrease in most sports activities among boys and girls. This indicated that as adolescents are getting older they may have different interests leading some to stop practicing PA. These findings imply that it is important to more effectively promote PA among adolescents, using different strategies based on age and sex.

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Contributorship Statement

AM and MGM contributed in conception and design. MGM contributed in acquisition of the data. AM and MGM contributed in analysis and interpretation of the data. AM contributed to the drafting of the manuscript. AM and MGM contributed to the revisions of the manuscript and the interpretation of the findings.

Competing interests

The authors declare that they have no competing interests.

Data Sharing Statement

No additional data available

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Title page

Adolescents' physical activity trends over the years. A three-cohort study based on the Health Behaviour in School-aged Children (HBSC) Portuguese survey

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Abstract

Objective: Many young people do not practice enough physical activity (PA) to benefit their health. The study aimed to investigate the prevalence of PA and understand the trends between 2002 and 2010, using three-cohort of representative samples of Portuguese adolescents.

Design, setting and participants: Participants were 8483 adolescents (4067 boys, 4416 girls), that participated in the Health Behavior in School-aged Children Portuguese survey in 2002, 2006 and 2010.

Design, setting and participants: A questionnaire was used to collected data of physical activity. Analyses were run separately for boys and girls.

Results: For the boys, at the age of 15-17 they reported practicing 3.5±1.9 times a week in 2002, 3.9±1.9 in 2006 and 3.8±1.9 in 2010, with a significant increase from 2002 to 2006/2010 (p<0.05). PA practice during the last 7 days decreased from 4.2±2.1 to 3.9+.1.9 between 2002 and 2006 (p<0.001) and decreased 4.4±2.1 to 3.8±1.9 between 2006 and 2010 (p<0.001). Among girls, PA practices during the last 7 days declined significantly from 3.5±1.9 to 2.7±1.7 between 2002 and 2006 (p<0.001), and from 3.3±1.9 to 2.9±1.7 between 2006 and 2010 (p<0.001).

Conclusions: The study points to age as a factor related to diminished PA participation. The study also revealed that the prevalence of PA has decreased over the years for the same age groups.

Strengths and limitations of this study

– Data from a representative sample was collected from three different cohorts (2002, 2006 and 2010), using a standard protocol, which allows for comparisons and for

understanding of the differences of PA over the years in two different age groups of boys and girls.

– Measurements of PA were based on self-report. Self-report generally has limited reliability and validity. So, the use of accurate objective measures is preferable, but it is not often feasible in epidemiological studies with large samples.

– Boys and girls do not practice enough physical activity to meet the recommended levels of 60 minutes in moderate to vigorous intensity on all or most days of the week. From a public health perspective there is a need to augment the time spent on physical activity.

– Soccer is the most practiced sports activity among boys and older girls. Thus, when considering an intervention aimed to increase PA, soccer should be considered as an activity that attracts adolescents.

INTRODUCTION

Young people's participation in physical activity (PA) is associated with health benefits, specifically improved bone mineral density, aerobic fitness, muscular strength, endurance, cardiovascular risk factor and mental health.[1] There is also a negative relationship between PA and careless nutrition, overweight and obesity among young people.[2, 3] Additionally, PA incorporated as a personal habit at a young age may persist into adulthood.[4] Thus, current guidelines from the World Health Organization (WHO) recommend that young people should engage in at least 60 minutes of PA in moderate to vigorous (MVPA) intensity on all or most days of the week.[5]

In spite of the health benefits, data suggests that many young people are not engaging in PA of sufficient length and intensity to benefit their health.[6, 7] The Portuguese figures are quite dramatic, revealing that only 36% of children aged 10-11 and 4% of adolescents aged 16-17 were considered sufficiently active.[8] Besides the lower levels of PA, the prevalence of active children and adolescents tended to decrease with age, particularly among girls.

In order to intervene and reverse this situation, it is important to understand the trends of PA over the years as well as the PA practices of adolescents. Nonetheless, because most adolescents do not commute actively to school, do not spend much time on PA and spend excessive time in sedentary behaviours[9], it is important to highlight sport participation. Studies have shown that sport participation contributes to adolescent attained PA guidelines,[10] and there is evidence that adolescents who participated in sports are more persistent exercisers than non-participants[11]. ~~Nevertheless, m~~Most studies related to PA and sports participation are cross sectional[8, 9, 12] and results can only be interpreted in the light of the period in which they were collected. Since little is known about the PA and sport participation ~~practices~~ of adolescents and how they have evolved over the years, studies that

allow researchers to compare patterns and practices of PA and sport participation are needed. Therefore, the present study, using three-cohort of representative samples of Portuguese adolescents, aimed to investigate the prevalence of PA and sport participation among Portuguese adolescents and understand how it has changed between 2002 and 2010.

METHODS

Participants

A proportionate nationally representative sample of 8483~~5~~ adolescents (4067 boys, 4416 girls), randomly selected from grades 6 and 10 participated in the Health Behaviour in School-aged Children (HBSC) Portuguese survey in 2002 (n=3023), 2006 (n=2556), and 2010 (n=2904).[13-15] HBSC Portugal is one of 43 countries and regions across Europe and North America that make up the HBSC Network. HBSC collects data every four years on children's and adolescent's health and well-being, social environments and health behaviors. Data is used at a national and international level to add new vision into young people's health and well-being, understand the social and psychological determinants of health, and incorporate policies to improve young people's lives. The methodological aspects of the HBSC study are well developed and published internationally.[16] The study received approval from the Ethical Committee of Porto Medical School and the Portuguese National Data Protection System. All school administrators gave their consent, legal guardians gave written informed consent, and students provided assent.

Measures

For data collection was used a questionnaire that was designed by the international HBSC members and is described in detail elsewhere.[16, 17] To assess PA, adolescents were provided with a common definition of PA,[18] and then were asked "How many days did you practice PA during the last 7 days?" Answers were given on an 8-point scale (1 = none to 8 =

daily). Seven days of PA recall is shown to be reliable and valid for use in research on PA in adolescents.[19] Adolescents were also asked if they practiced regular PA during the last 6 months. Answers were yes (≥ 3 times a weeks) or no (<3 times a week). The item has a high reliability, with intraclass correlation coefficients (one-week interval) of 0.95. Adolescents were then asked about the sports activity they usually practiced in organized or non-organized contexts.

Procedures

Questionnaires were administered in schools in January 2002, 2006 and 2010, and were answered anonymously. Participation in the study was voluntary. The administration of the surveys was conducted according to standard guidelines from the HBSC survey protocol[16] and it was carried out by trained school teachers during class time.

Analysis

Adolescents were grouped into two age groups (11-13 and 15-17). Descriptive statistics were calculated for all variables (means, standard deviation and percentages) for the entire sample and according to HBSC survey years (2002, 2006, and 2010), age group, and sex. ANOVA and chi-square were used to assess the differences among HBSC survey years in each age group. Independent t-tests and chi-square were used to compare adolescents from different cohorts. All statistical analyses were performed using IBM SPSS Statistics 20.0. The level of significance was set at 0.05.

RESULTS

Sample characteristics and displayed in table 1.

Table 1. Characteristics of participants.

		Cohorts		
	Total	2002	2006	2010

	n	%	n	%	n	%	n	%
Sex								
Boys	4067	47.9	1466	48.5	1261	49.3	1340	46.1
Girls	4416	52.1	1557	51.5	1298	50.7	15614	53.9
Age								
11-13	4266	50.3	1746	57.8	1275	49.8	1245	42.9
15-17	421720	49.7	1277	42.2	1284	50.2	16569	57.1
School grade								
Sixth grade	4348	51.32	1809	59.8	1275	49.8	1264	43.5
Tenth grade	41358	48.78	1214	40.2	1284	50.2	163740	56.5

Descriptive statistics and the differences among HBSC survey years for each age group and sex are presented in table 2.

For the boys aged 11-13, the number of times they reported practicing PA during the last 7 days was between 4.2±2.1 to 4.4±2.1 times. At the age of 15-17 they reported practicing 3.5±1.9 times a week in 2002, 3.9±1.9 in 2006 and 3.8±1.9 in 2010, with a significant increase from 2002 to 2006/2010 ($p<0.05$). In both age groups the prevalence of PA over the last 6 months decreased slightly between 2006 and 2010, but decreased significantly between 2006 and 2010 ($p<0.05$ and $p<0.01$). Soccer was the most practiced sports activity, but over the years there was a significant decline in the number of participants ($p<0.001$ for both age-groups). On the other hand, gymnastics participation decreased from 2002 to 2006 and then increased from 2006 to 2010, reaching the higher value in 2010 for the ages of 11-13 ($p<0.05$) and 15-17 years ($p<0.05$). The type of PA practiced changed over the years for the younger participants, decreasing the number of team sports participants and increasing participation in individual sports ($p<0.01$). Boys, younger and older, preferred team sports activities more than individual activities. However, over the years, young boys participation in team sports decreased progressively from 2002 to 2010 ($p<0.01$).

Girls reported practicing PA between 3.3±1.9 to 3.5±1.9 at the age of 11-13, and 2.7±1.9 to 2.9±1.7 at the age of 15-17. Soccer, gymnastics, and swimming were the most popular sports activities. Over the years, the number of soccer practitioners significantly decreased among younger girls ($p<0.001$). For the older girls, the number of participants

decreased significantly from 2002 to 2006 and then increased significantly from 2006 to 2010 (p<0.001). In respect to gymnastics, the number of participants decreased significantly from 2002 to 2006/2010 for both younger (p<0.01) and older girls (p<0.01). The number of older girls that practiced volleyball was inconsistent, decreasing significantly from 2002 to 2006 and increasing significantly again from 2006 to 2010 (p<0.05). Girls aged 11-13, preferred individual sports activities rather than team sports activities over the years (p<0.05). On the other hand, among older girls, participants in individual sports activities decreased significantly from 2006 to 2010 (p<0.01).

Table 2. Boys' and girls' physical activity participation in 2002, 2006 and 2010, according age group.

	11-13 years				15-17 years			
Boys	**2002 (n=865)**	**2006 (n=686)**	**2010 (n=625)**	***p***	**2002 (n=601)**	**2006 (n=575)**	**2010 (n=715)**	***p***
PA in the last 7 days (M±SD) [1]	4.2±2.1	4.4±2.1	4.3±2.1	0.243	3.5±1.9	3.9±1.9	3.8±1.9	0.019[a]
PA in the last 6 month (%) [2]				0.012				0.001
Did not practice PA	5.4	5.5	9.0		11.1	12.9	18.0	
Practiced PA	94.6	94.5	91.0		88.9	87.1	82.0	
Sports practiced (%) [2]								
Soccer	72.6	69.8	60.8	<0.001	57.1	50.1	44.3	<0.001
Basketball	22.1	26.4	22.4	0.102	16.6	12.7	13.7	0.130
Volleyball	8.6	12.4	10.6	0.089	9.2	7.8	8.1	0.683
Handball	9.7	11.8	11.2	0.388	8.3	7.1	7.0	0.619
Swimming	18.0	15.3	17.3	0.352	15.8	13.6	15.5	0.500
Athletics	12.7	13.8	13.1	0.806	8.2	7.7	9.2	0.575
Gymnastics	17.5	17.1	22.2	0.027	7.0	3.8	6.7	0.038
Cycling	22.7	24.2	21.4	0.490	18.5	16.7	14.7	0.181
Type of sport activity [2]				0.008				0.524
Individual	8.7	8.3	13.0		13.3	13.6	13.4	
Team	40.9	38.2	33.8		41.3	38.4	33.0	
Individual and collective	38.5	37.8	34.9		24.6	19.7	19.7	
Girls	**2002 (n=881)**	**2006 (n=589)**	**2010 (n=620)**	***p***	**2002 (n=676)**	**2006 (n=709)**	**2010 (n=944)**	***p***
PA in the last 7 days (M±SD) [1]	3.5±1.9	3.3±1.9	3.4±1.9	0.456	2.7±1.9	2.7±1.7	2.9±1.7	0.056
PA in the last 6 month (%)[2]				0.491				0.745
Did not practice PA	15.7	13.4	14.8		31.8	30.7	32.5	
Practiced PA	84.3	86.6	85.2		68.2	69.3	67.5	
Sports practiced (%)[2]								
Soccer	35.3	31.4	25.8	<0.001	15.7	9.7	16.7	<0.001
Basketball	17.8	16.6	18.7	0.640	9.3	7.2	9.6	0.189
Volleyball	14.0	11.0	10.3	0.069	13.6	9.7	14.5	0.012
Handball	6.1	6.3	8.4	0.191	2.7	3.8	5.8	0.006
Swim	25.0	21.2	21.0	0.112	13.5	14.8	13.9	0.757

Athletics	12.4	11.0	13.7	0.370	5.8	5.4	7.5	0.155
Gymnastics	36.1	28.4	29.4	0.002	15.4	10.4	9.5	0.001
Cycling	12.8	10.7	10.0	0.195	6.2	6.1	6.1	0.993
Type of sport activity [2]				0.015				0.002
Individual	28.0	26.8	28.4		21.2	21.6	16.3	
Team	17.0	21.1	14.7		19.2	13.7	18.8	
Individual and collective	30.0	23.2	25.0		11.4	8.5	12.0	

PA, physical activity
[1] Tested by ANOVA.
[2] Tested by Chi Square.
[a] Data from 2002 is statically different from 2006 and 2010. Tested by Tukey's HSD.

Table 3 presents PA information from 2 different cohorts, 4 years apart. Among boys, PA practices during the last 7 days decreased from 4.2±2.1 to 3.9±.1.9 between 2002 and 2006 (p<0.001) and decreased 4.4±2.1 to 3.8±1.9 between 2006 and 2010 (p<0.001). The prevalence of PA practiced over the last 6 month also declined significantly in both cohorts (p<0.001). Looking at the different sports activities, the number of practitioners decreased over the years in almost all activities. It is noteworthy that only volleyball from 2002 to 2006 and swimming from 2006 to 2010 remained relatively stable. In both cohorts, as age increased the number of participants of team sports activities declined, and, in contrast, participants of individual activities significantly increased (p<0.001).

Among girls, PA practices during the last 7 days declined significantly from 3.5±1.9 to 2.7±1.7 between 2002 and 2006 (p<0.001), and from 3.3±1.9 to 2.9±1.7 between 2006 and 2010 (p<0.001). Similar to what was observed among boys, the prevalence of PA over the last 6 months decreased in both cohorts (p<0.001). The practice of PA decreased significantly in all sports activities from 2002 to 2006. Data from 2006 and 2010 shows that the practice of PA also declined, with the exception of handball which remained stable and volleyball which, in contrast to other sports, had a marginally significant increase (p=0.052). Girls team and individual sports participation decreased between 2002 and 2006 (p<0.001) and between 2006 and 2010 (p<0.01).

Table 3. Boys' and girls' physical activity participation over the years.

Boys	2002 11-13 years (n=865)	2006 15-17 years (n=575)	*p*	2006 11-13 years (n=686)	2010 15-17 years (n=715)	*p*
PA in the last 7 days (M±SD [1]	4.2±2.1	3.9±1.9	0.001	4.4±2.1	3.8±1.9	<0.001
PA in the last 6 month (%) [2]			<0.001			<0.001
Did not practice PA	5.4	12.6		5.5	18.0	
Practiced PA	94.6	87.4		94.5	82.0	
Sports practiced (%) [2]						
Soccer	72.6	51.1	<0.001	69.8	45.1	<0.001
Basketball	22.1	13.9	<0.001	26.4	14.0	<0.001
Volleyball	8.6	8.6	0.082	12.4	9.1	0.010
Handball	9.7	6.9	0.104	11.8	7.2	0.002
Swimming	18.0	13.6	0.029	15.3	15.2	0.941
Athletics	12.7	7.8	0.002	13.8	9.3	0.007
Gymnastics	17.5	4.7	<0.001	17.1	7.1	<0.001
Cycling	22.7	17.0	0.006	24.2	14.8	<0.001
Type of sport activity [2]			<0.001			<0.001
Individual	8.7	13.6		8.3	13.4	
Team	40.9	38.4		38.2	33.0	
Individual and collective	38.5	19.7		37.8	19.7	

Girls	2002 11-13 years (n=881)	2006 15-17 years (n=709)	*p*	2006 11-13 years (n=589)	2010 15-17 years (n=944)	*p*
PA in the last 7 days (M±SD) [1]	3.5±1.9	2.7±1.7	<0.001	3.3±1.9	2.9±1.7	<0.001
PA in the last 6 month (%) [2]			<0.001			<0.001
Did not practice PA	15.7	30.1		13.4	32.1	
Practiced PA	84.3	69.9		86.6	67.9	
Sports practiced (%) [2]						
Soccer	35.3	11.1	<0.001	31.4	16.6	<0.001
Basketball	17.8	7.5	<0.001	16.6	9.7	<0.001
Volleyball	14.0	10.0	0.011	11.0	14.5	0.052
Handball	6.1	3.7	0.039	6.3	5.9	0.741
Swimming	25.0	14.8	<0.001	21.2	13.7	<0.001
Athletics	12.4	5.2	<0.001	11.0	7.4	0.021
Gymnastics	36.1	11.1	<0.001	28.4	10.0	<0.001
Cycling	12.8	6.1	<0.001	10.7	6.1	0.002
Type of sport activity [2]			<0.001			0.004
Individual	28.0	21.6		26.8	16.3	
Team	17.0	13.7		21.1	18.8	
Individual and collective	30.0	8.5		23.2	12.0	

[1] Tested by t Test.
[2] Tested by Chi Square.

DISCUSSION

This is the first study among Portuguese adolescents to explore the PA and sport participation ~~practices~~ of different cohorts, collecting data through the same standard protocol. The goal of the study was, using three-cohort of representative samples of Portuguese adolescents, to investigate the prevalence of PA and sport participation among Portuguese adolescents, and understand how it changed between 2002 and 2010. Overall, the

study points to age as a factor related to diminished PA participation. The study also revealed that the prevalence of PA and sport participation haves decreased over the years for the same age groups.

Younger and older adolescents reported practicing PA less than 7 times a week. Although it was not assessed the duration and intensity of PA, results indicated that adolescents do not get enough practiced to meet the recommended levels of 60 minutes of moderate to vigorous PA each day.[5] This is in line with other recent studies among Portuguese people that described the prevalence of PA.[8, 12] Because our data is from different HBSC waves, it was possible to observe the evolution of PA in each age group over the 2002-2010 time frames. With the exception of boys aged 15-17, there were no significant changes over the years in regard to PA practiced during the last 7 days. Moreover, there was a decrease in the prevalence of PA over the last 6 months, especially among boys. These results can be interpreted in several different ways. First, strategies to increase the number of times that adolescents practice PA have not been successful. Second, adolescents and adults may not be aware of the recommended levels of PA for young people. Consequently they might assume that they are active enough and therefore may conclude that there is no need to be more physically active.[20] Third, schools, even though called to give greater attention to provision of PA for students,[21] seem to have failed at promoting PA. Results indicate that there has been no progress made toward attaining this goal.

Adolescent behaviorbehaviour, such as PA and inactivity over the years, is an issue rarely studied in Portugal. This type of study is important and should be of interest on a national and international level because it helps policy makers, educators and health professionals to understand young people's health in their social context and tracks changes as they develop over the years. Therefore, with data from successive surveys, trends can be identified making it possible to evaluate more accurately the impact of programs and

strategies implemented in order to promote PA and reduce sedentary ~~behavior~~behaviour among adolescents. While the HBSC conducts national[13-15] and international systematic surveys,[6, 16] in the United States of America, the Center for Disease Control and Prevention also conducts a periodic survey of adolescent health risk and health protective ~~behaviors~~behaviours.[22] This shows the importance of studying and tracking adolescent ~~behavior~~behaviour and allows cross-national comparisons.

The trend of PA declining with age was significant among boys and girls in the two different cohorts of adolescents (2002 to 2006 and 2006 to 2010). These results are similar to those found in others studies with adolescents from Portugal[23] and other countries.[6, 7] In Europe, the inverse relationship between PA and age is common in most countries.[6] Riddoch et al.[24], in what is considered the first study to objectively measure physical activity with a representative sample of European children, verified that 9 year old children were considerably more active than 15 year old adolescents, presenting similar results in all countries. Virtually all 9 year old children practiced the recommended amount of PA, or more than recommended, while only a small percentage of 15 year olds did so. This indicated that as age increased PA decreased.

The decline of PA with age has triggered much discussion in the scientific community. Sallis[25] ~~analyzed~~analysed various studies related to the decline of PA, and concluded that the ages between 13 and 18 are at risk. Having also observed the decline in animals, the author was lead to suppose that the decline had a biological origin. The consistency of the results of the Riddoch et al.[24] among adolescents from different countries is in some way congruent with Sallis'[25] assumptions, allowing one to conclude that children's and adolescents' PA is probably determined biologically. However, although the effect of age is significant on PA, it sometimes only explained 1% of the variability[26] which means that the decline in PA with age could be related to other factors such as the great academic pressure

adolescents are under,[27] longer time in sedentary activities such as screen time [28], and having part-time jobs to earn some money.[29] Therefore, qualitative studies to understand clearly the reasons for the decrease in PA among adolescents are needed.

Soccer was the most practiced sports activity among boys and older girls over the years and at different ages. This is understandable since it is the most popular sports activity in Portugal and it is the activity with the most participants.[30, 31] Nevertheless, the number of participants decreased over the years within both age-groups. As the number of participants in others sports activities did not increase significantly, this suggests that the decrease of soccer participants might be related to the prevalence of adolescents who did not practice PA over the last 6 month. This shows the importance of soccer as a sports activity among Portuguese adolescents. Thus, when considering an intervention aimed to increase PA, soccer should be considered as an activity that attracts adolescents.

The type of activity practiced by boys has the tendency to change over the years. While the number of team sports participants decreased between 11-13 and 15-17 years, participation in individual sports increased. On the other hand, for the girls, participation in both individual and team sports decreased with age. The reason for the choice of individual or team sports may be related to social factors, and some could argue that team sports would be better for the development of social skills. However, studies have shown that there is no difference in social self-esteem between participants in individual or team sports.[32, 33] For the older boys the increased participation in individual sports may be related to their level of autonomy.

The present study had some limitations. Measurements of PA were based on self-report. Self-report generally has limited reliability and validity.[34] So, the use of accurate objective measures is preferable, but it is not often feasible in epidemiological studies with large samples. Moreover, the intensity and duration of PA ~~sessions~~ were not measured. These

evaluations would be useful in determining the prevalence of adolescents who attained recommended levels of PA.

There are also several strengths in the present study. First, data from a representative sample was collected. Second, data from three different cohorts was collected (2002, 2006 and 2010), using a standard protocol, which allows for comparisons and for understanding of the differences of PA over the years in two different age groups of boys and girls.

CONCLUSION

The prevalence of physical inactivity increased significantly among boys between ages 11-13 and 15-17, but not in girls. The number of times adolescents practiced PA during the last 7 days remained relatively stable, which means that the campaigns and attempts to increase PA among adolescents have not been very successful. With age, there was a significant decrease in most sports activities among boys and girls. This indicated that as adolescents are getting older they may have different interests leading some to stop practicing PA. These findings imply that it is important to more effectively promote PA among adolescents, using different strategies based on age and sex.

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Competing interests

The authors declare that they have no competing interests.

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Research checklists

	Item No	Recommendation
Title and abstract	1	Indicate the study's design with a commonly used term in the title or the abstract. Provide in the abstract an informative and balanced summary of what was done and what was found.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported.
Objectives	3	State specific objectives.
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	Give the sources and methods of selection of participants.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers.
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement).
Bias	9	Describe any efforts to address potential sources of bias
Quantitative variables	10	Explain how quantitative variables were handled in the analyses.
Statistical methods	11	Describe all statistical methods
Results		
Participants	12	Report numbers of individuals at each stage of study.
Descriptive data	13	Give characteristics of study participants.
Outcome data	14	Report numbers of outcome events or summary measures over time
Main results	15	Give estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
Other analyses	16	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	17	Summarise key results with reference to study objectives.
Limitations	18	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.
Interpretation	19	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.
Generalisability	20	Discuss the generalisability of the study results.
Other information		
Funding	21	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based